Aviation Week & Space Technology

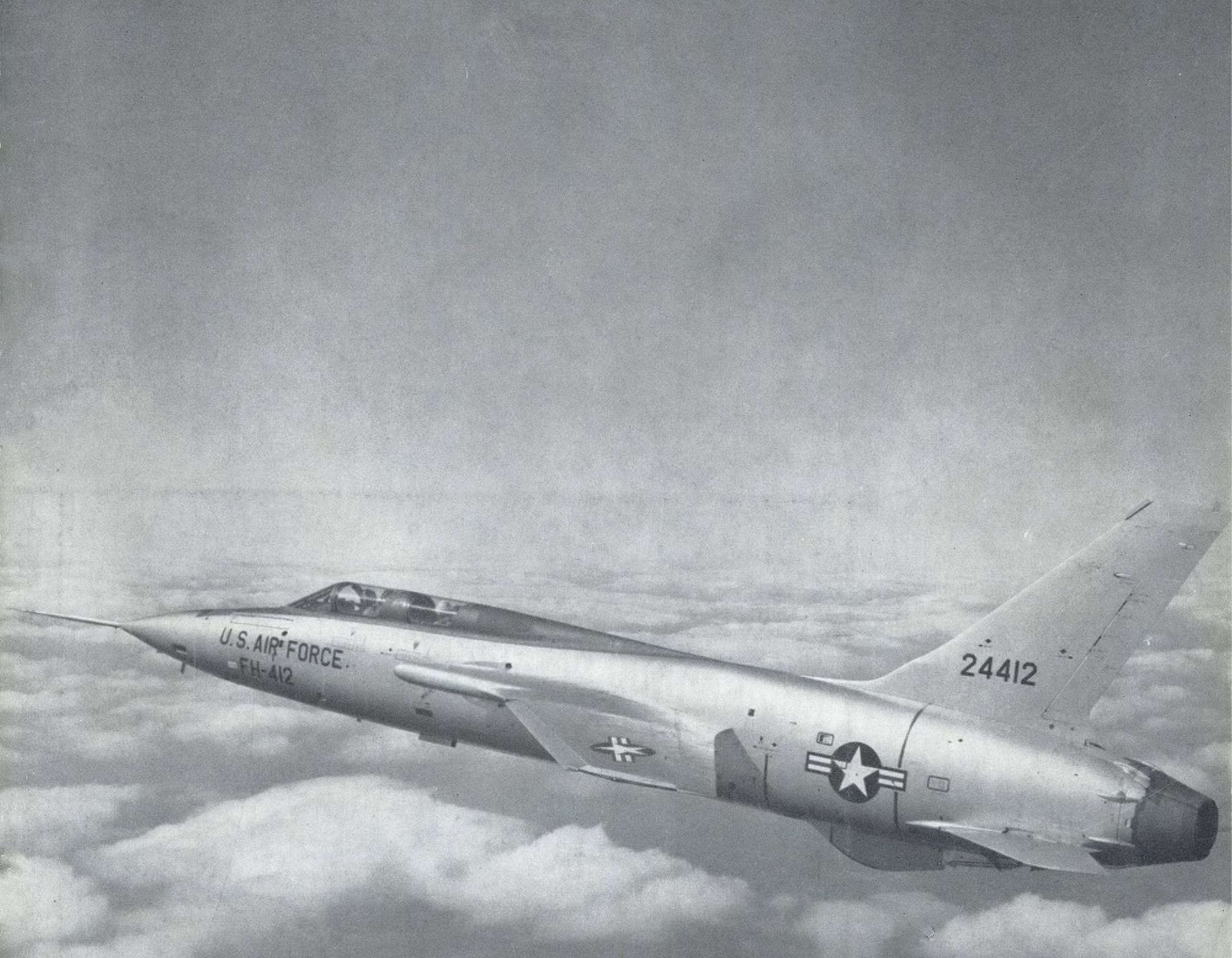
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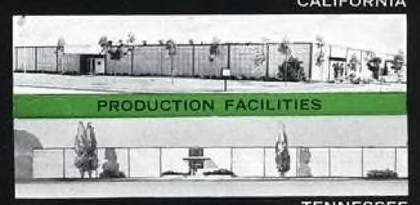
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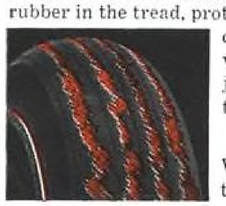
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AEROSPACE CALENDAR

Sept. 16-18—International Aviation Research and Development Symposium, Atlantic City, N. J. Sponsor: FAA.
Sept. 18-19—1963 Airwork Operations and Maintenance Symposium, Millville, N. J.
Sept. 19-20—Third Annual Conference on Environmental Effects on Aircraft Systems, U. S. Naval Air Turbine Test Station, Trenton, N. J.
Sept. 20-21—11th Annual Conference on Communications (Microelectronics), Institute of Electrical and Electronics Engineers, Hotel Roosevelt, Cedar Rapids.
Sept. 20-29—Ninth Annual Houston International Trade & Travel Fair, Sam Houston Coliseum, Houston, Tex.
Sept. 21—Project Beacon Meeting, Electro-Sonics Hangar, Port Columbus, Columbus, Ohio. Sponsored by FAA and State of Ohio Div. of Aviation in cooperation with the National Aviation Trades Assn.
Sept. 23-25—12th Annual Meeting, Standards Engineers Society, Statler-Hilton Hotel, Washington, D. C.
Sept. 23-25—Symposium on Aeroelastic and Dynamic Modeling Technology, Biltmore-Hilton Hotel, Dayton, Ohio. Sponsors: Air Force Systems Command's Aeronautical Systems Div.; AIA.
Sept. 23-27—National Aeronautic and Space Engineering and Manufacturing Meeting and Display, Society of Automotive Engineers, Ambassador Hotel, Los Angeles.
Sept. 23-27 — International Telemetering

(Continued on page 7)

AVIATION WEEK & Space Technology

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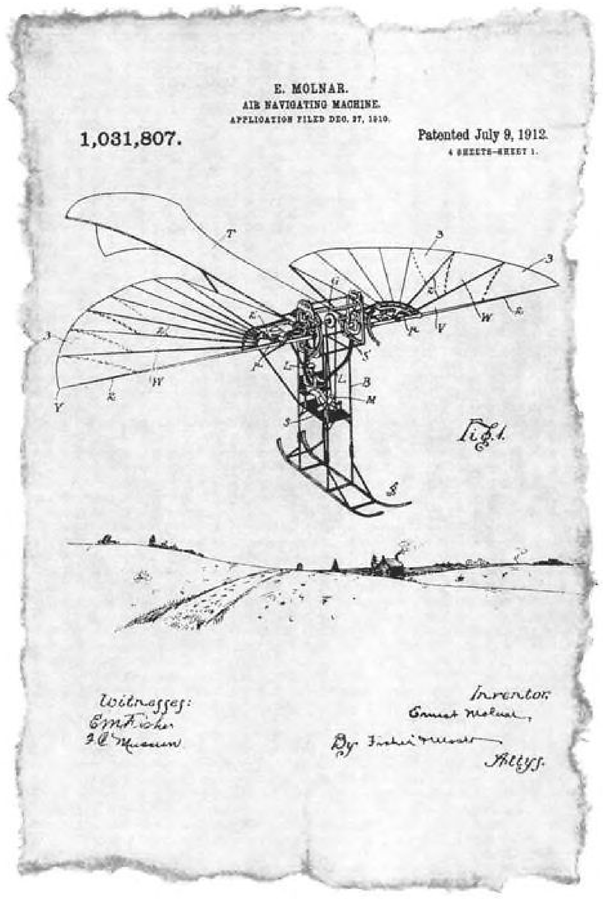
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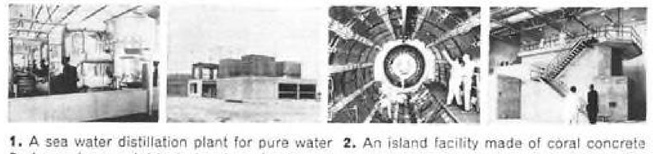
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AEROSPACE CALENDAR

(Continued from page 5)

Conference, Savoy Place, London, England. Sponsors: Institution of Electrical Engineers (London); American Institute of Aeronautics and Astronautics; Institute of Electrical and Electronics Engineers; Instrument Society of America.

Sept. 24-26—16th Annual Convention and Aircraft Show, National Business Aircraft Assn., Shamrock-Hilton Hotel, Houston.

Sept. 25-26—Second Annual Symposium on the Physics of Failure in Electronics, Chicago, Ill. Sponsors: Rome Air Development Center; Armour Research Foundation.

Sept. 25-26—Seminar and Exhibit, American Assn. for Contamination Control, Sheraton-Atlantic Hotel, New York, N.Y.

Sept. 25-Oct. 1—14th Congress, International Astronautical Federation, Paris.

Sept. 27-28—Society of Experimental Test Pilots' Seventh Annual Report to the Aerospace Profession and Awards Banquet, Beverly Hilton Hotel, Beverly Hills.

Sept. 30-Oct. 1—Manned Interplanetary Exploration Meeting, American Institute of Aeronautics and Astronautics, Cabana Motor Hotel, Palo Alto, Calif.

Sept. 30-Oct. 2—Canadian Electronics Conference, Inst. of Electrical and Electronics Engrs., Exhibition Park, Toronto.

Oct. 1-2—Project Mercury Summary Conference, NASA Manned Spacecraft Center, Houston, Tex. (By invitation.)

Oct. 1-3—Eighth National Symposium on Space Electronics, Institute of Electrical and Electronics Engineers, Fontainbleu Hotel, Miami Beach, Fla.

Oct. 1-3—National Aerospace Nuclear Safety Topical Meeting, American Nuclear Society, Albuquerque, N. M. Co-sponsors: Los Alamos Scientific Laboratory; AEC Albuquerque Operations Office; AF Special Weapons Center; AF Directorate of Nuclear Safety; Sandia Corp.; University of New Mexico.

Oct. 1-3—Symposium on Physics and Nondestructive Testing (unclassified), San Antonio, Tex. Sponsored by Southwest Research Institute.

Oct. 1-4—First National Aerospace Nuclear Safety Topical Meeting, American Nuclear Society, Albuquerque, N. M.

Oct. 2-4—National Assn. of Air Traffic Specialists, Sheraton-Oklahoma Hotel, Oklahoma City, Okla.

Oct. 5-20—10th International Aircraft Display, Genoa International Fair, Genoa, Italy.

Oct. 7—Second Annual USAF Contract Aerospace Services Symposium, Dayton Biltmore Hotel, Dayton, Ohio. Sponsor: National AeroSpace Services Assn.

Oct. 7-9—Ninth National Communications Symposium, Institute of Electrical and Electronics Engineers, Hotel Utica, Utica.

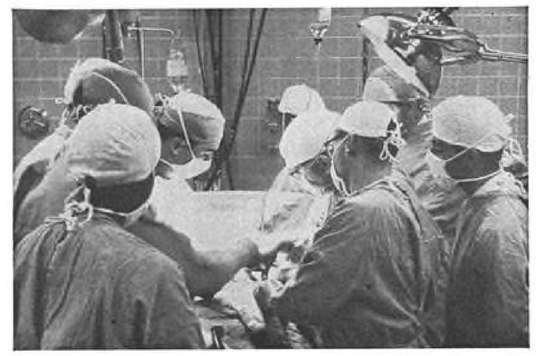
Oct. 7-11—International Air Transport Assn. 19th Annual General Meeting, Rome, Italy.

Oct. 7-14—William Tell 1963, USAF Interceptor Weapons Meet, Tyndall AFB, Fla. Host: Air Defense Command.

Oct. 8-10—10th Annual Air Force Science and Engineering Symposium, Air Force Academy, Colo. Sponsors: Office of Aerospace Research; AFSC.

(Continued on page 9)





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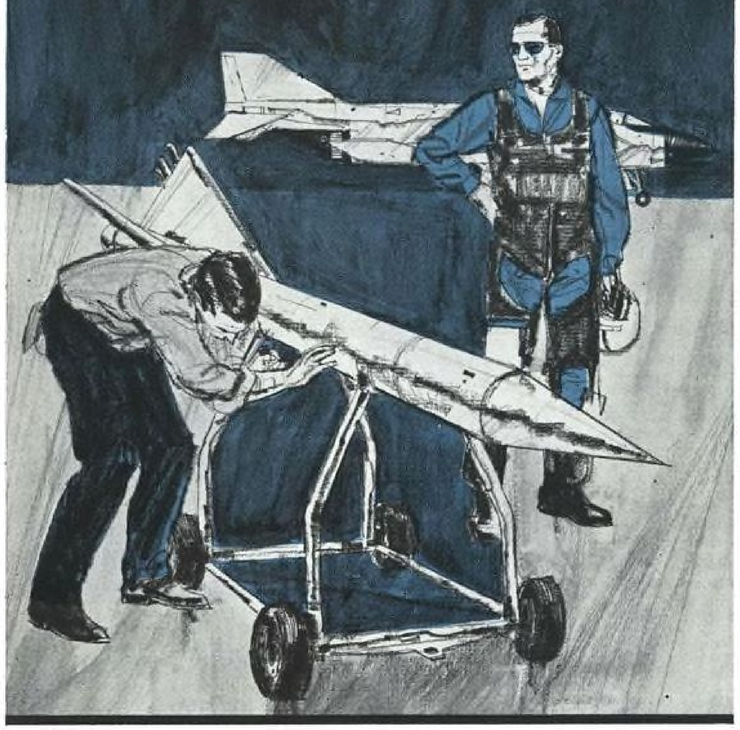
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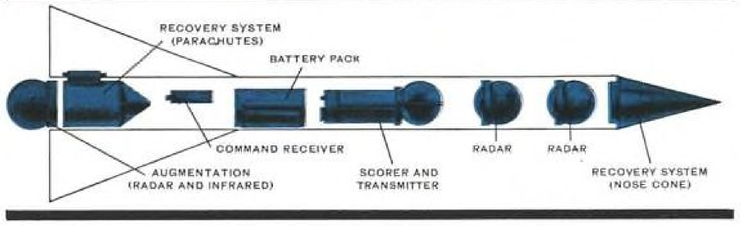
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SPACE CONDITIONING:
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SYSTEMS:
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AEROSPACE CALENDAR

(*Continued from page 7*)

Oct. 8-10—National Airport Conference, Norman, Okla. Sponsors: American Assn. of Airport Executives & University of Oklahoma with the cooperation of the Federal Aviation Agency.

Oct. 9-11—21st Annual Aerospace Electrical/Electronics Conference, Aerospace Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif.

Oct. 12-21—1963 General Conference, Federation Aeronautique Internationale, Mexico City.

Oct. 13-17—16th Annual Meeting and Conference, Airport Operators Council, Roosevelt Hotel, New Orleans, La.

Oct. 14-16—Eighth Annual Exposition and Symposium, Air Traffic Control Assn., Statler Hilton Hotel, Dallas, Tex.

Oct. 15-18—Eighth Symposium on Ballistic Missile and Space Technology, Naval Training Center, San Diego, Calif. Sponsors: AF Space Systems Div.; AF Ballistic Systems Div.; Aerospace Corp.

Oct. 16-18—Tenth National Vacuum Symposium, American Vacuum Society, Statler Hilton Hotel, Boston, Mass.

Oct. 17-18; Oct. 21-22—Ninth Anglo-American Conference, American Institute of Aeronautics and Astronautics-Canadian Aeronautics and Space Institute-Royal Aeronautical Society. Massachusetts Institute of Technology, Cambridge, Mass. (Oct. 17-18). Queen Elizabeth Hotel, Montreal, Canada (Oct. 21-22).

Oct. 21-23—Tenth Annual East Coast Conference on Aerospace and Navigational Electronics, Institute of Electrical and Electronics Engineers, Emerson Hotel, Baltimore, Md.

Oct. 21-25—23rd National Convention, Society for Nondestructive Testing, Pick-Carter Hotel, Cleveland, Ohio.

Oct. 28-29—13th Annual Aerospace Fluid Power Conference, Pick-Fort Shelby Hotel, Detroit, Mich. Sponsor: Aerospace Div. of Vickers, Inc.

Oct. 28-29—Fall Meeting, Western States Section/The Combustion Institute, University of Southern California, Los Angeles, Calif.

Oct. 28-30—National Electronics Conference, McCormick Place, Chicago, Ill.

Oct. 30-Nov. 1—Annual Convention, Southeastern Airport Managers Assn., Roanoke Hotel, Roanoke, Va.

Oct. 31-Nov. 1—1963 Electron Devices Meeting, Institute of Electrical and Electronics Engineers, Sheraton-Park Hotel, Washington, D. C.

Nov. 3-8—International Air Safety Seminar, Flight Safety Foundation, Athens, Greece. For FSF members and by invitation.

Nov. 4-6—Vehicle Design and Propulsion Meeting, American Institute of Aeronautics and Astronautics/Air Force Systems Command, Wright-Patterson AFB, Dayton, Ohio. (Classified.)

Nov. 4-6—Northeast Electronics Research and Engineering Meeting (NEREM), Institute of Electrical and Electronics Engineers, Commonwealth Armory/Somerset Hotel, Boston, Mass.

Nov. 12-14—Symposium on Supersonic Airliners, London, England. Sponsors: British, French and U.S. Air Line Pilot Associations.

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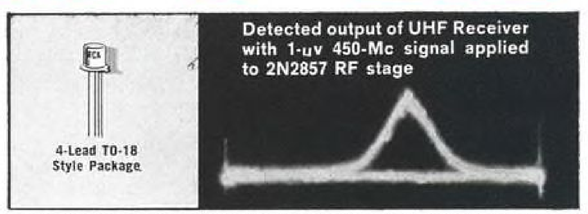
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Never Before A Commercially Available Silicon Transistor With The Low-Noise Performance of RCA 2N2857

4 db NOISE FIGURE AT 450 Mc



DESIGNED FOR UHF • SPECIFIED FOR UHF • 100% TESTED FOR UHF

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- High Gain...14 db typical at 450 Mc in neutralized 20 Mc bandwidth amplifier
- Excellent 450-Mc Mixer Performance...NF=7 db, Gain=15 db (typical)
- Excellent UHF Oscillator Performance...Power Output=40 mw typical at 500 Mc, 20 mw typical at 1 Gc (unit will oscillate at frequencies to 2 Gc)
- Maximum Ratings...V_{CBO}=30V, V_{CEO}=15V, P_t=200 mw at 25°C free-air
- Gain–Bandwidth Product=1200 Mc Typical

Each RCA 2N2857 is tested for maximum noise figure and minimum power gain @ 450 Mc as a standard factory procedure. Specified 2N2857 values are based on ½-inch leads. With shorter leads gain can be improved as much as 1.5 db gain and noise figure as much as 0.5 db.

RCA also offers New Silicon NPN Transistor 2N2708 designed specifically for VHF Applications. The new RCA 2N2708 planar epitaxial transistor is specifically designed for VHF applications to 500 Mc. Here are some of the features of this new transistor:

- 200 Mc wideband RF amplifier...15 db min. gain (neutralized common-emitter)
- Maximum ratings...V_{CBO}=35V, V_{CEO}=20V, V_{EBO}=3V
- Gain–Bandwidth Product...700 Mc min.
- NF=8.5 db max. at 200 Mc, I_C=2 ma

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2	AIR PRODUCTS	52 MG OF LOX	PITTSBURGH, PA.
1	AIR PRODUCTS	52 MG OF LOX	WIERTON, W. VA.
1	AIR PRODUCTS	62 MG OF LOX	SPARROWS PT., MD.
2	AIR PRODUCTS	178 MG OF LN_2	SPARROWS PT., MD.
3	AIR PRODUCTS	100 MG OF LOX	SANTA SUSANA, CALIF.
1	AIR PRODUCTS	200 MG OF LOX	SANTA SUSANA, CALIF.
1	AIR REDUCTION	54 MG OF LN_2	CITY OF INDUSTRY, CALIF.
1	AIR REDUCTION	54 MG OF LN_2	S. ACTON, MASS.
1	AIR REDUCTION	270 MG OF LN_2	RICHMOND, CALIF.
1	AIR REDUCTION	108 MG OF LN_2	BEAUMONT, TEX.
1	AIR REDUCTION	43 MG OF LOX	BEAUMONT, TEX.
1	AIR REDUCTION	350 MG OF LOX	BUTLER, PA.
1	AIR REDUCTION	350 MG OF LOX	CLAYMONT, DEL.
1	AIR REDUCTION	330 MG OF LN_2	BUTLER, PA.
1	AIR REDUCTION	330 MG OF LN_2	CLAYMONT, DEL.
1	AIR REDUCTION	330 MG OF LN_2	ACTON, MASS.
1	AIR REDUCTION	50 MG OF O_2	CHICAGO, ILL.
1	AIR REDUCTION	50 MG OF O_2	CITY OF INDUSTRY, CALIF.
2	AIR REDUCTION	350 MG OF LOX	ALBION, MICH.
1	AIR REDUCTION	300 MG OF LN_2	WARREN, OHIO
1	AIR REDUCTION	300 MG OF LOX	WARREN, OHIO
1	DRAVO	110 MG OF LOX	FARRELL, PA.
1	DRAVO	35 MG OF LN_2	FARRELL, PA.
1	FORD MOTOR CO.	115 MG OF LOX	DETROIT, MICH.
2	LINDE	217 MG OF LOX	HUNTSVILLE, ALA.
1	LINDE	700 MG OF LOX	HUNTSVILLE, ALA.
1	LINDE	700 MG OF LOX	ASHTABULA, O.
1	LINDE	217 MG OF LOX	PUEBLO, COLO.
2	LINDE	217 MG OF LOX	NEOSHO, MO.
1	LINDE	217 MG OF LOX	EAST CHICAGO, IND.
1	LINDE	131 MG OF LOX	LACKAWANNA, N.Y.
1	LINDE	87 MG OF LOX	YOUNGSTOWN, O.
2	LINDE	87 MG OF LOX	ECORSE, MICH.
1	LINDE	217 MG OF LOX	ESSINGTON, PA.
1	LINDE	87 MG OF LOX	DEER PARK, TEX.
2	LINDE	217 MG OF LN_2/LOX	PITTSBURG, CALIF.
1	LINDE OF CANADA	131 MG OF LOX	SAULT STE. MARIE, ONT.
1	N.A.S.A.	125 MG OF LOX	CAPE CANAVERAL, FLA.
1	N.A.S.A.	56 MG OF LN_2	CLEVELAND, O.
1	N.A.S.A.	35 MG OF LN_2	CAPE CANAVERAL, FLA.
1	N.A.S.A.	64 MG OF LN_2	GREENBELT, MD.
3	N.A.S.A.	75 MG OF LOX	NIMBUS, CALIF.
2	N.C.G.	35 MG OF LOX	CHICAGO, ILL.
1	ROCKETDYNE	100 MG OF LOX	SANTA SUSANA, CALIF.
3	ROCKETDYNE	220 MG OF LOX	EDWARDS AFB, CALIF.
1	ROCKETDYNE	300 MG OF LN_2	EDWARDS AFB, CALIF.

LH_2 STORAGE (−423° F)

AIR PRODUCTS	200 MG	LONG BEACH, CALIF.
AIR PRODUCTS	200 MG	LONG BEACH, CALIF.
AIR PRODUCTS	90 MG	INDIANA TOWN, FLA.
AIR REDUCTION	100 MG	PEDRICKTOWN, N.J.
DOUGLAS AIRCRAFT	90 MG	NIMBUS, CALIF.
DOUGLAS AIRCRAFT	90 MG	NIMBUS, CALIF.
LINDE	342 MG	ONTARIO, CALIF.
LINDE	44 MG	TORRANCE, CALIF.
LINDE	750 MG	SACRAMENTO, CALIF.
N.A.S.A.	100 MG	NIMBUS, CALIF.
N.A.S.A.	100 MG	NIMBUS, CALIF.
N.A.S.A.	227 MG	MERCURY, NEV.
N.A.S.A.	110 MG	MERCURY, NEV.
N.A.S.A.	105 MG	NIMBUS, CALIF.
N.A.S.A.	70 MG	MERCURY, NEV.
N.A.S.A.	250 MG	NIMBUS, CALIF.
N.A.S.A.	250 MG	NIMBUS, CALIF.
PRATT & WHITNEY	90 MG	UNITED, FLA.
ROCKETDYNE	560 MG	SANTA SUSANA, CALIF.
ROCKETDYNE	90 MG	SANTA SUSANA, CALIF.

LNG SHIPMENT AND STORAGE (−259° F)

CONSTOCK, TANKER—"METHANE PIONEER"	32,000 BBL LNG	OCEAN TANKER
CONCH, TANKER	170,000 BBL LNG	OCEAN TANKER
METHANE TANKER LTD.	170,000 BBL LNG	OCEAN TANKER
CONSTOCK LIQUID METHANE	35,000 BBL LNG	LAKE CHARLES, LA.
NORTH THAMES GAS BOARD	16,400 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	16,400 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	59,300 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	59,300 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	59,300 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	59,300 BBL LNG	CANVEY IS., ENGLAND
NORTH THAMES GAS BOARD	59,300 BBL LNG	CANVEY IS., ENGLAND
C. A. duMETHANE LIQUIDE	69,189 BBL LNG	PORT ARZEW, ALGERIA
C. A. duMETHANE LIQUIDE	69,189 BBL LNG	PORT ARZEW, ALGERIA

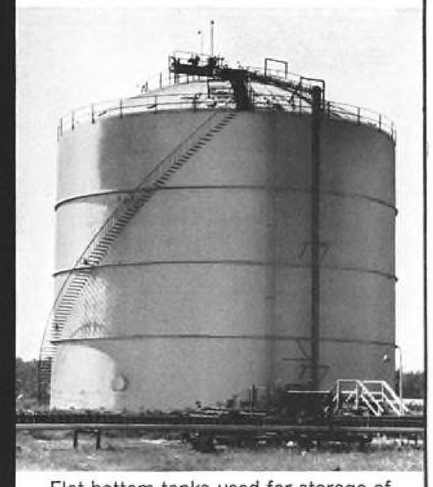
*Capacity is expressed in thousands of Gallons (MG) or Barrels



Spherical storage for liquid oxygen, nitrogen, hydrogen and ethylene.

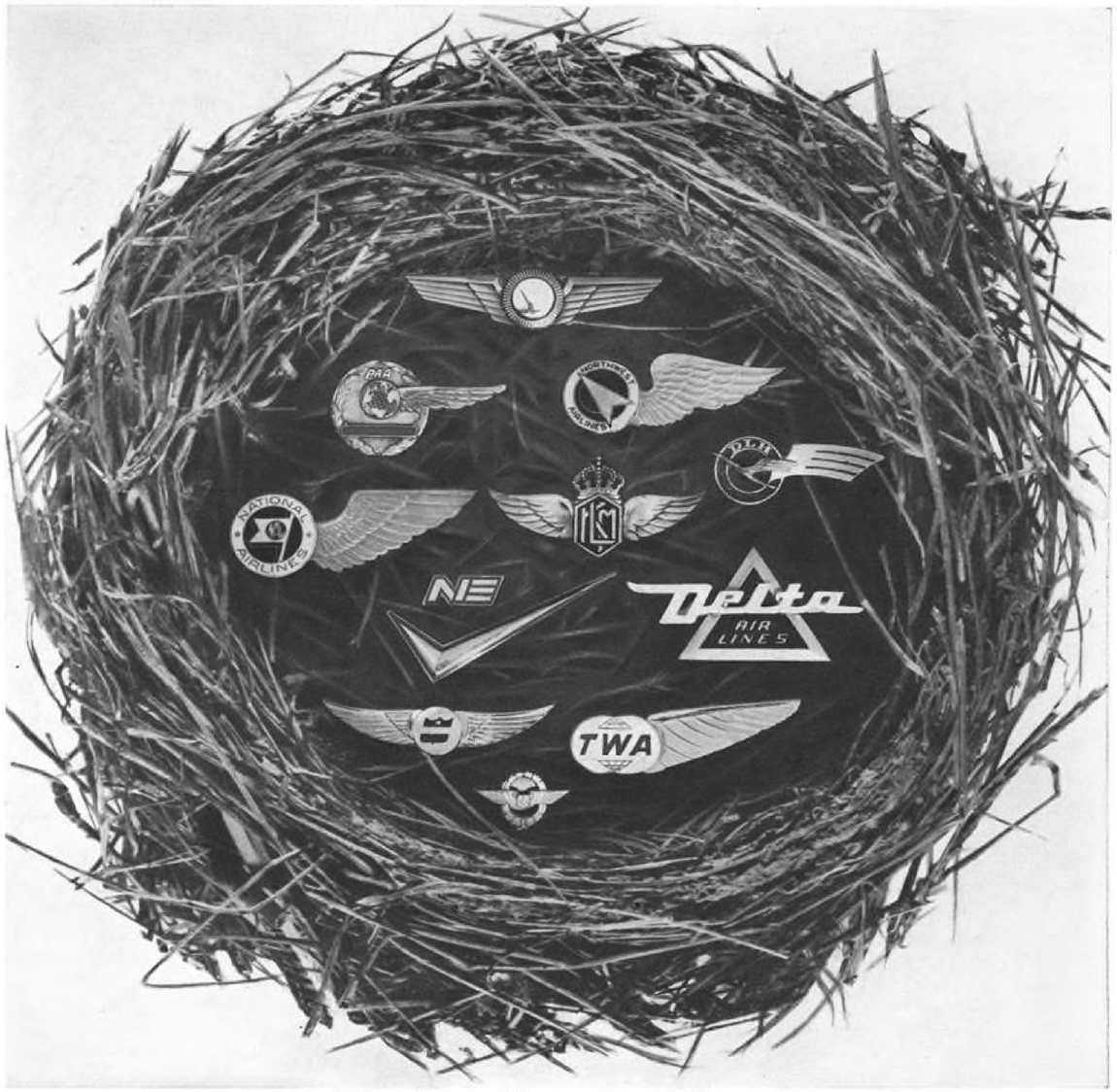


Liquid natural gas shipment by sea using rectangular aluminum tanks to hold liquid methane.



Flat-bottom tanks used for storage of liquid nitrogen, oxygen and methane.

KAISER ALUMINUM



Birds of a feather!

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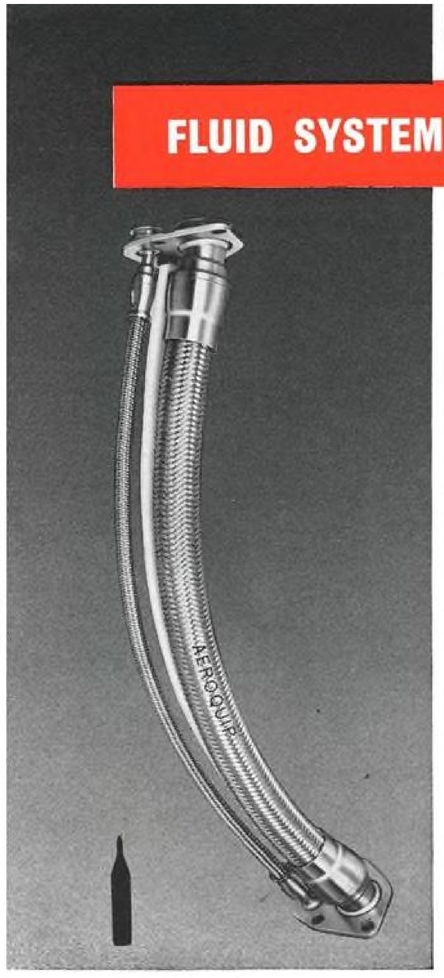
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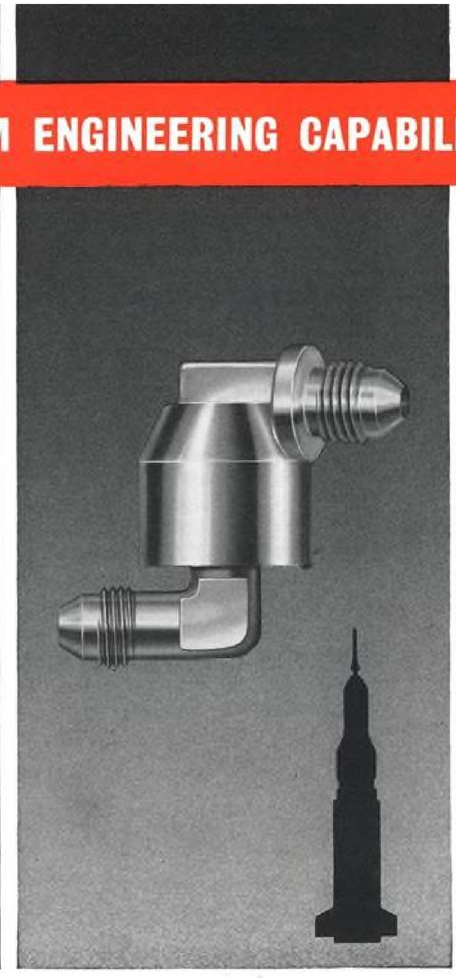
Whatever your power need — whether it's a rocket or a shaver — there's probably a Sonotone sintered-plate, nickel-cadmium cell or battery to do the job. Let Sonotone help you out. For complete information, just drop us a line, stating your application and power requirements. We'll be glad to supply you with the technical data you need.

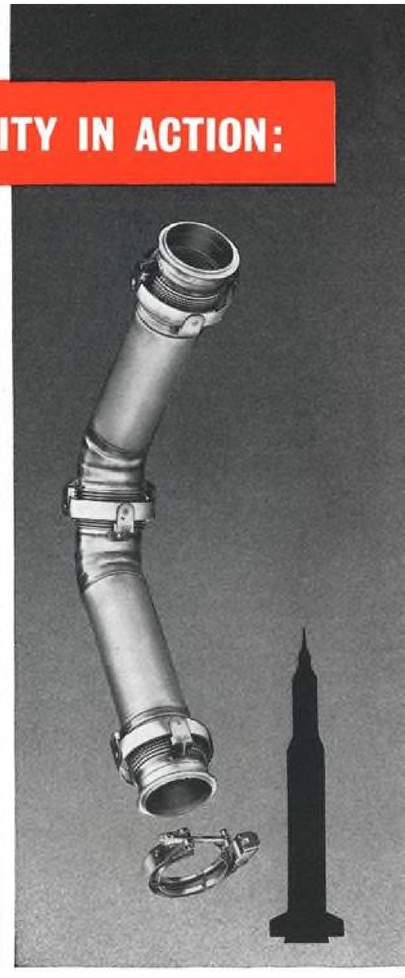
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FLUID SYSTEM ENGINEERING CAPABILITY IN ACTION:







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Designed to meet critical weight, space and thermal requirements, highly engineered flexible manifold assemblies convey low temperature fluids to control the flight of the Polaris missile. Exceptionally lightweight -12 and -3 Hose of Teflon and stainless steel Super C Fittings with precision elbow bends convey fluids; unbraided tube is electrical conduit. AEROQUIP AIRCRAFT DIVISION, JACKSON, MICHIGAN.

Special Stainless Steel Swivel Joints Meet Reliability Requirements For Saturn S-1 Booster

A specially designed series of stainless steel Barco Swivel Joints capable of handling high pressure gases, hydraulics, exotic fuels and meeting critical missile performance requirements has been selected for use on the Saturn S-1 Booster. Barco's many years of experience in engineering and producing all types of dynamic seal fluid joints can help solve your special problems. AEROQUIP BARCO DIVISION, BARRINGTON, ILLINOIS.

Functional Liquid Hydrogen Venting On Saturn S-IV Assured Under Extreme Temperatures At 20g Loads

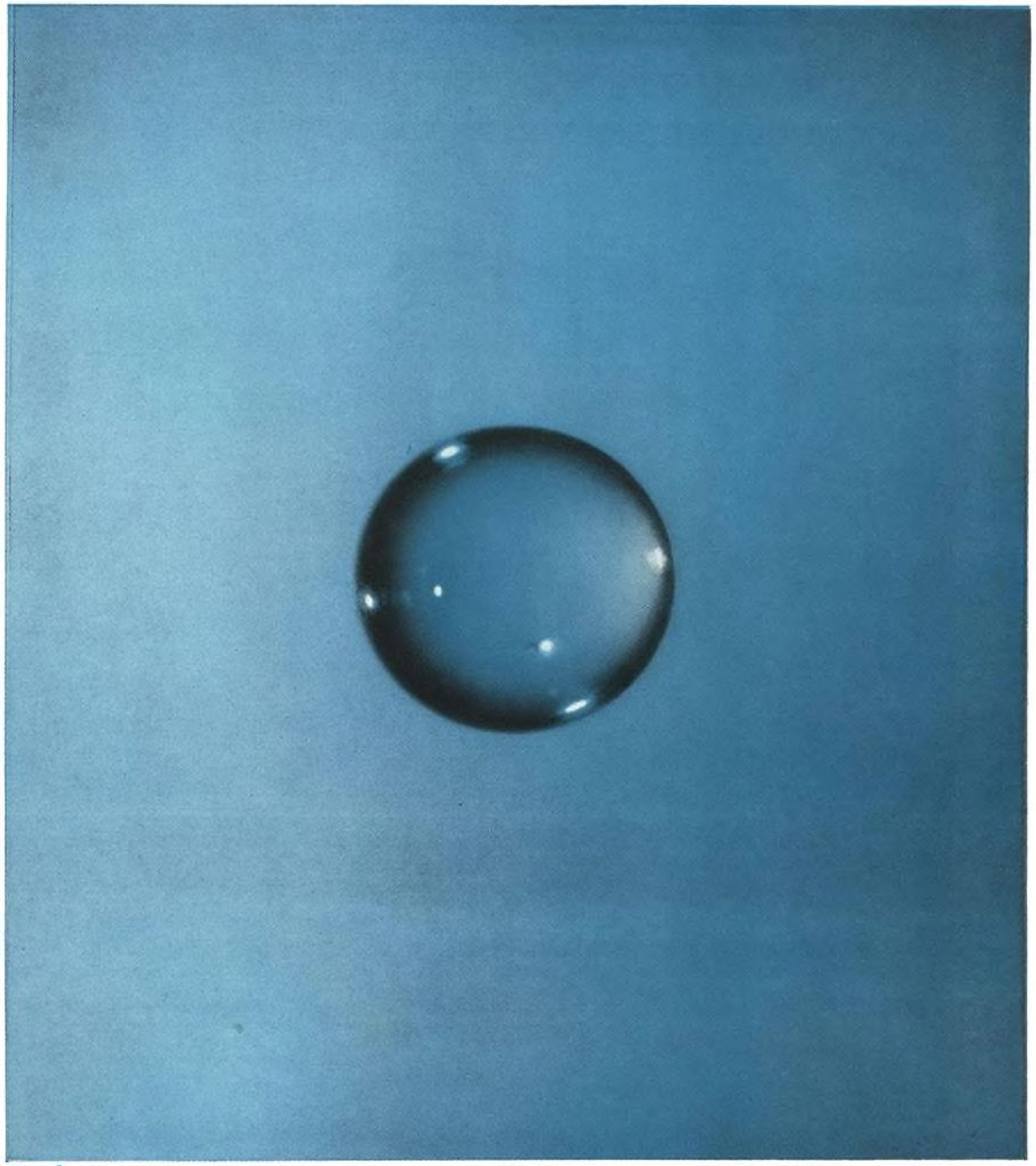
Precision 4" ducting and lightweight external gimbal joints, fabricated of stainless steel, were used to develop this liquid hydrogen vent line on the Saturn S-IV. Line interior is free of re-entrant pockets that could entrap propellant. CONOSEAL Joints at either end assure zero leakage connection. Produced by AEROQUIP MARMAN DIVISION, LOS ANGELES, CALIFORNIA.

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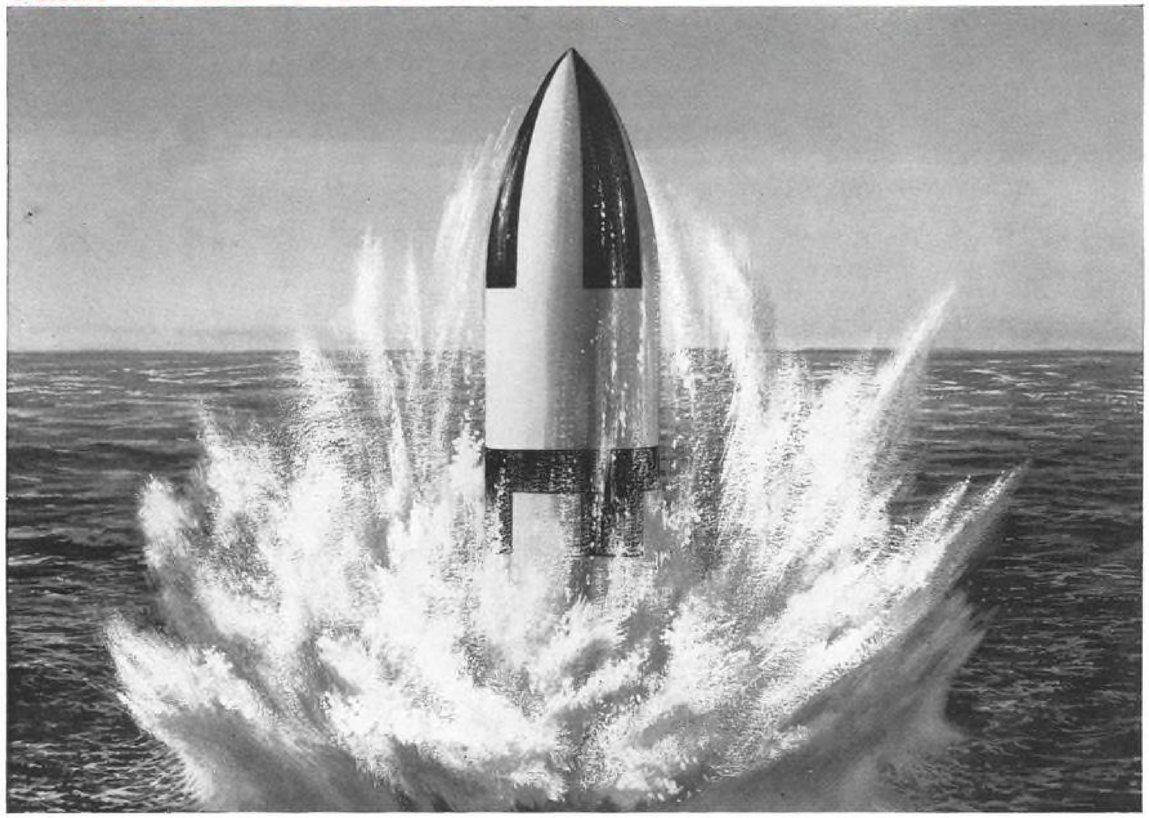
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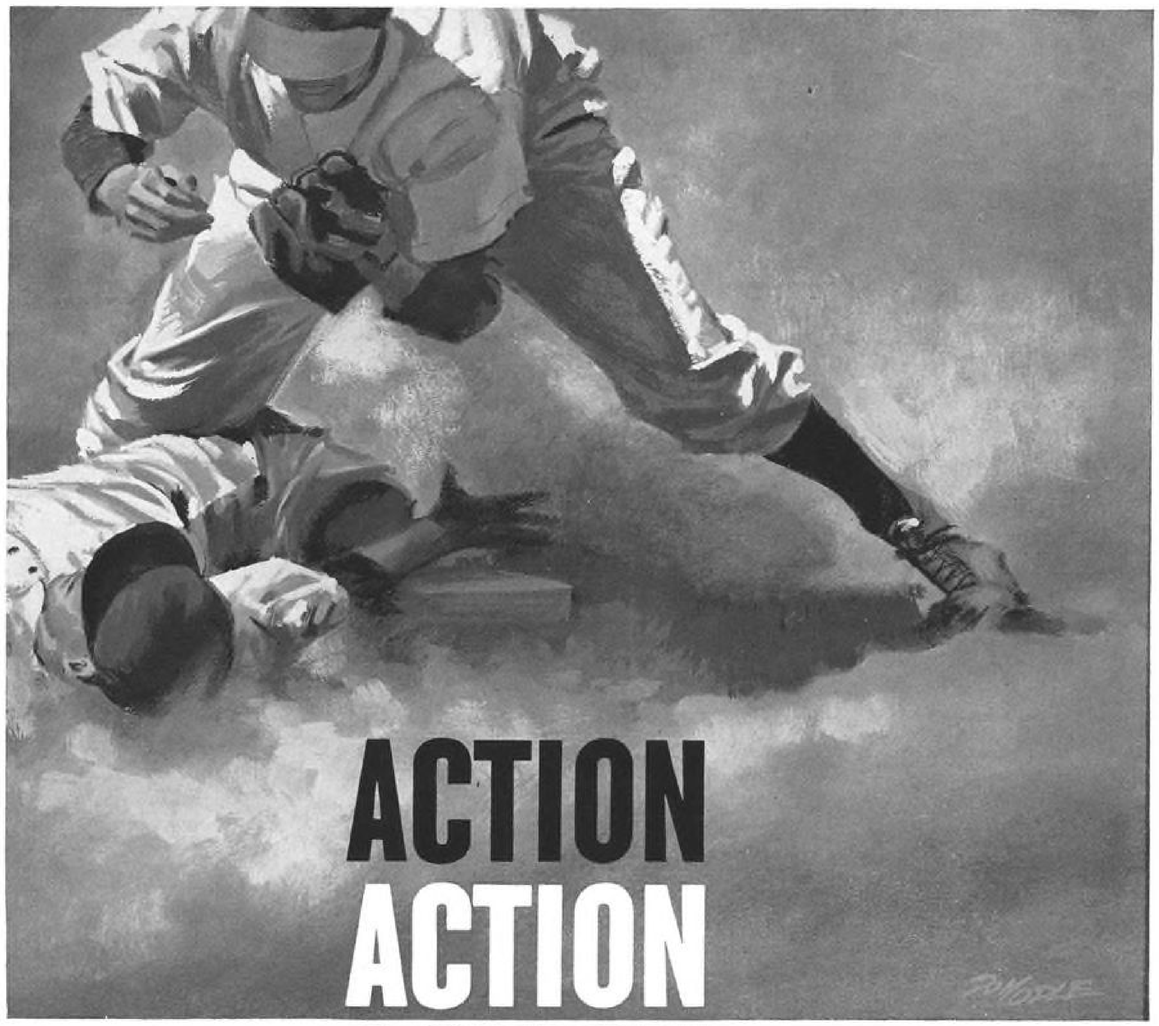
At first, the new propellant presented a design problem. Its fantastically hot exhaust gases (6000° F. range) caused erosion of the rocket nozzle entrance caps and exit cones in the 1st Stage power plant. LINDE's Plasma-Plating helped Aerojet-General solve the problem: to the graphite base material, LINDE applied an undercoat of pure tantalum —topped by a coating of pure tungsten—each only mils thick. Thin as they are, these coatings provide the heat- and erosion-resistant "skin" that helps the Polaris to utilize its more powerful propellant! Today, many critical wear problems are being solved for important aerospace parts by LINDE's Flame-Plating coating service—including rocket engine combustion chambers, jet engine compressor blades, aircraft valves, turbine engine seals, hydraulic pumps, and rocker arms.

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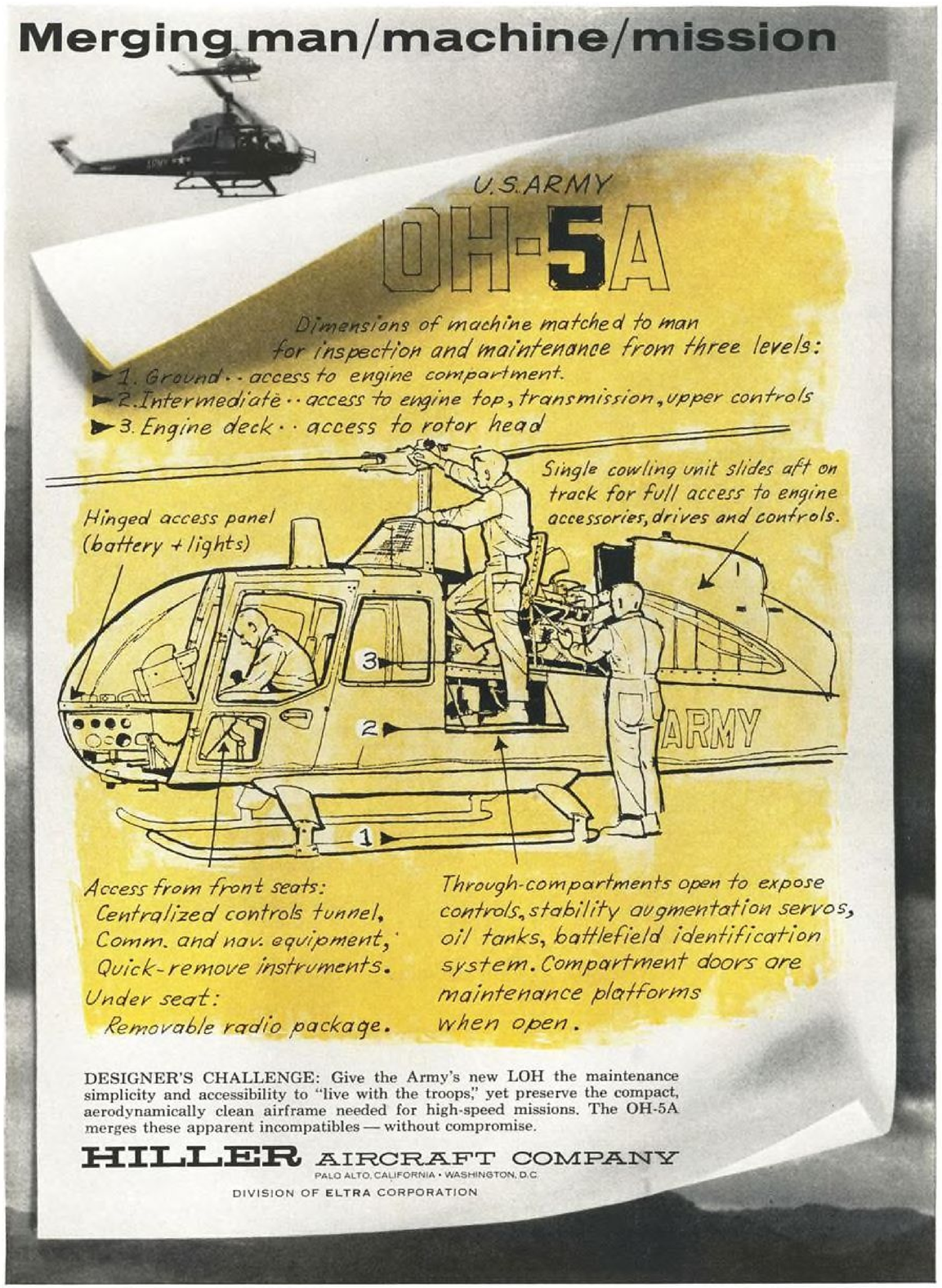
COVER: Republic Aviation Corp. F-105F, two-seat version of the single-seat F-105D fighter-interceptor, is shown in flight during Air Force evaluation tests currently under way at Eglin AFB, Fla. The 1,400-mph. jet is designed for the same missions as the F-105D and also for improved combat pilot mission training (AW July 1, p. 59). First two prototypes are being flown in the Eglin tests with both cockpits occupied.

PICTURE CREDITS

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EDITORIAL

Adm. Anderson's Dissent

(Last week former Chief of Naval Operations Adm. George W. Anderson became the first high-level appointee of the Kennedy Administration to make a public attack on a number of controversial Defense Dept. policies (see p. 30). Because of the vital importance of these issues to the aerospace industry, AVIATION WEEK & SPACE TECHNOLOGY is presenting excerpts from Adm. Anderson's speech to the National Press Club.)

I am concerned . . . regarding a trend in the major procurement policies within the Dept. of Defense to the ultimate detriment of our military services. One proposal has been advanced which would in effect eliminate the requirement for specific recommendations by military personnel on matters such as design competitions or source selection procedures. I view any diminution of military recommendations on weapons procurement with grave alarm. Certainly the abrupt reversal of military recommendations without interim consultation, as was the case in the TFX and V/STOL contracts, is fraught at a minimum with unpleasant developments, and potentially with grave dangers. The civilian authorities exercising control, and the military, have two common objectives: First, to obtain the best weapons or weapons systems possible; second, to prevent the use of defense appropriations for anything except best performance for least cost. . . .

I have spoken of the danger of making abrupt reversals in regard to procurement. The same reasoning applies to formulating defense policies with our allies. Specifically, a principal trouble in the Skybolt affair sprang from our encouraging our ally confidently to look forward to the timely availability of a superior weapon when, apparently, we were not justified in giving them so much encouragement. This illustrates the need for continuous consultation between civilian and military experts and for avoiding abrupt actions timed to our own budget cycle.

At all important conferences involving our national security it would be of great benefit for any secretary of defense to have with him a senior military representative from the Joint Chiefs of Staff. . . .

I am concerned that, in the selection of weapons, aircraft, or ships, there may not be a full appreciation of the decisiveness of a narrow edge in superior performance, both to achieve maximum safety, and to succeed in combat. I am concerned that service experience tends to be subordinated to evaluation by operations analysts on the staff of the secretary of defense or involved in contract research activities.

Military experience builds an appreciation of the truth that slight margins make big differences when the chips are down. Those who fought in the Pacific know what the narrow margin of operational superiority in the Japanese Zero fighter cost in American lives. . . .

Creativity of the military can be stifled. . . . It is curious that those who criticize the military as being backward tend to be the very ones who are proponents of procedures and policies which would discourage a creative corps of military professionals. Today, by making too many detailed decisions at high level, by attempting to stamp officers of all services into a common mold, we may kill incentive, imagination, and independent thought. . . .

There is another alarming peril to obscuring the role of the military, found in a modern fallacy that theories, or computers, or economics, or numbers of weapons win wars. Alone, they do not! Good leadership unfailingly recognizes that man is the key to success or failure. . . .

Military men have no crystal ball that can guarantee infallible decisions; but neither do scientists, analysts, engineers, businessmen, lawyers, or for that matter, computers—which must rely on human assumptions for inputs. All of us must shun reasoning based on unquestioned assumptions that become self-deceptions. . . .

I am concerned that the system of checks and balances so wisely provided for in our constitution and further translated into legislative code may unconsciously be in process of growing unbalanced with respect to the Dept. of Defense. A sometimes forgotten partner in civilian control, the Congress, is a part of our checks and balances. On occasions, committees of Congress have been right, we in the executive departments wrong. . . .

Overcentralized structures are conducive to the abuse of power and compounding of mistakes. Monolithic-structured organizations can kill imagination, stultify initiative, completely eliminate the effectiveness of those in the officer corps who have gained wisdom and experience. . . .

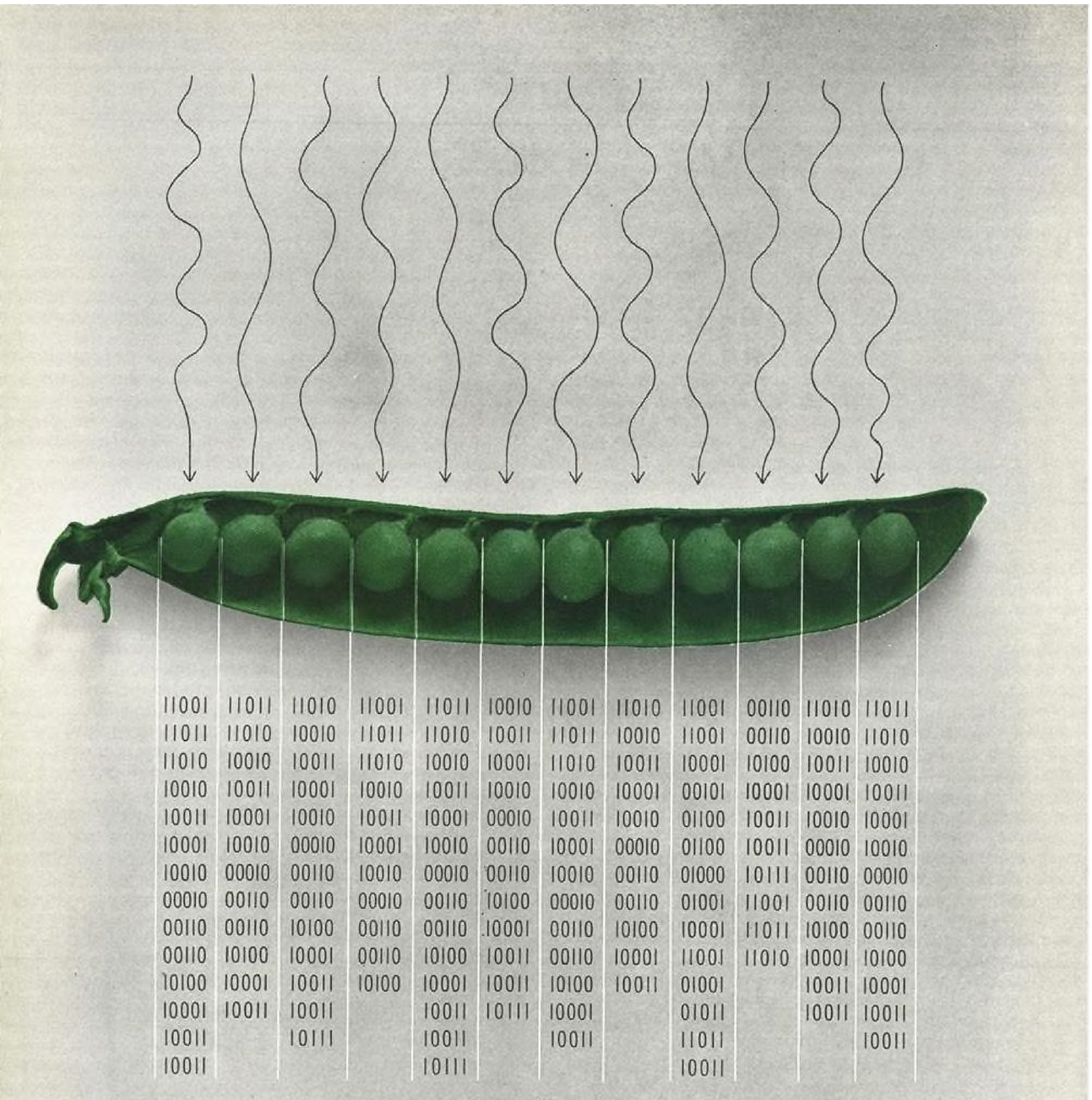
Thankfully, built-in checks and balances are provided in the National Security Act. One of them is the separate services, for they often take differing viewpoints and thus afford higher authority clear options and greater flexibility in decision-making.

Within the department, another check is the Joint Chiefs of Staff. Never should this body become a political one, or merely a rubber stamp to the secretary of defense in implementing decisions or carrying out orders. As a collective body, the chiefs must represent military requirements from differing view-points, so that we do not ignore the value of mixed, balanced, diversified forces. The joint chiefs should not be swamped with matters that should be processed in service channels, nor should their functions be taken over by segments of the office of the secretary. . . .

Experience teaches that there are no infallible judgments with respect to national security in these times of the unknown, the changing and the unexpected. The best hope of surviving the pitfalls is found in a precept which I commend to those who lead the Dept. of Defense, now and in the future. It was stated by our President in his first State of the Union message, when he said:

"Let it be clear that this Administration recognizes the value of dissent and daring, that we greet healthy controversy as the hallmark of healthy change."

In the spirit of these wonderful lines, I have given you the valedictory to my military career. . . .



HERE'S A 12 CHANNEL CONVERTER COMPACT AS PEAS IN A POD

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WHO'S WHERE

In the Front Office

W. H. Lynch, vice president-advanced planning, Aerolab Development Co., Pasadena, Calif., a subsidiary of Marshall Industries.

Michael Hirsh, vice president-marketing, Benson-Lehner Corp., Van Nuys, Calif.

William L. Rose, executive vice president, Milgo Electronic Corp., Miami, Fla.

Francis M. Joseph, vice president-engineering, Inland Motor Corp., Radford, Va., a subsidiary of Kollmorgen Corp.

Teleflex, Inc., North Wales, Pa., has appointed the following as vice presidents: **L. K. Black**-commercial operations; **L. E. Hatch**-defense operations; **E. W. Doran**-controller and assistant treasurer; **A. J. Kompanek, Jr.**,-product planning.

R. A. Correa, corporate vice president-business development, American Machine & Foundry Co., New York, N. Y.

Josiah V. Thompson, II, treasurer and assistant secretary, Airwork Corp., Millville, N. J. Mr. Thompson has resigned as board chairman; **Francis L. Hines** assumes the title of chairman as well as president.

John A. Gautraud has resigned as director of systems engineering, National Aeronautics and Space Administration's Office of Manned Space Flight; **Dr. James H. Turnock, Jr.,** is now acting director. Mr. Gautraud has returned to Avco Corp.

Changes

Dr. Roger E. Gaumer, director-mechanical and mathematical sciences laboratory, Research and Development Div., Lockheed Missiles and Space Co., Sunnyvale, Calif.

Maj. Joe S. Schiele, USAF project pilot for Northrop Corp.'s slit-winged X-21 laminar flow control aircraft, Edwards AFB.

Arthur W. Robinson, head of the newly established Advanced Requirements Planning Operation, General Electric Co.'s Missile and Space Div., Valley Forge, Pa. Mr. Robinson is rejoining GE after two years as assistant director of research and engineering for International Programs, DOD.

Dr. Ulrich Heidelauf, director, Intelligence and Exploration Systems, Raytheon Co.'s Space and Information Systems Div., Lexington, Mass.

William J. Jackson, controller, Cook Electric Co., Morton Grove, Ill.

Edward P. Tighe, controller, Space and Systems Div., Packard Bell Electronics, Los Angeles, Calif.

Dr. Herbert D. Becker, director, Engineering Sciences, Allied Research Associates, Inc., Concord, Mass., succeeding **Dr. George Gerard** (AW Aug. 5, p. 23).

Richard H. Allen, contracts administrator, Rocket Power, Inc., Mesa, Ariz.

Dr. Kaj L. Nielsen, director of systems analysis, Engineering Physics Staff, Battelle Memorial Institute, Columbus, Ohio.

Edgerton, Germeshausen & Grier, Inc., Boston, Mass., has appointed the following as associate division managers of the company's Systems Div.: **Edward A. Colson**-engineering and fabrication; **Raymond C. O'Rourke**-research; **Frank I. Strabala**-field services.

INDUSTRY OBSERVER

► Design features of a military synchronous communications satellite have been outlined for Air Force's Space Systems Div. and Aerospace Corp. by Hughes Aircraft, contractor for National Aeronautics and Space Administration's Syncom 2 satellite. Hughes previously had presented details of its projections for the military communications satellite to Dept. of Defense Research and Engineering Div. The military Syncom would require a secure command feature and probably would include a de-spin antenna for high communications capacity, instead of the omni-directional antenna used in the NASA Syncom satellite.

► **National Aeronautics and Space Administration's present order for Saturn vehicles from Chrysler Corp. calls for production of eight Saturn 1s and 12 Saturn 1Bs. Consideration is still being given to a Saturn 1B third stage, which would be the S-6, powered by Pratt & Whitney RL-10 engines.**

► Hypersonic-cruise aircraft projections examined under Project Forecast (AW Apr. 8, p. 25), as part of Air Force's survey of its mission needs in the next decade, envision speed ranges between Mach 6 and 11. Expandable structures also have been considered to aid in control in the landing regime. Bomber concepts analyzed have included both low- and high-altitude penetrators for long- and short-range missions.

► **Micrometeorite collision with Project West Ford needles (AW May 20, p. 34) will contribute significantly to their break-up, according to a study conducted for Air Force's Cambridge Research Laboratory by Dr. A. Sauval at Liege University, Belgium, Institut d'Astrophysique. Dr. Sauval's prediction raises questions concerning the immunity of the satellite-relay radio communications belt to natural disturbances. MIT's Lincoln Laboratories, manager of the West Ford project for Air Force, estimates solar radiation pressure will destroy the belt in about three years, but maintains higher orbits would give the belt a longer lifetime regardless of natural phenomena.**

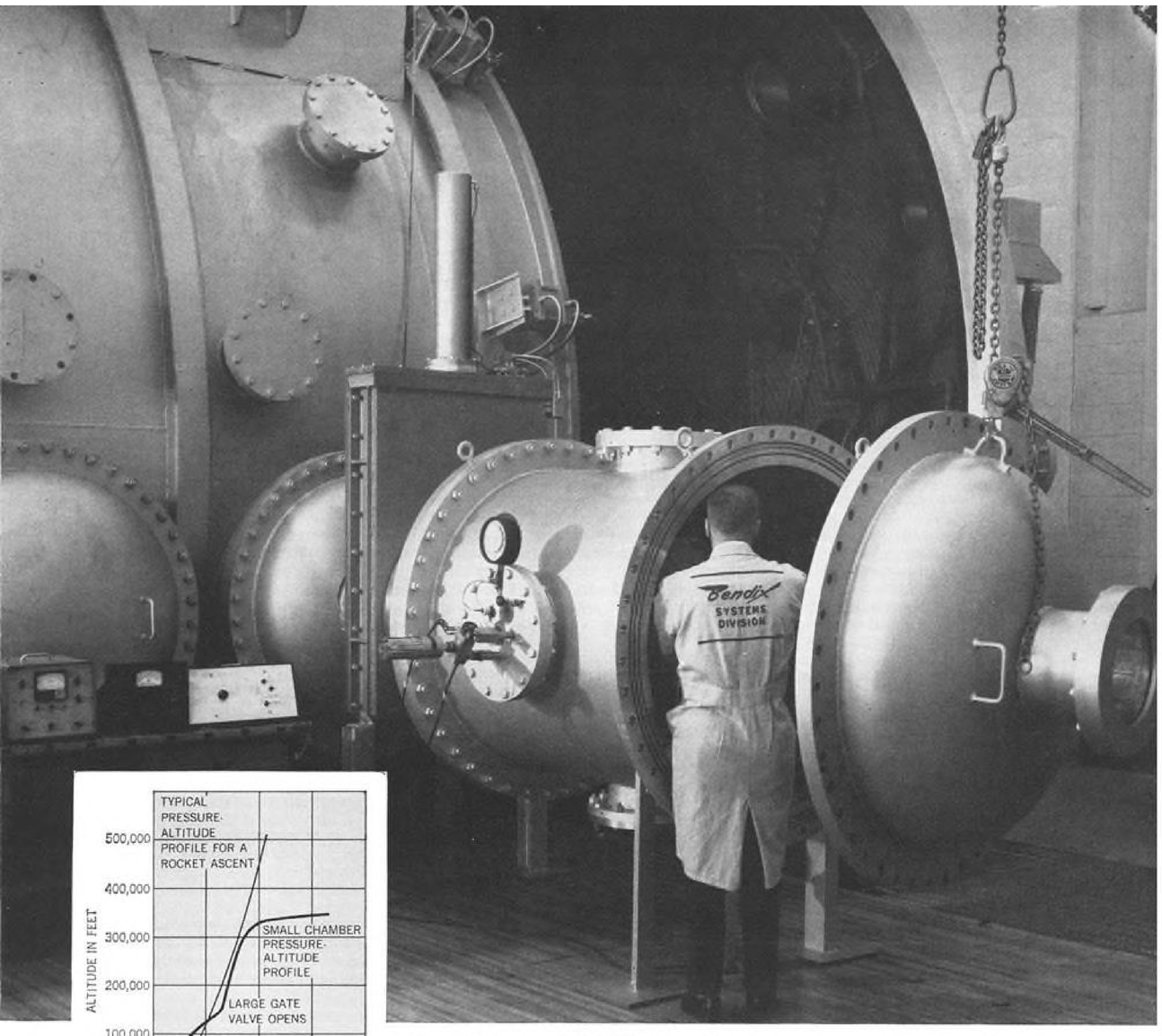
► Air Force is analyzing the potential of a large logistics-type aircraft with laminar flow control, which may afford lift-to-drag ratios as high as 35. After Northrop's Norair Div. completes an initial period of testing on its X-21 LFC research aircraft (AW June 24, p. 52), Air Force is expected to take over the test program. Operation in Alaska probably will be included to investigate maintenance of LFC features in very cold, unfavorable weather.

► **Requirements to protect guidance equipment of future-generation ICBMs against pressure, heat and radiation hazards following the detonation of an enemy nuclear warhead in the missile's flight path are being analyzed by USAF as part of an evaluation of the post-launch phase of ICBM vulnerability.**

► Proposal requests for two of the three remaining housekeeping contracts for National Aeronautics and Space Administration's Merritt Island launch area—base services and administrative and management services—are being reviewed by NASA headquarters. Base services may be further divided into two packages. NASA's Launch Operations Center (LOC) will issue the proposal requests to invited firms as soon as the proposals have been approved by NASA headquarters. LOC has yet to write the request for launch support, pending definition of final technical requirements. The fourth package, communications (AW Aug. 12, p. 30), was rewritten.

► **Fabrication of a miniaturized model of a personal telemetry transmitter for body function responses will be sponsored by Air Force's Aeronautical Systems Div. The complete system will not weigh more than 10 oz. with case and a battery capable of sustaining it for 20 hr. operation. Size of the transmitter will be approximately 7 cu. in., and power consumption will be 80 mw. Integrated circuit design for the complete package is not considered feasible. Proposals from industry will be submitted by Sept. 19, and the contract award is expected by the end of November.**

► Air Force is studying possible contributions that an advanced version of Gemini could make to its projected space missions. Indications are that if the Titan 2 first-stage motor were uprated by about 45,000 lb. thrust and its tankage increased, it could lift over a ton of additional payload.



RISE-TO-ALTITUDE TEST FACILITY. The small 4 x 4 foot chamber attached to the large 20 x 27 foot chamber has been designed and developed to duplicate the pressure history experienced by a rocket-borne payload as it climbs to altitude. The large chamber acts as a vacuum reservoir, isolated from the small chamber by an air-operated gate valve. The test sequency first evacuates the small chamber to a pre-determined level, then opens the valve to the large chamber which can be evacuated to 5 x 10^{-8} torr. The insert shows the resulting approximation to the actual vehicle pressure history.

INSTANT SPACE SIMULATION (JUST ADD VACUUM). The rise-to-altitude chamber, to simulate pressure changes encountered by rocket-borne payloads, is a new addition to the Bendix environmental laboratories where engineers design, fabricate and test space vehicles. Engineers experienced in integration, assembly and test will find new careers at the Bendix Systems Division, Ann Arbor, Michigan. Write or call our Personnel Director.—An equal opportunity employer.

Bendix Systems Division THE Bendix CORPORATION **WHERE IDEAS UNLOCK THE FUTURE**

Washington Roundup

TFX Cost Confusion

Senate Permanent Investigating Subcommittee is still insisting that Defense Secretary Robert McNamara supply it with cost-effectiveness studies showing the advantages of the TFX over existing Air Force and Navy aircraft (see p. 26).

The whole question of cost of the TFX is confusing to the committee and the totals are debatable even in the Pentagon. Estimates for the research and development program and production of 1,700 aircraft range from $7 billion to 10 billion (AW Sept. 2, p. 17). The five-year program package also has to include operation and maintenance money. That could double the R&D-plus-production figure, so even if the $7 billion is accurate, the package might total $14 billion.

Air Force's long-standing plan to study the feasibility of a space station has finally received top-level approval after it was informally coordinated with the President's Scientific Advisory Committee, the National Aeronautics and Space Council, State Dept. and NASA (AW Sept. 2, p. 17). Proposal requests for the studies are expected to go to industry immediately.

Marshall Reorganization

Marshall Space Flight Center has further strengthened its ability to monitor contractors involved in building the Saturn launch vehicles for the Apollo program. Marshall's budget has grown to $1.5 billion, and 90% of this now goes out to industry.

Part of a major reorganization aimed at coping with the over-all growth and expanding contractor participation, the center recently hired Robert B. Young, former Aerojet-General vice president (AW Aug. 19, p. 25). Young's office now becomes Industrial Operations. Col. Lee B. James will head the Saturn 1 and 1B project office, Dr. Arthur Rudolph will head the Saturn 5 office, and Leland Belew the engine office.

Nine technical divisions have been formed into a Research and Development Operations unit to be headed by Hermann K. Weidner. Dr. Oswald H. Lange is moving from head of the old Saturn Systems Office to a new post as assistant director of the center for scientific and technical analysis.

Joseph S. Imirie has resigned as assistant secretary of the Air Force for materiel to join Litton Industries. His replacement is expected to come from outside the government.

Soviet Space Journal

USSR Academy of Sciences is publishing a new journal called Cosmic Research. Editor-in-chief Leonid I. Sedov, who has headed the academy's space committee for years, said the bimonthly journal "will be widely circulated all over the world." It will cover flight dynamics, celestial ballistics, cosmic physics, results of observations, instruments for cosmic research and designs of cosmic apparatus, cosmic biology and medicine. Sedov said the journal will carry scientific papers by Soviet space workers and "we do not exclude the possibility" of printing papers "by foreign authors." The first issue was due to be published this month.

NASA will have a stronger voice in the standard space launch vehicle program as the result of an agreement with the Air Force covering the use of the Lockheed Agena stage. The two agencies have been operating only under a letter agreement since February, 1961. NASA now can go directly to the contractor for Agena modifications instead of going through Air Force. NASA also will be represented on the USAF configuration control board for Atlas, Thor and Agena. Air Force also transferred complete responsibility to NASA for 11 Agena Bs already on order but not yet delivered.

Risks of Test Ban

A report highlighting the risks that would be involved in agreeing to a nuclear test ban is expected this week from the Senate Preparedness Investigating Subcommittee. It will balance the Senate Foreign Relations Committee report issued last week, which was strongly in favor of a ban.

The preparedness subcommittee is divided. Two members—Barry Goldwater and Strom Thurmond—are campaigning against Senate ratification of a treaty. Sen. Henry Jackson is skeptical about the treaty but may end up voting for it. Sen. Stuart Symington, a former Air Force secretary, signed the favorable Foreign Relations report. Three other members—Leverett Saltonstall and Margaret Chase Smith, and possibly Chairman John Stennis himself—are expected to vote in favor of ratification.

Poor Timing

Soviet Union, which claims to have invented almost everything, now claims that its Second State Watch Plant has produced a watch for cosmonauts that uses a mechanism "of an entirely new design." It turns out to be a tuning fork vibrated at 360 cps. by an electromagnetic field created by magnets and a small battery. Bulova introduced a similar watch three years ago, based on the same principle. The watch is worn by U.S. astronauts and the basic Accutron timing device is used on the Explorer, Tiros, Telstar and Syncom satellites to silence radio signals when desired.

—Washington Staff

Rift May Affect TFX Role, Configuration

F-111A low-level, conventional weapon delivery capability questioned; cost-effectiveness factor probed.

By Larry Booda

Washington—Internal Defense Dept. controversy over the General Dynamics F-111A (TFX) Air Force version of the bi-service tactical fighter could alter the aircraft's employment and configuration.

Arguments center mainly around F-111A mission profiles and its cost effectiveness when used for the delivery of non-nuclear weapons. Defense analysts have discovered that an existing aircraft, the McDonnell F-4C, can perform the mission as cheaply as the F-111A, although it lacks the 15-min. supersonic dash and long ferry range capabilities of the F-111A.

Air Force, Navy, director of defense research and engineering and the assistant secretary of defense-comptroller are engaged in the controversy.

At this point in the exchange of studies and rebuttals, the office of the deputy DDR&E for tactical warfare programs finds itself arbitrating the mission differences of the two services, whose positions are prepared by experienced warfare analysis experts.

Concurrently, the cost-effectiveness analysts in the comptroller's office are continuing studies which began only after Defense Secretary Robert S. McNamara admitted to Government Accounting Office investigators that he had only used "rough judgment" in determining whether General Dynamics or Boeing had the more realistic cost proposals (AW May 6, p. 24). These studies now are going beyond the actual cost of the development and production program by examining the cost of delivering weapons on targets.

Air Force Requirement

Basically, what the Air Force wants in the F-111A configuration, and has wanted through the entire history of the TFX even before McNamara made it a multi-service system, is a variable geometry wing aircraft which would carry a tactical nuclear weapon internally and be able to approach a target on the deck at Mach 1.2 for 15 min., or about 200 mi.

When the Air Force and Navy requirements were combined, the capability for delivering conventional armament was added as a requirement. This immediately posed a problem, as the F-111A's internal bomb bay could carry only a compact payload of limited weight. It would be too little for economical delivery of conventional armament. To achieve this, armament stores would have to be added to wing pylons, which in turn would make a supersonic low-altitude approach more costly in fuel and distance.

It is this point that the Navy has been belaboring in its studies. The Navy maintains that the F-111A is an impractical aircraft for the low-level attack mission carrying conventional weapons. As a nuclear weapon delivery system, it is simply another strategic bomber with a multi-megaton capability, the Navy says.

Lending fuel to the fire are several industry and Navy studies dating as far back as two years showing that the F-4C in an attack configuration could deliver a larger payload of conventional weapons more economically than the F-111, but without the transocean ferry capability and low-altitude supersonic dash.

Navy's Position

The Navy has been maintaining that a Mach 0.9 dash at low altitude is sufficient to accomplish the attack mission safely. The Air Force says that the speed advantage of Mach 1.2 could mean the difference between success and failure in areas heavily defended by ground-to-air missiles and fighters.

Another point of contention has been whether conventional weapons such as general purpose high explosive (HE) bombs could stand the supersonic environment. The typical HE explosive mixture begins to melt at about 200F. As a solid it is highly stable. Bombs can be dropped from flight altitudes on concrete without the fuses being armed and will not explode, although slow burning may occur.

A 15-min. supersonic dash, one source said, would heat the bomb bay area to about 240F. The cockpit and avionics compartments will be air-conditioned, but not the bomb bay. A nuclear weapon could function at this temperature, but the HE explosive would become molten. When dropped, the bombs would explode on contact rather than when triggered by the fuze. Also, if any of the bombs hit each other on leaving the bomb bay, they would explode. Thus, heat-resistant conventional bombs would have to be developed, an added cost.

Cockpit Arrangement

The F-111A, which is now in full scale mockup form at the General Dynamics plant in Ft. Worth, has side-by-side cockpit seating. The aircraft bears some resemblance to the Grumman A-6A Intruder aircraft. The design engineering inspection of the mockup, conducted by the Air Force Aeronautical Systems Div. project office, began two weeks ago and is expected to be completed this week.

Even the side-by-side cockpit arrangement has been criticized by pilots. Since the pilot in command sits on the left side, his view is hampered during right hand turns in approaching a target.

If the F-111A proves unsuitable for the attack mission, an alternative is that it be used as an interceptor by the Air Defense Command. ADC has revived its requirement for a Mach 3 interceptor, but stands little chance to have a new aircraft program approved. In performance, the F-111A as an interceptor could be a Mach 2.5-plus aircraft. However, a completely different avionics system for air-to-air missile guidance would have to be designed in place of the ground guidance system designed for the attack version.

As the bickering goes on, there is a growing sense of dissatisfaction among the working level pilot officers of the Air Force and Navy regarding the entire program.

They are beginning to wonder whether the F-111 will ever become a production aircraft.

Senior officers have already become aware of this feeling and are planning an internal information program to inform officers of the system's advantages and to emphasize the system's positive aspects.

TSR-2 Production

London—British Aircraft Corp. has been given the go-ahead by the Ministry of Aviation to order materials for TSR-2 (tactical strike reconnaissance) bomber squadron production.

So far, the order is for 20 airplanes to be used in both a development test program and Royal Air Force evaluation. The TSR-2, along with the Hawker P.1154 VTOL fighter, will constitute the RAF's quick strike power when the V-bomber fleet is gradually phased out of service in the late 1970s.

The TSR-2 is scheduled to make its first flight in December or early January. Its date has slipped considerably due to a weight problem.

Firms Picked for DH-125 U.S. Sales

De Havilland DH-125 turbojet executive aircraft, manufactured by Hawker Siddeley Aviation, Ltd., in Great Britain, will be marketed in the U. S. by Atlantic Aircraft Sales Corp. and AiResearch Aviation Service Co. under terms of an agreement signed last week (AW Aug. 26, p. 23).

Sales demonstration tour of the U. S. by a DH-125 is planned later this year. Federal Aviation Agency certification is expected by the end of 1963, and first deliveries are scheduled for mid-1964.

Under terms of the agreement, AiResearch, of Los Angeles, a division of the Garrett Corp., would be DH-125 sales representative in states west of the Mississippi, plus states east of the Mississippi which border on the river.

Atlantic Aircraft Sales Corp., a subsidiary of Atlantic Aviation Corp. of Wilmington, Del., would be sales representative in eastern states.

Each company would have the right to sell in the other's territory, with the commission to be divided on such sales. The company having jurisdiction over the territory would then provide warranty service.

Atlantic and AiResearch will install interiors and avionics equipment to customer specifications. Price will be $575,000 without interiors or avionics gear. Fully equipped, the DH-125 is expected to sell for approximately $730,000 to $750,000 (AW Sept. 2, p. 52).

Fixed-base operators will be licensed to provide airframe maintenance in cities where the distributors do not have facilities. Engine maintenance and overhaul will be handled separately by Airwork Corp., Millville, N. J. Bristol Siddeley Engines, Ltd., manufactures the aircraft's twin Viper 20 engines.

TFX Probe to Focus on Possible Conflict in Gilpatric, Korth Roles

By George C. Wilson

Washington—Senate investigation of the F-111 (TFX) contract award will swing sharply away from technical considerations in its next phase and focus on whether Deputy Defense Secretary Roswell L. Gilpatric and Navy Secretary Fred Korth should have disqualified themselves from the selection process to avoid the type of conflict of interest the Supreme Court condemned in its Dixon-Yates decision.

Already in the marathon inquiry there have been insinuations that previous associations with General Dynamics influenced their F-111 recommendations. But the ranking Republicans of the Senate Permanent Investigations Subcommittee—with the backing of Chairman John L. McClellan (D.-Ark.)—plan to go beyond this and examine the conflict-of-interest question in detail when hearings resume, probably early next month.

Their strategy is to emphasize that the Supreme Court has ruled public officials cannot content themselves with acting honestly but must also avoid putting themselves in situations where conflict of interest conceivably could occur. The court's Dixon-Yates decision is complemented by the Kennedy Administration's own 1961 standards of conduct for defense officials which declare, in part, that "even though a technical conflict of interest . . . may not exist, it is desirable to avoid the appearance of such a conflict from a public confidence point of view."

Gilpatric did considerable legal work for General Dynamics before becoming deputy defense secretary, while Korth headed a Ft. Worth, Tex., bank which loaned money to the firm. Korth is from Ft. Worth, where General Dynamics will do its F-111 work. The program is expected to cost at least $7 billion (see p. 26). Both men have steadfastly denied all inferences that they were guilty of any conflict of interest in the award.

However, Sen. McClellan himself feels there is enough question to justify a detailed examination. Sen. McClellan will not attempt to make a legal case against the Defense officials, but he feels that Korth certainly should have exercised better judgment and disqualified himself from the F-111 competition just as he did in the X-22A research vehicle selection process. Korth declined to participate in the X-22A competition because he formerly was a director of Bell Aerospace Corp. whose Aerosystems Div. won over Douglas Aircraft Co. (AW June 24, p. 36).

Navy had recommended that Douglas get the X-22A contract.

As for Gilpatric, his standing with Sen. McClellan plummeted when the deputy defense secretary visited his office and said he did not know who gave the press a background briefing criticizing the subcommittee's F-111 investigation. A few days later Gilpatric admitted during a subcommittee hearing that he had given such a briefing. So Gilpatric can expect little sympathy from Sen. McClellan when the Republicans on the subcommittee explore conflict of interest possibilities, even though it will be a Democratic-controlled subcommittee challenging the ethics of a Democratic Administration.

Gilpatric came to his present Defense post from the New York law firm of Cravath, Swaine and Moore which has represented many defense contractors, including General Dynamics. Gilpatric told the Senate Armed Services Committee during his confirmation hearing Jan. 17, 1961, that once he was confirmed "I will retire, of course, from that firm, and I will have no financial or other interest in it, except that I will be paid sums of money that will represent my interest in work that was done before I left the firm; not large sums of money, but sums that represent the unbilled and uncollected work of the firm for past periods. But I repeat, I will have no interest whatsoever in the future business of the firm, and I will sever my connection with it."

Although he said at the time he was prepared to stay in the Defense Dept. "as long as I am asked to do so and feel I can be effective in doing so," Gilpatric's announced plans call for departure this year.

Gilpatric told the McClellan subcommittee last Mar. 21 that after he left the post of under secretary of the Air Force in 1953, "I made it a matter of my personal policy never to represent any client in any dealings with the Defense Dept.," adding that he would follow that same practice if he returns to law again. "I did do certain work for Boeing and for General Dynamics," he said, "but I had no direct dealings with the Defense Dept."

Korth was president of the Continental National Bank in Ft. Worth when he was nominated as Navy secretary. He told the Senate Armed Services Committee at his confirmation hearing Jan. 18, 1962, that he had disposed of all stocks "which might have even a remote defense implication." He said at the time that when he left government service he hoped to return to the Continental National Bank. Korth said during the F-111 hearings that his bank loaned General Dynamics less than $600,000, calling it participation "in a small way" in a loan that was

Argosy Production

London—Hawker Siddeley's Avro Whitworth Div. will build 10 Argosy turboprop Series 200 freighters on speculation against orders now being negotiated. First Series 200 airplane (AW Nov. 19, 1962, p. 49) is in final assembly at division's Bitteswell factory and the aircraft will fly before the end of the year.

Company says use of the new box-spar wing permits increase in take-off weight to 90,000 lb., a 2,000-lb. increase, and landing weight will be 86,000 lb., compared with 80,000 lb. on Series 100 airplanes. Maximum payload increases 3,000 lb. to 310,000 lb.

Of 10 Series 100 Argosies built, seven are in service with Capitol Airways and three with British European Airways. Order for 56 military versions, with beaver tail doors and designated Argosy C-1, will be completed soon for the Royal Air Force.

negotiated by the Chase Manhattan Bank.

Sens. Karl E. Mundt (R.-S.D.) and Carl T. Curtis (R.-Neb.), ranking Republicans on the subcommittee, are expected to lean heavily on the Supreme Court's Dixon-Yates decision in charging that at the very least, Gilpatric and Korth failed to avoid the appearance of conflict of interest.

The court (U.S. vs. Mississippi Valley Generating Co., Jan. 9, 1961) interpreted the federal conflict of interest statute (18 U.S.C. 434), which was still in force when the F-111 contract was awarded but since has been superseded by a similar law. The statute states: "Whoever, being an officer, agent or member of, or directly or indirectly interested in the pecuniary profits or contracts of any corporation, joint-stock company, or association, or of any firm or partnership, or other business entity, is employed or acts as an officer or agent of the United States for the transaction of business with such business entity, shall be fined not more than $2,000 or imprisoned not more than two years, or both."

One interpretation expected to be raised by Sen. Mundt is that Gilpatric and Korth would have an indirect interest in the pecuniary profits of their old firms if they planned to return there after government service.

"The moral principle upon which the statute is based," the court said, "has its foundation in the Biblical admonition that no man may serve two masters, a maxim which is especially pertinent if one of the masters happens to be economic self-interest. . . . The statute does not specify as elements of the crime that there be actual corruption or that there be any actual loss suffered by the government as a result of the defendant's conflict of interest. . . . The statute is thus directed not only at dishonor, but also at conduct that tempts dishonor. This broad prescription embodies a recognition of the fact that an impairment of impartial judgment can occur in even the most well-meaning men when their personal economic interests are affected by the business they transact on behalf of the government. To this extent, therefore, the statute is more concerned with what might have happened in a given situation than with what actually happened. It attempts to prevent honest government agents from succumbing to temptation by making it illegal for them to enter into relationships which are fraught with temptation."

The court said that Adolphe H. Wenzell, who served as a consultant to the government on a contract which might benefit his own First Boston Corp., violated the conflict of interest statute "by entering into a relationship which made it difficult for him to represent the government with the singleness of purpose required by the statute."

A question the Republicans want to explore is whether Korth could act with a singleness of purpose on a contract as vital to the fortunes of his hometown firm.

Compilation of Summary Reports Due to Begin in Project Forecast

Los Angeles—USAF's Project Forecast is scheduled to move this month into its second phase, involving compilation of final reports summarizing projections of Air Force activities over at least the next 10 years (AW Apr. 8, p. 25).

Briefings and discussions on the project were scheduled to end in mid-September. The summary reports will encompass aeronautical and space regimes and will define operational system goals, capabilities to be demonstrated and technology to be pursued during the coming decade.

The reports are to be submitted to USAF Chief of Staff Gen. Curtis LeMay, Defense Dept. and the President and are to be included, where applicable, in the Fiscal 1965 budget request.

The Forecast program has been comprised of 13 technical panels. These groups have been briefed by industry, scientific institutions and individuals. The panels will act as filters to make recommendations in specific areas to satisfy USAF capability requirements. Panel categories include:

- **Weapons,** encompassing nuclear, non-nuclear, biological, and chemical warfare types.
- **Electronic countermeasures** and counter-countermeasures.
- **Reconnaissance.**
- **Surveillance and detection.**
- **Communications.**
- **Guidance and navigation.**
- **Data processing and display.**
- **Flight dynamics.**
- **Propulsion.**
- **Power sources.**
- **Materials.**
- **Bioastronautics.**
- **Geophysics.**

Capability areas analyzed in Project Forecast include:

- **General war.**
- **Limited war.**
- **Air defense.**
- **Intelligence,** surveillance, and reconnaissance.
- **Support.**

Aspects of potential threat, national policy and military doctrine, resources and costs have been available to the panels and capability-area analysis groups.

Director of Project is Gen. Bernard A. Schriever, commander of Air Force Systems Command, who reports to Gen. LeMay. Manager of Forecast for Gen. Schriever is Maj. Gen. C. A. Terhune, commander of USAF's Electronic Systems Div.

The 13 technical panels contain military and civilian personnel. The groups that are engaged in investigating the five capability-areas are composed of military personnel.

Military Comsat

Various government agencies were briefed last week on the details of the source selection board's choice of a contractor for the military medium-altitude communication satellite (AW Sept. 2, p. 40).

The briefings were conducted by USAF Space Systems Div.'s Col. H. B. Kucheman, Jr., a non-voting member of the source selection board, which met Aug. 28-29.

After a presentation to Gen. Bernard A. Schriever, commander of USAF's Systems Command, the board briefed Defense Communications Agency Sept. 3, USAF's Aeronautical Systems Div. Sept. 4, Air Council Sept. 5, and Dept. of Defense Research & Engineering Sept. 6.

Following this, contractor selection and opinion of the reviewing bodies were to be presented to Defense Secretary Robert S. McNamara and the President.

NASA Lunar Orbiter Competition Stirs Broad Interest in Industry

By Edward H. Kolcum

Washington — Long-awaited photographic lunar orbiter finally achieved program status last week when National Aeronautics and Space Administration asked industry to bid on design, engineering and construction of complex camera payloads that will be launched by Atlas Agena D. The orbiter will take closeup pictures of the moon's surface to determine sites for safe Surveyor and Apollo landings.

The orbiter is one of the few new NASA programs that will be initiated with Fiscal 1964 money. Consequently it is generating considerable aerospace industry interest. By late last week, more than 50 potential contractors had asked for copies of the proposal request.

Schedule calls for technical bids to be submitted by Oct. 4, and cost bids two weeks later. The space agency hopes to award a single contract for five flight and three ground test payloads by mid-November. First-year funding for both payload and launch vehicles will total about $20 million.

Surveyor Plan

Lunar photographic orbiter has been considered a critical preliminary to the Apollo manned lunar landing mission and was carried in the NASA program for several years under the name of Surveyor orbiter. However, it never got beyond feasibility studies, mainly because of cost overruns in other unmanned lunar and planetary programs. The name Surveyor orbiter (AW Sept. 2, p. 18) has now been dropped.

The orbiter now planned represents significant changes from the original Surveyor orbiter. The program will be managed by Langley Research Center rather than the Jet Propulsion Laboratory, which has handled all NASA unmanned lunar and planetary payloads until now.

Aviation Week & Space Technology learned that JPL asked several months ago to be relieved of this project because of its heavy workload in the Ranger, Surveyor and Mariner programs. Several other centers bid for the orbiter, and Langley was selected (AW July 8, p. 35). Goddard Space Flight had proposed to modify the IMP (interplanetary measurement probe) payload for a lunar photography mission, and to launch it with the Delta vehicle.

The orbiter program manager is expected to be Clifford H. Nelson, who will report to Navy Capt. Lee R. Scherer in the Office of Space Sciences at NASA headquarters. Oran W. Nicks will be the liaison between the space sciences office and the Manned Space Flight Office, which will use the data.

Capt. Scherer said the contractor will be given a fairly wide latitude in selecting payload configuration, camera subsystem and means of picture storage, and in methods of pointing and stabilizing the payload. Major constraints are payload weight—830 lb.—and the requirement to fit the payload into the envelope of one of five fairings that have been qualified on Agena flights.

In concept, the major difference between the Langley and Surveyor orbiters is that the new one will concentrate on high-resolution photography of the specific Apollo-Surveyor landing area, rather than try to obtain total coverage of the lunar surface, as Surveyor would have. Region of coverage will be specified for each mission within the limits of ±10 deg. latitude and ±60 deg. longitude. Camera resolution will be one meter per television line, as compared with the Surveyor requirement of 10 meters. This means the Agena orbiter will be able to distinguish topographical features as small as 2.5 meters.

Initially, Capt. Scherer said, the Agena orbiter will be used for:

- **Apollo site certification.** This is considered the payoff mission for the payload because the results will be tied in with the findings of the Ranger and the Surveyor soft lander. The orbiter will use albedo variance, shadows or stereo techniques to detect lunar surface faults—ground slopes of over 7 deg. and projections and depressions as small as 1.5 ft. high and 6 ft. in base diameter.

This mission will be accomplished in what is called the high resolution mode, which requires that the payload orbit the moon no lower than 22 mi., and provide total coverage of 1,250 sq. mi. In single area contiguous coverage, a minimum dimension of 7.5 mi. is required. Basic objective is to determine nearly flat areas as small as 25 sq. ft., which is the landing area required for the Lunar Excursion Module (LEM).

- **Surveyor site certification.** This mission is designed to provide the specific aiming circle for Surveyor by eliminating areas which appear dangerous. In this mission, the camera will be required to cover a 25,000 sq. mi. contiguous area with a minimum single dimension of 62 mi. Camera resolution is not specified but probably will be about one-fifth that of the high-resolution mission, or 5 meters. Projections 12.8 ft. high and 41.2 ft. in base diameter are to be detected.

If the orbiter program runs into delays, it will not hold up the Surveyor lander program, Capt. Scherer said.

- **Design certification.** Pictures of specific possible landing sites will be taken throughout the entire region of coverage in a mission similar to the high-resolution mission above. It differs in that the camera will be commanded on and off over selected areas instead of sweeping across the general proposed landing area continuously.

Other Tasks

In addition to these initial missions, the orbiter is capable of a number of other tasks, Capt. Scherer said. Among them are exploration of the higher lunar latitudes, determination of the precise shape of the moon, and sensing of radiation and micrometeoroid incidence.

Apollo flights will be concentrated essentially around the lunar equator, and the initial exploration of the surface will be on this part of the moon. After the Apollo landing has taken place, an Agena orbiter could photograph areas other than the equatorial region.

Shape and mass distribution of the moon can be determined by tracking a lunar orbiter for a period of about two months. A transponder probably will be added to an orbiter for this mission.

Photographs and data from the Agena orbiter will be transmitted to JPL's Deep Space Network.

The ground test program includes payloads for qualifications test and mission simulation reliability test, both by the contractor, and a performance demonstration test by NASA at the Goldstone tracking facility.

Orbiter Schedule

Washington—Lunar photographic orbiter program has an extremely tight schedule calling for first flight in Fiscal 1965 and the remaining four payloads to be launched every 75 days. Each payload will have one mission, involving either high or moderate resolution, and is not required to be capable of both.

Although the orbiter can complete its task in two or three cycles of the moon, the sun and the area to be photographed must be in acceptable positions. Consequently, National Aeronautics and Space Administration is specifying that all photographic data be transmitted within 30 days after launch, and that components have 60-day minimum lifetimes.

To attain the payload on schedule and within bid cost, NASA will award a cost-plus-incentive-fee contract. Contractor will be penalized an amount not decided if he does not deliver on time. For every dollar over-run, the contractor will absorb 10 cents. For every dollar under-run, he will receive an extra 10 cents in fee.

Adm. Anderson Attacks Pentagon Policies

Washington—Former Chief of Naval Operations Adm. George W. Anderson last week accused civilian Defense Dept. officials of by-passing military recommendations in design competitions and source selection procedures, making too many decisions at high levels and trying to stamp officers into common molds.

Adm. Anderson, who was dropped as the Navy's chief after one term because of his opposition to Administration policies, including the TFX decision (see p. 26), is now serving as ambassador to Portugal.

In a speech made the day after he assumed his duties as ambassador, Adm. Anderson said he is "gravely concerned that within the Defense Dept. there is not the degree of confidence and trust between the civilian and military echelons that the importance of their common objective requires. This two-way responsibility requires wisdom, respect and understanding from both sides."

Contrary Views

Expressing a contrary view in proper channels or making a frank response to congressional inquiries does not mean a challenge to civilian control, he said. Military conduct is based on integrity, but the standard of integrity can be lowered quickly by impulsive actions or intemperate judgments, Adm. Anderson said.

"I view any diminution of military recommendations . . . with grave alarm. Certainly the abrupt reversal of military recommendations without interim consultation, as was the case in the TFX and V/STOL contracts, is fraught at a minimum with unpleasant developments and potentially grave dangers . . . Ground rules for competitive procurement must be clear, consistent and impartial," Adm. Anderson said.

He applied the same reasoning to U. S. relations with its allies, specifically mentioning the cancellation of the Skybolt air-to-ground missile program after an ally had been encouraged to look forward to the availability of the weapon. Continuous consultation is necessary to avoid abrupt actions tied to the budget cycle, he added.

Adm. Anderson said a senior military representative from the Joint Chiefs of Staff should participate at every international conference involving weapons programs, along with the secretary of defense. This was an obvious allusion to the all-civilian Bermuda conference at which the Skybolt cancellation was announced to the British.

Adm. Anderson also defended the existence of separate services, saying: "Monolithic structured organizations can kill imagination, stultify initiative, completely eliminate the effectiveness of those in the officer corps who have gained wisdom and experience. Overcentralization at the top, and discouragement of initiative at lower echelons can critically increase reaction time in crisis."

Too many decisions are being made at higher levels than is necessary and attempts are being made to stamp officers into common molds, Adm. Anderson said. Different services take different positions on many matters, offering higher authority clear options and greater flexibility in making decisions, he said.

The desirability of having a narrow edge in the performance of a weapon system to achieve greater safety and success in combat was stressed by Adm. Anderson.

"I am concerned that service experience tends to be subordinated to evaluation by operations analysts on the staff of the secretary of defense or involved in contract research activities," he said.

"I am disturbed because now, the operations analyst—properly concerned with 'cost-effectiveness'—seems to be working at the wrong echelon—above the military level rather than in an advisory capacity to the military, who should thoroughly appreciate his assistance.

Unhealthy Imbalance

"Specialists cannot, without danger, extrapolate their judgments into fields in which they do not have expert knowledge. Unfortunately, today in the Pentagon an unhealthy imbalance has resulted because at times specialists are used as experts in areas outside their fields. This has resulted in a tendency to draw conclusions before all the evidence has been examined," he said.

To justify this imbalance, senior military officers are pictured as villains opposed to progress and new ideas, Adm. Anderson said.

Adm. Anderson made a plea that those Joint Chiefs of Staff who also head their services be appointed for four-year terms in order to achieve service stability. He pointed to the Marine Corps as an example.

The Joint Chiefs, he said, are part of the checks and balances of the U. S. government and should not become a rubber-stamp body. They "should not be swamped with matters that should be processed in service channels, nor should their functions be taken over by segments of the office of the secretary," he said.

Adm. Anderson concluded by quoting from President Kennedy's first State of the Union address: "Let it be clear that this Administration recognizes the value of dissent and daring, that we greet healthy controversy as the hallmark of healthy change."

High-Pressure Thrust Chambers Static-Fired

Pratt & Whitney Aircraft has successfully static-fired eight high-pressure rocket thrust chambers, burning liquid hydrogen and liquid oxygen, at the company's West Palm Beach, Fla., research and development center.

Most significant aspect of the firings, according to the company, was the successful demonstration of a coolant system for the combustion chamber. Although Pratt & Whitney declined to reveal the coolant technique used, it was believed that the method was transpiration cooling, in which a fluid bleeds through pores into the chamber to form a thin insulating film along the walls of the chamber.

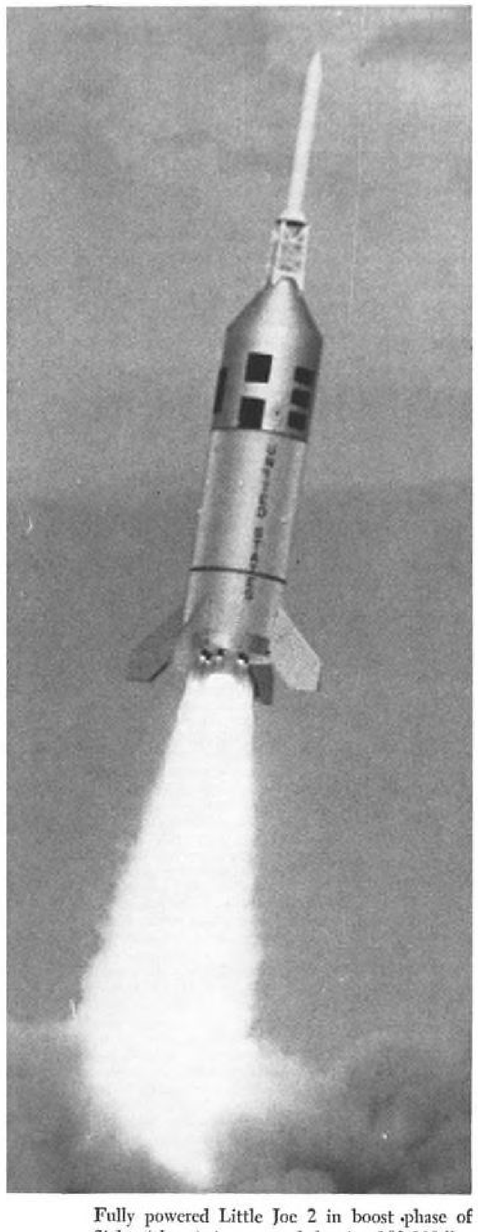
Virtue of a high-pressure engine lies in the fact that higher pressures tend to increase the specific impulse of the unit, by elevating combustion temperatures and increasing exhaust gas velocity. Some cooling, however, is required for the thrust chamber, but the company found that the regenerative technique—in which the fuel is circulated in tubes along the outer wall of the engine prior to introduction into the chamber—was inadequate. Ablation and char techniques also were ruled out.

Thrust chambers used in the series of tests consisted of chamber, injector and nozzle and were understood to be about 10-in. long and 2.5-in. in diameter, with a throat exit of about 1.5-in. dia.

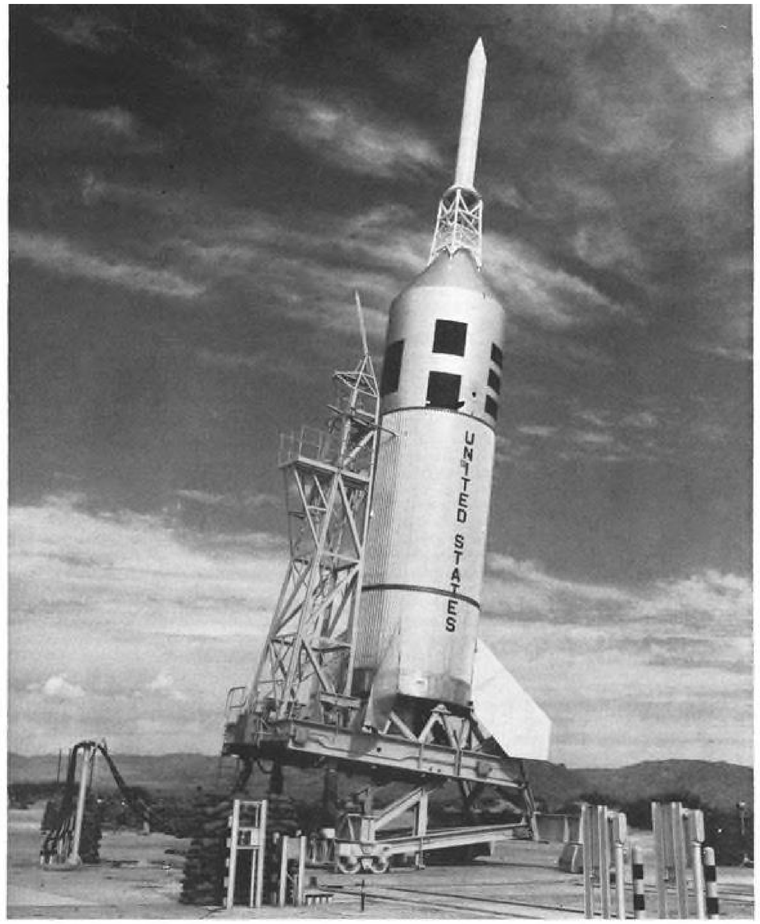
Thrust achieved was consistently about 11,000 lb. Chamber pressure was believed to be an order of magnitude greater than that of Pratt & Whitney's RL-10, which is about 300 psi., but USAF's Rocket Test Center, Edwards AFB, Calif., which sponsored part of the work, refused to divulge exact figures. Most of the work done in the series was company-funded.

The company said that the series, which ran from the beginning of April through mid-July, 1963, indicates that successful development of the high-pressure concept—which many propulsion companies have been investigating—could lead the way to future engines with greatly increased thrust and improved fuel consumption, with little corresponding increase in physical size over today's engines.

Little Joe 2 Shown With Dummy Module In First Flight Test

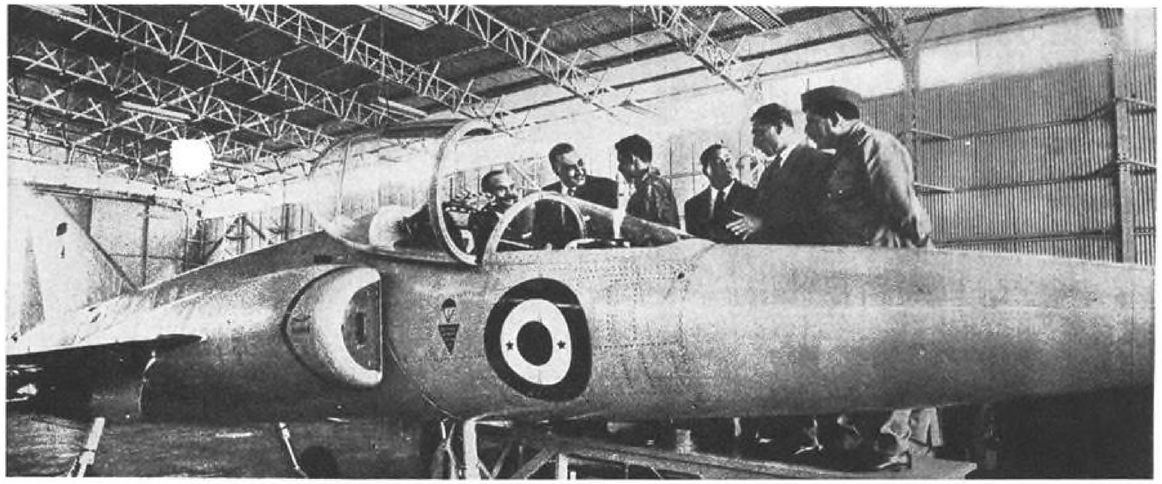


Fully powered Little Joe 2 in boost phase of flight (above) is powered by its 103,200-lb.-thrust Aerojet-General Algol sustainer and six 34,460-lb.-thrust Thiokol boosters. The vehicle attained programed speed of about Mach 1.1 and a maximum altitude of about 24,000 ft.



Little Joe 2 is seen in firing position (above) for its successful first flight test at White Sands Missile Range Aug. 28 (AW Sept. 2, p. 20). Steel simulated Apollo command module and dummy escape tower top the General Dynamics/Convair Little Joe 2 vehicle. Launch followed a 6-hr. 10-min. countdown during which no holds were encountered. The vehicle impacted (below) about 47,000 ft. downrange, rather than the approximately 35,000 ft. planned, as a result of a failure to terminate thrust when the Algol motor destruct system did not work. About 100 sec. of telemetry was recorded during the flight of the Little Joe 2 vehicle.





FIRST EGYPTIAN-BUILT SUPERSONIC FIGHTER, based on the Spanish Hispano HA-300 designed by Willy Messerschmitt, is inspected by Egyptian President Gamal Abdel Nasser (second from left). Original design called for a truncated delta wing planform. One change evident is in the engine inlets, which have larger ducts and semicircular geometry, not the wedge shape of the early concept. Dimensions of the original design were 43 ft. length and 22 ft. span.

Egypt Plans Satellite Launch Within Year

By Cecil Brownlow

Cairo—United Arab Republic, with a struggling aerospace industry that has largely sprung from the desert over the past three years, plans to launch a satellite into orbit within the next 12 months as a concrete example of the country's growing political-military strength in the arena of world affairs.

Designated "The Star" and developed primarily by a team of German technical experts working in Cairo, the satellite package has a primary mission of dramatically demonstrating Egypt's paramount role within the Middle East, its position of leadership within the "neutralist" bloc and its general technological surge under the aegis of President Gamal Abdel Nasser.

A related and corollary political mission will be to impress the newly independent nations of Central Africa, a region in which Egypt and Israel already are grappling in a battle for superiority of influence and prestige.

On the technical side, the satellite's payload will be oriented toward probing the earth's electromagnetic field. With the limited facilities currently available to Egypt, data readout and tracking could pose serious problems, and some observers believe the launch may be delayed until adequate ground stations can be constructed.

Others, however, believe the launch may be made as early as late November, and most agree that an attempt will be made to place the vehicle into a relatively low orbit of approximately 300 mi. before next July 23, anniversary date of the Egyptian revolution.

In a possible related move for follow-up launches of more sophisticated vehicles, Dr. Hassan Marie, chairman of the country's Supreme Committee for Space Research, has recommended to Minister of Scientific Research Dr. Salah Hedayet that the U. S. should be invited to establish a tracking station in Egypt as part of the former's global network.

The station also would serve as a stimulus to Egypt's interest in space research as a whole.

Probable launch vehicle for "The Star" will be the two-stage Al Ared (Pioneer) tactical missile first shown at this year's revolutionary day parade (AW July 29, p. 26; Aug. 5, p. 30) or possibly a three-stage version of the vehicle reportedly now under development.

In the missile field as such, UAR officials also are believed to be planning to produce within Egypt a version of the Russian SA-2 radar-guided surface-to-air defense system, probably at the Heliopolis factory near Cairo where the 600-mi.-range Al Ared and its one-stage predecessors—the Al Kahir (Conqueror) and Al Zafir (Victory)—are now being produced. It is not known whether a formal licensed-production agreement has been, or will be, signed with the Soviet Union.

Much of the know-how can be attained through investigation of the SA-2s already delivered directly to the UAR from Russia for the area defense of major Egyptian cities and installations, particularly Cairo, Alexandria and the Suez Canal. Over 100 SA-2s have arrived here thus far and, with the aid of Soviet technicians, construction of the concrete ground emplacements is under way, with between 12 and 16 missiles scheduled for each individual site. Egyptians also reportedly are adapting the SA-2 for shipboard use.

While the SA-2 employs a solid propellant, Egypt's three tactical missile systems displayed to date use liquid fuel, probably kerosene and nitric acid. Al Kahir, which bears a family resemblance to the German V-2 of World War 2 vintage, has a reported range of 360 mi. Range of the smaller Al Zafir is quoted at 225 mi.

On the aircraft side, prototype of the UAR's Mach 2.2 fighter project, the HA-300, recently was rolled out from the new engine-airframe manufacturing complex in near-by Helwan. Aircraft, based upon a design by Willy Messerschmitt (AW Apr. 22, 1957, p. 27), will be test flown in Egypt by an Indian pilot, and its advanced engine design will be flight tested in India prior to series production at Helwan.

The HA-300 bears a conceptual resemblance to India's HF-24 developed by Dr. Kurt Tank (AW Dec. 17, p. 88), and to the Northrop F-5A. The Egyptian fighter has a long needle nose, slim fuselage and thin wing section. Tank will aid in the Indian tests of the aircraft's new engine developed at Helwan by Dr. Ferdinand Brandner, noted Austrian designer who helped father the 12,000 shp. Type K turboprop engine for the Russian Bear long-range bomber while a Soviet prisoner after World War 2 (AW Apr. 8, 1957, p. 53).

Incorporating an advanced state-of-the-art design, including provision for use of a variable geometry inlet, the Brandner engine began running on a Helwan test bench in mid-July and, according to one observer, met or exceeded "all expectations." Under present scheduling, series production should begin within approximately one year's time.

Two of the engines, believed to have over 7,000-lb. thrust each, will be used to power the HA-300.

To maintain the tempo of the airframe test program for the HA-300, the prototype and possibly other initial aircraft off the line will be powered by two Bristol Siddeley Orpheus 703 turbojets of 4,850-lb. thrust each. In this configuration, the aircraft probably will be able to operate only in the lower supersonic ranges. One spokesman says, however, that the aircraft can and will be retrofitted to take the Brandner powerplant once its test program has been completed.

HA-300 also will be equipped with the Martin-Baker zero-altitude ejection seat. Total of six of these ejection seats are believed to have been ordered thus far.

Wind tunnel tests on the HA-300 configuration and engine-airframe combination have been conducted in the United Kingdom, The Netherlands and Switzerland. Majority of the avionic components are being ordered directly from West European suppliers.

Aside from prestige, a primary reason behind Egypt's drive to establish an independent aerospace industry is its reluctance to be dependent upon any outside power—East or West—for the equipping and support of its armed forces, a situation with which it is now forced to live.

The UAR, some observers say, has experienced difficulty in the past in obtaining sufficient spares from Russia for its series of Soviet MiG fighter aircraft. As a consequence, some components, particularly for the MiG-21, have been fabricated on a bread-board basis for the UAR aircraft at factories within Western Europe.

In addition to the HA-300 and the HA-200 jet trainer built under license from Spain's Hispano-Aviacion, the Egyptian industry also is contemplating development and production of a short-range transport, initially for use by United Arab Airlines over its internal route structure. Effort also probably would be made to export the aircraft to neighboring countries, particularly the newly-independent African nations where in many instances there is a severe shortage of surface transport facilities.

The Helwan complex, officially inaugurated by President Nasser in July, 1962, is cutting its jet production teeth on the HA-200 tandem two-seat trainer, of which the first prototype appeared in Spain in 1955. Aircraft essentially is a Messerschmitt design.

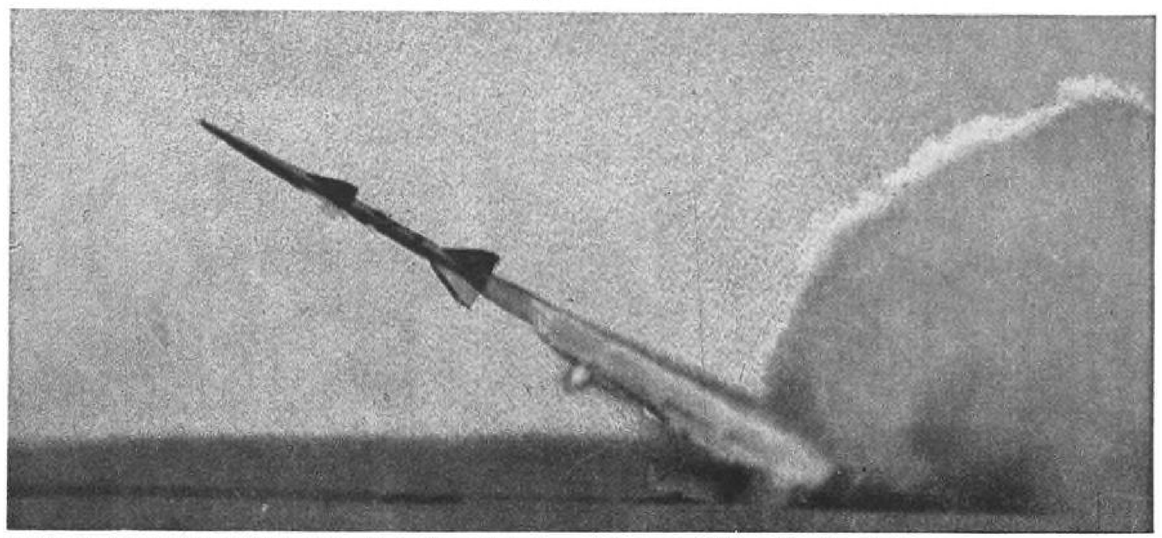
A total of nine HA-200s, known as the Al Kahira in Egypt, are believed to have been built at Helwan thus far. Eight of these appeared in the July 23 fly-by of Egyptian military aircraft.

A modified version of the HA-200's Turbomeca Marbore 2A powerplant also is now being produced at Helwan. First Egyptian model of the engine was placed on the test bench in April, 1962, and series production got under way in June of this year. Two of the Marbores, which have a static thrust of 880 lb. each, are used to power the HA-200.

The Helwan complex, with approximately 323,000 sq. ft. of floor space, has literally sprung up since 1960 when Dr. Brandner and other European experts began working for the UAR. Engine facility, latest to get under way, is expected to be fully operational by the end of the year. Tooling for both the airframe and engine lines has been purchased almost entirely from Western Europe. A number of component parts also are still being produced in Europe and probably will be for some time to come, particularly in the case of avionics.

The Heliopolis missile facility, on the other hand, is the outgrowth of an aircraft factory originally established there in 1950 for the licensed production of World War 2 Bucker BU 181 piston-engine trainers.

With such a rapid buildup coupled with a thin background of experience, Egypt has had to rely largely upon experienced European engineers and technicians. Egyptian engineers, however, are being trained and schooled by the Europeans, both in the classroom and in on-the-job training procedures. Relatively large numbers of students also are being trained in aeronautical engineering at schools here and abroad, and the Arab republic eventually plans to have the capability of supporting and expanding its aerospace industry with little or no assistance from outside technicians.



FIRING OF A RUSSIAN-DESIGNED SA-2 anti-aircraft missile is shown being conducted in an Egyptian desert area.

M-2 Research Craft Landed Seven Times

Edwards AFB—Feasibility of landing a lifting-body re-entry vehicle in the same manner as conventional aircraft is being investigated by the National Aeronautics and Space Administration's Flight Research Center with a low-cost, lightweight research craft designated the M-2.

The M-2 has been successfully landed seven times following air drops from 12,000 to 13,000 ft. in a flight test program which is to include another 15 to 20 flights over the next two months.

Other aspects of the lifting body program which can be explored with the basic M-2 vehicle include moving the cockpit forward for better visibility and eliminating the elevons. Those modifications to the basic M-2 plywood shell would not require that a new vehicle be built. They are now being made to wind tunnel models at Ames Research Center.

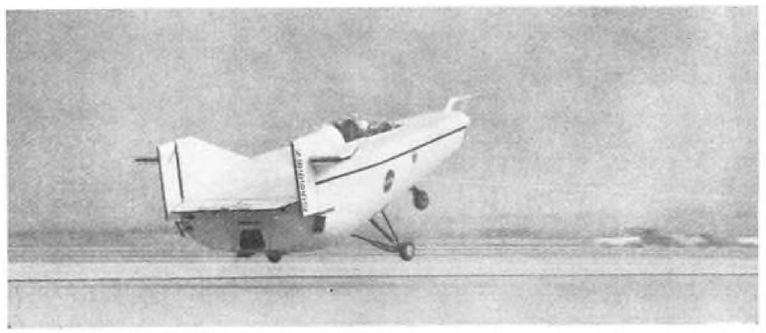
Combining the present test program with proposed modifications could carry M-2 research through next spring. A potential follow-on to the present M-2 would be a full-weight vehicle of metal rather than plywood construction. It would be selected from various wind-tunnel model candidates and probably would be air-dropped in the same manner as the X-15.

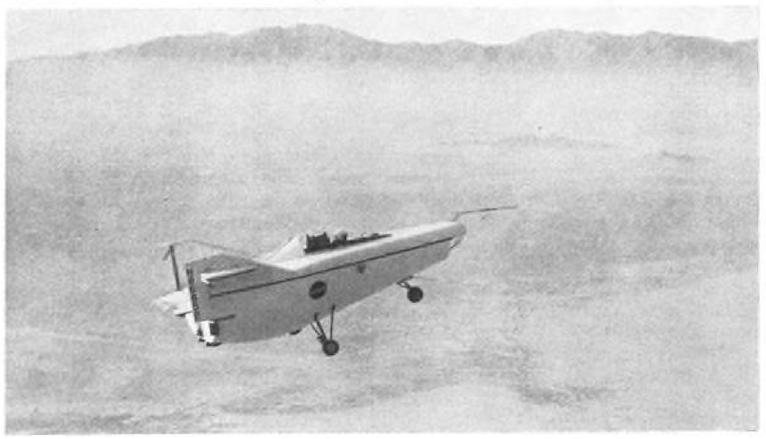
One objective of the follow-on research vehicle program would be to explore the lateral range capabilities of lifting-body re-entry vehicles at subsonic and transonic speeds. No follow-on program has been approved yet, however. NASA Test Pilot Milton Thompson, who has flown the M-2 on all flights, reported that handling characteristics of the M-2, with the exception of lateral control, are similar to winged aircraft.

The M-2, which has immediate and positive response about all axes, is susceptible to turbulence and gusty wind conditions because of its limited lateral stability. Stability augmentation is not incorporated in the vehicle but is considered a necessary feature for advanced models.

The half-cone-shaped, wingless vehicle was based on an original design and wind tunnel work at Ames Research Center (AW Mar. 18, p. 52). The M-2 is fabricated of ¾-in. mahogany plywood and tubular steel. Its nose is fiber glass on the upper portion and plexiglass on the lower section for better visibility at high angles of attack.

The M-2 is 20 ft. long, 10 ft. high and 13 ft. wide. Its weight with pilot is 1,130 lb. Control surfaces are dual rudders for yaw, elevons on each side of the vertical fins for roll and pitch augmentation, and trailing edge flaps for pitch.





M-2 RESEARCH VEHICLE, piloted by NASA's Milton O. Thompson, begins a takeoff run (above) at Rogers dry lake bed towed by a C-47. M-2 then is towed (below) to 15,000 ft. M-2 has been successfully landed seven times after air drops.

Cost of the M-2 up to the first flight was estimated at $60,000. That included $20,000 for the vehicle and $40,000 in related costs such as engineering. The relatively low cost of the vehicle has been achieved primarily through lightweight construction and maintaining simplicity in design.

The air-tow program, following investigation of stability during ground tow, used a C-47 with a 1,000 ft. tow rope. Flights were made early in the day to avoid windy and turbulent conditions. During the two flights to altitudes of 12,000 and 13,000 ft. (MSL) the M-2 was flown higher than the C-47 to stay out of the aircraft's wake. Tow speed was 110-115 kt. Following release, about over the point of intended landing, full left rudder and left stick were applied to guide the M-2 to the left of the aircraft's wake. A standard technique of balancing out altitude and position from the point of touchdown, just as used in flame-out approach maneuvers, was adopted to reach the point of intended landing.

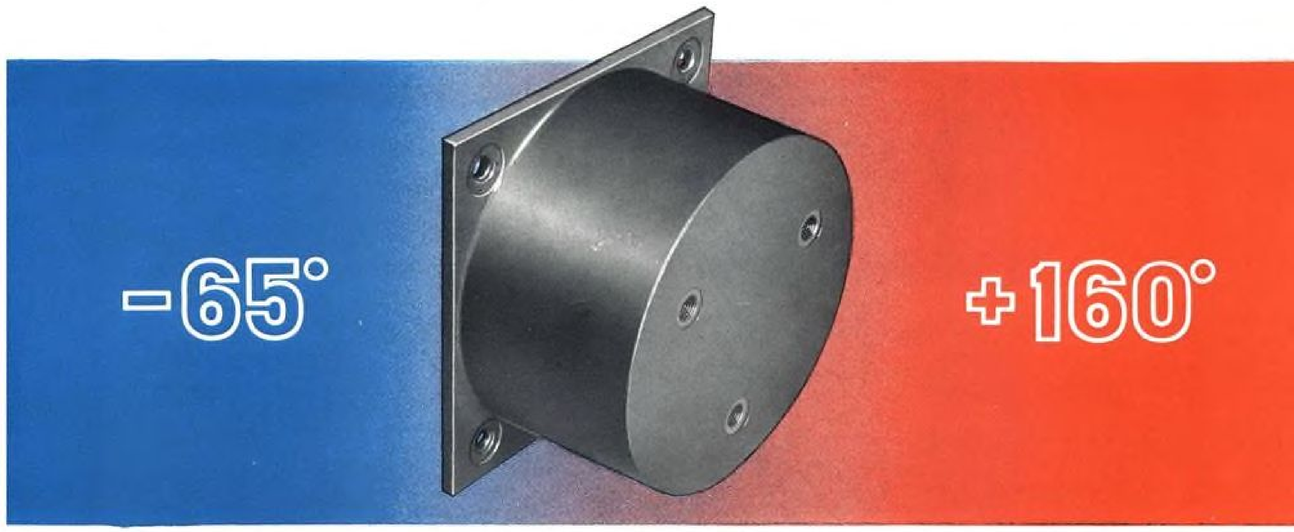
The M-2 was glided between 115 and 120 kt. with a rate of descent of about 4,000 fpm. up to the final portion of the approach. During that time it was flying less efficiently than its optimum maximum range speed of 72 kt. which would give it a glide ratio of approximately 3.2 at an angle of attack of 12 deg. Therefore, altitude is most efficiently lost by increasing speed during the 360-deg. descent to keep from landing long. Landings between 75-80 kt. were made on the dry lake bed. Other features of the M-2 include:

- **Nose wheel steering.**
- **A 240-lb. solid-propellant rocket** for emergency propulsion during landing or takeoff. The rocket, called "instant l/d" (lift over drag) would be used to decrease rate of deceleration and would provide extra time to maneuver.
- **Two tail skids** preventing over-rotation and damage to the aft portion of the vehicle. When the aircraft is rotated to the tail skids, such as on takeoff, the vehicle is at an angle of attack of 12 deg.
- **Lightweight, Weber rocket-assisted** ejection seat provides zero-zero ejection capability. Addition of the ejection seat and other modifications forced the original vehicle weight up from a planned 800 lb. to 1,130 lb.

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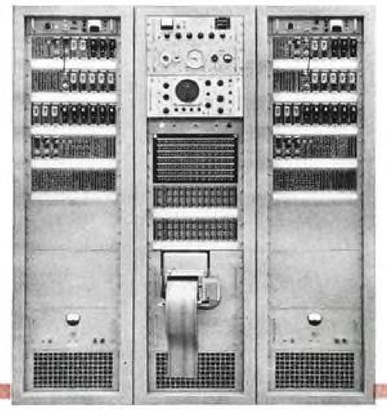
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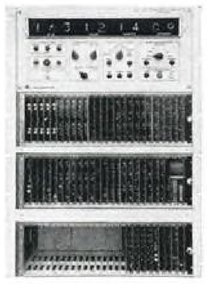
Model 6220 UNIVERSAL... translates all serial time codes to decimal display... parallel BCD output. Tape Search and Control Units (Models 6224, 6225, 6226) available for universal automatic tape search.

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10

Six Fastener Companies Indicted In Federal Price-Fixing Charges

Los Angeles—Two-pronged anti-trust action has been filed here by the federal government against manufacturers and distributors of most of the self-locking nuts sold in this country.

Six firms and three individuals have been charged with violation of the Sherman Anti-Trust Act in a federal grand jury criminal indictment returned to the U.S. District Court here. The indictment accuses the defendants of engaging in a "continuing agreement and concert of action to raise, fix, maintain and stabilize prices for the sale of self-locking nuts."

An accompanying civil complaint ordered by Attorney General Robert F. Kennedy was filed in the same court against four firms, including three named in the criminal action. The civil complaint asked the court to halt the alleged price-fixing and to order the companies to issue new price lists and discount sheets based upon "individual cost figures and individual judgments as to profits."

List of Defendants

Firms named in the criminal indictment were:

- **Elastic Stop Nut Corp.** of America, Union, N. J., and the Collins-Powell Co. of Beverly Hills, Calif., acquired by ESNA in August, 1959, and operated as a subsidiary.
- **Kaynar Mfg. Co., Inc.,** Fullerton, Calif.
- **Standard Pressed Steel Co.,** Jenkintown, Pa.
- **Townsend Co.,** Norwalk, Conn., which last November was merged into Textron Industries, Inc., Providence, R. I., and Boots Enterprises, Norwalk, which was acquired by Townsend in November, 1960.

Individuals named in the criminal indictment were W. F. McGuinness, president of Elastic Stop Nut; Frank A. Klaus, president of Kaynar, and H. Thomas Hallowell, Jr., president of Standard Pressed Steel.

The civil complaint was filed against Elastic Stop Nut, Kaynar, Standard Pressed Steel and Textron.

The criminal indictment charged the price-fixing began prior to January, 1956, and continued until at least October, 1962. As a result of the price fixing, the indictment said, price competition among the corporate defendants was "suppressed," and purchasers were "deprived of the opportunity to purchase self-locking nuts at competitive prices."

The civil complaint repeated the same allegations, with the added charge that "defendants will continue said unlawful combination and conspiracy" unless stopped. The change in some corporate defendants from the criminal indictment is due to changes in corporate status and activities of those involved, since the civil action is based on alleged current activities.

According to the indictment, 1962 sales by the accused companies of pertinent self-locking nuts were: Kaynar, $9,580,000; Elastic Stop Nut, $4,035,000; Standard Pressed Steel, $3,035,000, and Collins-Powell (a distributor only), $1,150,000.

That total was said to amount to 93% of the $19.6-million of the particular type of self-locking nuts sold in this country last year.

Limited Reaction

Reaction of the companies involved in the criminal indictment was limited. A spokesman for Kaynar and that company's president, Klaus, said it is a company policy not to comment upon pending litigation. He added, however, that it is "our policy to obey all federal and state statutes." Robert G. Willis, president of Collins-Powell, said, "I haven't had a chance to study the action, but I'm confident that neither Collins-Powell nor Elastic Stop Nut has done anything to violate the anti-trust laws. It [the indictment] came as a complete surprise to me."

A legal spokesman for Standard and its president, Hallowell, said "it always has been company policy to adhere to the letter and the spirit of the law . . ."

An officer of Elastic said on behalf of it and McGuinness: "The indictment came as a great surprise to us. There is no basis for the charges."

Textron Statement

In Providence, a Textron spokesman said: "Textron's policy always has been to require strict compliance with the anti-trust laws by all of its companies. Boots Aircraft Nut was acquired for Townsend in 1960. We are not aware of any facts indicating violation by officials of Boots."

Self-locking nuts involved in the action appear to cover practically all of that type of fastener used by the aerospace industry. An anti-trust attorney said the term as used in the indictment means those special type of nut fasteners qualified under National Air Standards and military standards.

One company spokesman said his firm made 6,000 fastener-type items, and the self-locking nuts involved represented less than 15% of production.

News Digest

Boeing Co. has won a $6-million Advanced Research Projects Agency contract for the High G Boost (HIBEX) rocket. The project is a part of the Hardpoint anti-ballistic missile program. Boeing will do research and development and produce 12 to 16 vehicles at Seattle, Wash. Testing will be done either at White Sands, N. M., Vandenberg AFB, Calif., or Cape Canaveral, Fla.

First of six USAF-McDonnell Aircraft Corp. ASSET gliders is scheduled to be flown about 800 mi. down the Atlantic Missile Range next week aboard a slightly modified Thor IRBM. The glider will be a 1,100-lb. thermodynamic model (AW Mar. 18, p. 34) and will gather data on temperatures, heat fluxes and pressure distributions on a lifting body during re-entry.

Apollo service module engine was started and stopped 51 times in succession during a recent 900-sec. test of the engine's multiple-restart capability at Aerojet-General, Sacramento, Calif. Throat degradation was within specified tolerances.

Philco Corp. last week received a program definition phase contract for the initial satellite communication control center (ISACCC) which will be the ground terminal for Defense Dept.'s medium-altitude communications satellite. Mellonics Systems Development, Inc., will be a major subcontractor to Philco.

Vice Adm. William F. Raborn, who recently retired as director of Navy Special Projects Office, has joined Aerojet-General Corp. as vice president for program management at El Monte, Calif.

Philco Corp. is discontinuing manufacture of transistors and its Lansdale Semiconductor operations henceforth will confine work to microcircuitry and special semiconductor products. The company is the second organization within one month to cease transistor production. Tung Sol dropped its transistor lines early last month.

Two tetrahedral research payloads, carried piggyback aboard a single Lockheed Agena vehicle, were launched recently by Air Force. The 6-in. diameter satellites, TRS-2 and 3, were built by Space Technology Laboratories, Inc.

Army Nike Zeus missiles have made two more successful intercepts of ICBM targets launched by USAF from Vandenberg AFB. Latest targets used Titan 1 and Atlas ICBM boosters.

FAA, Eastern Test 'Silent Clearance' Plan

Procedure to reduce ATC communications volume is being evaluated on New York-Washington shuttle.

By James R. Ashlock

New York—New procedure called the "silent clearance" is being evaluated on Eastern Air Lines shuttle flights by the Federal Aviation Agency in quest of a means to reduce the growing volume of air traffic control radio communications on high density routes.

Spokesmen for the FAA explained that the proposed procedure involves a compilation of all the factors involved in an instrument flight rule (IFR) clearance, such as taxi instructions, routes, altitude assignments, radio frequencies and radar transponder assignment.

These factors are then applied to specific routes, those from New York-LaGuardia to Washington National, for example. Consequently, a pilot preparing to fly from New York to Washington can make out his flight plan according to the predetermined pattern and file it with the air route traffic control center, usually 30 minutes before his anticipated departure time.

When he is ready to taxi away from the ramp, the pilot calls the airport tower, gives his aircraft identification number, and says "silent clearance alpha Washington."

Phrase is actually a code, informing tower personnel that the pilot has acquainted himself with the required procedures, including the taxi route to the active runway and the flight pattern to the point where he is handed off to control of the air route traffic control center. Thus, if he is cleared to taxi, the tower has only to acknowledge reception of the pilot's call.

Under present procedures, tower personnel give out a stream of instructions on taxiways and runways. Subsequently, the pilot receives a further list of climb and departure routing data on the ground control frequency. All of this, the FAA hopes, can be eliminated or substantially reduced by the silent clearance arrangement. The airlines hope to simplify the paperwork involved in an IFR clearance.

Reduced Communications

"Elimination of a need to issue oral taxi instructions alone will substantially reduce the amount of communication normally required," said Gerald S. Collins, who is coordinating the test program with Eastern.

Collins explained that "silent clearance" means the pilot holds a provisional IFR clearance contingent on oral approval of the air route traffic control center. In effect, the clearance is not finally approved until orally confirmed by the center once the flight is under way.

"It is extremely important that pilots recognize the necessity of this oral clearance," Collins said. "This is the point on which we expected the most problems during the evaluation, but actually it has posed no real difficulty."

Upon calling the air traffic center, the pilot has only to notify it that he is on its frequency. But until the oral clearance is given, he must maintain the altitude marked on his charts for this particular segment of his flight. Even though his "silent clearance" may call for a higher cruising altitude, he cannot proceed toward it until receiving the center clearance.

Alternate Altitude

Collins explained that although the "silent clearance" package contains a standard preferred cruising altitude for the specified routes, leeway is left for alternate altitudes that may be better due to weather conditions.

"What we tried to do in drawing them up was to take into consideration what happens 90% of the time," he said. "But we also had to consider the varying factors."

Pilots can therefore request alternate altitudes, with all other elements in the "silent clearance" package remaining the same, thereby limiting radio talk to merely obtaining the altitude change.

FAA also had to consider the situation in which a pilot might file a flight plan without knowing of late changes in procedures for the route he plans to fly. In the event of such changes the route designation is changed, and instead of being "alpha" perhaps would become "bravo."

If the pilot uses "alpha" in notifying controllers of his silent clearance, the controller knows he isn't aware of the changes and replies simply "bravo." This tells the pilot that there have been some alterations, and to stand by for instructions. Then the controller will instruct him as to routings, climb procedures and radio frequencies under the new arrangement, much the same as is done by the controller in normal procedure at present.

Collins said the FAA has become increasingly concerned at the great amount of talk involved in traffic control, particularly at the peak traffic periods when many flights are converging on airports. In the case of a 67-min. shuttle flight, as much as 10% of the time is currently devoted to air route communication.

It is felt, he said, that the silent clearance may prove especially helpful on high density routes such as those flown by Eastern's shuttle, and where routings and altitudes change little from day to day.

"That's the reason we chose the shuttle for our evaluation," Collins said. "It flies on high density routes, its schedules are constant and the altitudes flown do not vary much, seldom exceeding 14,500 feet."

If the five-month evaluation results are satisfactory, FAA may adopt silent clearance procedure on specified routes for scheduled operations.

CAB Rulings Reflect Helicopter Policy

Washington—Civil Aeronautics Board's determination to control and reduce subsidy payments for helicopter operations has been demonstrated in two recent Board actions limiting approval of new helicopter operators to those able to function without subsidy aid.

San Francisco and Oakland Helicopter Airlines (SFO) was recommended for indefinite certification last week by CAB Examiner Herbert K. Bryan, primarily on grounds that it had already been operating more than a year and appeared likely to become profitable without subsidy eventually.

Earlier, the five-member CAB dismissed a three-year old case investigating the need for a subsidized helicopter operation in the Washington-Baltimore area. Annual cost of the operation would have been $2 million initially, increasing to a higher amount with very little prospect of any subsidy-free operation in less than six years.

Explaining its certification of subsidized helicopter operations in New York, Chicago and Los Angeles, CAB said its purpose has been to encourage the development of rotary wing aircraft as a means of transportation, rather than to meet immediate service needs. Supporting the earlier findings of an examiner, the Board said that the existing helicopter experiment in the three cities is adequate to supply any needed experience.

Service between the cities of Washington and Baltimore, plus the airports of Washington National, Dulles International and Friendship, "with or without subsidy eligibility" was contemplated in the investigation. However, the eight applicants made it clear that they would not accept certification without the protection of subsidy backing.

Examiner Bryan emphasized SFO's unique geographical location, high utilization of equipment and strong public support, and concluded that the carrier was unlikely to require any subsidy support for its operations.

SFO has been operating for about 18 months, has a higher revenue yield and daily utilization rate than any of the three subsidized helicopter operations, Bryan said. Its yield per revenue passenger mile is 49.8 cents, as compared with 29.6 for Chicago Helicopter Airways; 16.8 for Los Angeles Airways and 40.6 cents for New York Airways. Average stage lengths for flights are 2 to 7 mi. shorter for SFO than the others, permitting a daily utilization rate of 5 hr. 27 min., compared with the next highest rate of 3 hr. 2 min. for New York Airways.



VICKERS VISCOUNT G-ASDS, shown parked on the line at Hurn, England, site of British Aircraft Corp.'s main assembly plant, is fourth aircraft in a series of five to be ordered by Red China. Three series 810 Viscounts, G-ASDP, G-ASDQ and G-ASDR, have already been delivered to Peking by BAC crews. A sixth Viscount is presently being built for delivery to China. Aircraft shown here has been painted white on upper half, while bottom is unpainted aluminum. Note temporary registration markings on lower fuselage aft of boarding ladder. Internal markings are in English and are changed after delivery to China. Aircraft for China are powered by Rolls-Royce Dart RDa.7/1 (Mark 525) engines of 1,990 ehp. at takeoff.

Red China Air Expansion Seen

Washington—U. S. is now interpreting the Sino-Pakistani bilateral air transport agreement (AW Sept. 2, p. 31) as a first step in a Red China drive to open international routes that will link it with its European ally, Albania, and permit further expansion into Africa and beyond to Cuba and Latin America.

The growing controversy over the agreement has drawn threats from India to abrogate its air pact with Pakistan and caused a "postponement" of a $4.3-million U. S. loan to Pakistan. The dispute has again focused attention on the close correlation between air transportation and international politics (AW Sept. 2, p. 28).

Although no specifics such as rates, schedules and flight frequencies had been worked out between Pakistan and China as of late last week, it was clear that negotiations were conducted in a harmonious atmosphere. The bilateral calls for reciprocal traffic rights between Dacca, Karachi and Lahore in Pakistan and Shanghai and Canton in Red China with beyond rights for Pakistan International Airlines to Tokyo.

The Chinese will permit American and other international passengers aboard Pakistan flights to enter Red China en route to Tokyo without a Chinese transit visa and to disembark at the Chinese terminal during stopovers. Service is expected to begin early next year.

Chief problem facing the Chinese air expansion program will be in obtaining transit rights over territories intermediate to points at which it obtains landing rights. Failure of the Soviet airline, Aeroflot, to win such rights from Western European nations forced the carrier to inaugurate its service to Cuba from Murmansk across the Barents Sea north of the Scandinavian peninsula.

However, the Red Chinese government has sent technicians into Albania, many parts of Africa and into Cuba and wants to establish aerial communications into these areas.

Under the agreement, China will expand runways at both the Canton and Shanghai airports to accommodate Pakistani Boeing 720B transports. The Communist Chinese airline, operated by the Civil Aviation Administration of China, will fly Vickers Viscount turboprop transports on the route. Six Viscounts have been purchased from the British (see photo above).

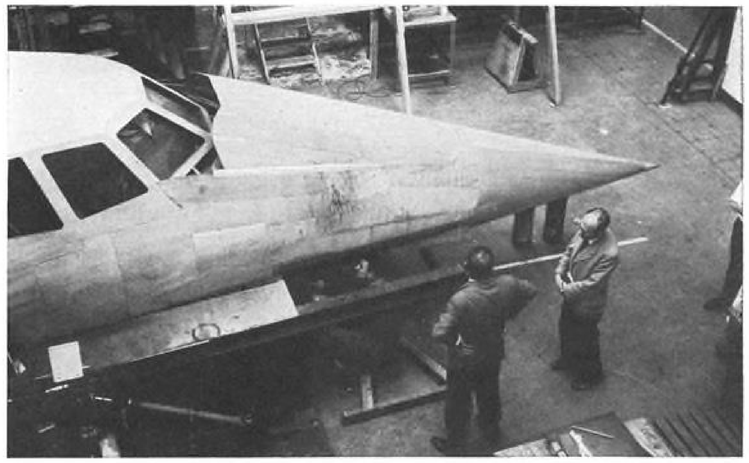
Meanwhile, Prime Minister Jawaharlal Nehru of India last week said India would refuse Red China first and second freedoms—the right to fly over India or land for emergency measures. In addition, Indians last week were carefully weighing the possibility of renouncing the bilateral agreement with Pakistan because of the Sino-Pakistani pact.

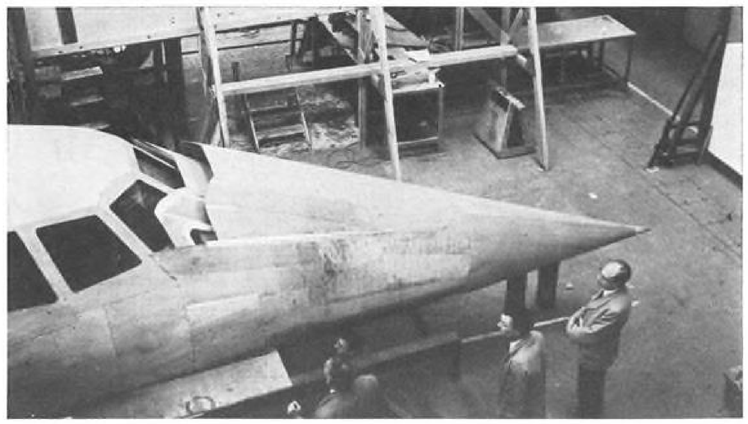
The U. S. postponed the $4.3-million loan to Pakistan when it learned that the agreement with China had been signed. Funds from the loan were to be used for expansion of the airport at Dacca in East Pakistan.

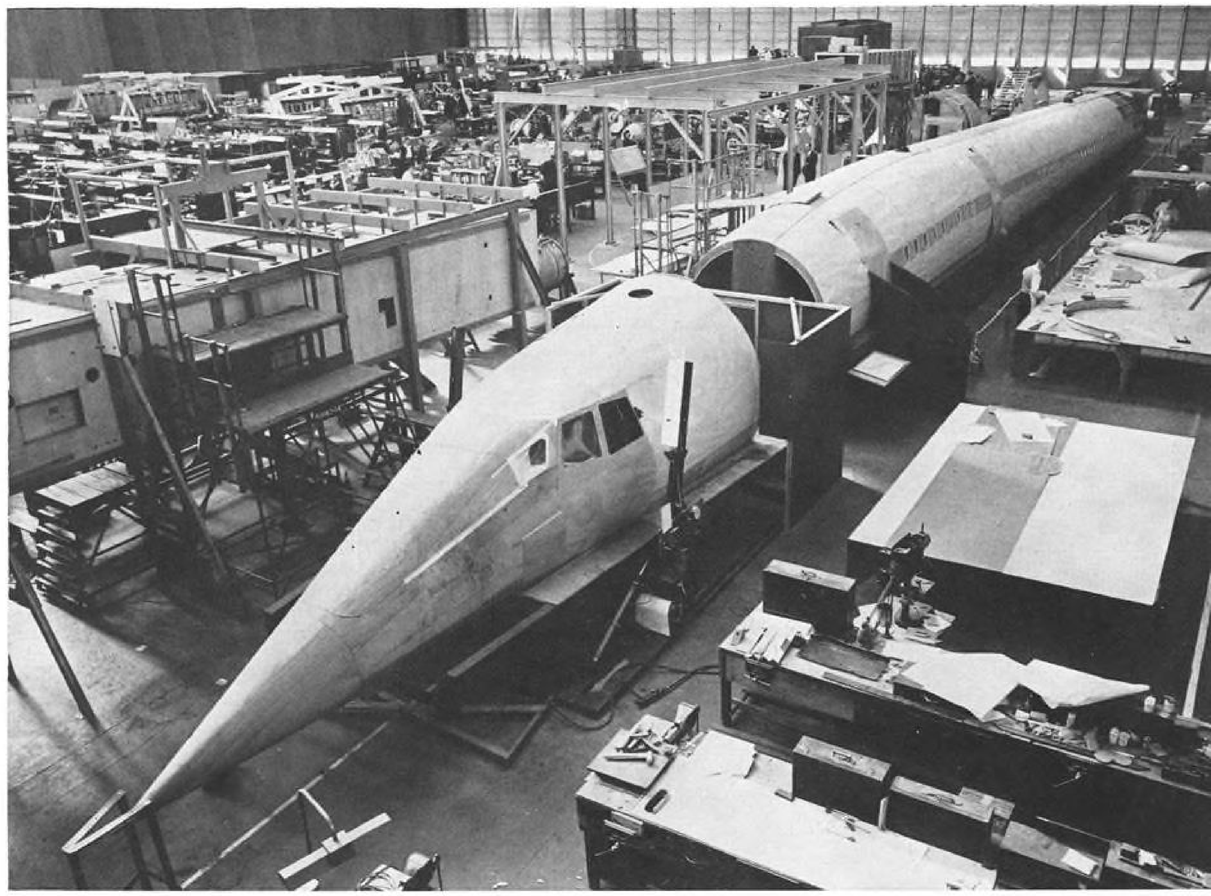
Later this month, a Soviet air delegation is scheduled to meet with Pakistani air officials to negotiate an agreement that will permit Aeroflot planes to overfly Pakistani territory on the route between Moscow and Jakarta, Indonesia.

Concorde Mockup Unveiled

Full-scale fuselage mockup of the Anglo-French Concorde supersonic transport reveals details of the metal visor designed to cover pilots' windshields during supersonic flight. Note visor in flight position (opposite page). Closer views of nose section (this page) show visor fully retracted forward and downward for subsonic flight and partially extended. Side windows are made of quartz. These first photos of the Concorde mockup were made at Bristol Aircraft production plant in England. Bristol is a division of British Aircraft Corp., partner in the SST program with Sud Aviation of Toulouse. Mockup eventually will include wings and tail section, under present plans. Two flying prototypes will be completed in 1966, one in England and the other in France. The Concorde mockup at Bristol shows interior arrangement with four-abreast seating in main passenger compartment. The airplane will be fitted with 25 rows of seats (AW Jan. 7, p. 42). Floor-to-ceiling height is 77 in. and aisle is 15-in. wide between arm rests.







Northeast Case Pressure Seen as Threat

By L. L. Doty

Washington—Congressional pressure to restore the New York-Florida route to Northeast Airlines is being viewed here as a serious threat to the U.S. regulatory system.

Last week, legislation that would grant permanent certification to trunklines that have operated under temporary authority since 1957 was introduced in both the House and Senate by New England legislators. Since Northeast's New York-Florida certificate is the only temporary domestic trunkline authority currently in effect, the legislation was obviously designed for the sole purpose of overriding the Civil Aeronautics Board decision in the Northeast renewal case (AW Sept. 2, p. 31).

The congressional drive to over-rule the CAB on permanent certification is not unprecedented. Congress crossed the CAB when it passed legislation in 1955 to give local service carriers permanent authorization. It somewhat mollified an irate Board, however, by placing approximately 20% of the local carrier route system under temporary authority to allow for route adjustments that might be required by economic pressures.

Later, Congress again passed legislation over CAB objections authorizing permanent certification to States-Alaska carriers. In both cases, industry officials expressed concern over the implications of the congressional action.

The current move is considered particularly serious because the bills are aimed at correcting a single transportation problem affecting a single region. Although the proposed bills are designed to return Northeast to the Florida market, the main purpose appears to provide the New England voting constituency with assurances that every attempt will be made to sustain regional services within New England.

Rep. Hastings Keith (D.-Mass.) bluntly stated that "if there are no Florida routes, there may well be no Northeast."

Bills call for an amendment of the Federal Aviation Act of 1958 in order to provide the permanent certification of Northeast's southern routes. Fear here is that if the legislative drive is successful, other similar moves prompted by regional interests would be encouraged that eventually would prevent the CAB from operating freely as a regulatory agency.

It could encourage a disappointed candidate for a route to use congressional influence to change a CAB decision in his favor. It could expand congressional interference in the affairs of the CAB, which was established by Congress as a quasi-judicial body.

Greatest concern is that the legislation could set a precedent that would bring the opinions of a regulatory agency into the political arena. The prime purpose of the regulatory system is to provide regulation of an industry in the public interest without any political considerations.

CAB Chairman Alan S. Boyd spoke vehemently on this point during testimony given before the House Aeronautics Subcommittee. He stressed that the regulatory "system is your system . . . set up by Congress" and suggested that if Congress did not feel it was a good system, Congress should change it. Throughout the congressional turmoil over the Northeast decision, Boyd has held firm to his belief that the Board acted properly in the case and has shown no signs of wavering on his vote in the decision despite the heavy pressures exerted on him.

Temporary certification was authorized under the Federal Aviation Act to permit the CAB to fulfill air transport requirements on an interim basis to meet unusual temporary demands.

The Board, however, has used the temporary certificate more often in circumstances where financial success was in doubt, as in regional scheduled helicopter operations, international routes, supplemental airlines or, initially, in local service and intra-Hawaiian and intra-Alaskan services. On this point, Malcolm A. MacIntyre, president of Eastern Air Lines, said this:

"There has been, undoubtedly, a tendency to use the temporary certificate device for interim authorizations when there were doubts as to the economic soundness of the grant. Temporary certificates ought not to be granted on that basis. The requirements of public convenience and necessity should be proved, judgment exercised firmly, and disposition of applications made accordingly. If permanent certification is not believed to be warranted on economic grounds, a 'temporary' certificate should not be granted in the hope that 'things might turn out all right.'"

MacIntyre agreed that Northeast operated under a handicap as a result of its temporary certificate in the New York-Florida market, but stressed that competing carriers operating with a permanent certificate also suffer from the uncertainties of the temporary certification. He noted that the permanently-certificated carrier experiences a diversion of business with a loss of revenues.

"As it suffers losses and seeks financing upon reasonable terms, it is immediately confronted with the question of whether the temporary certification of the third carrier will be continued," he said. "That makes the problems of the permanently-certificated carrier . . . quite analogous to the situation of the temporarily certificated carrier."

In a special statement, Rep. Keith emphasized that the bill he sponsored was not intended to have any influence on other pending administrative or judicial proceedings. He said that the primary concern is the public interest, but added: "I cannot believe that it was the intention of Congress to have an airline which has efficiently served New England and the East Coast . . . for more than seven years, denied this operation by a Board it [Congress] created to promote the best possible air-passenger service."

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Ilyushin 18 turboprop transports and toy horses for Russian carousels and playgrounds are products of plant that will build Il-62.

Ilyushin 62 Tests Aim at 1965 Route Service

Soviet Russia's Ilyushin 62 186-passenger, aft-mounted jet transport is expected to enter service with Aeroflot in 1965, probably starting with flights on internal routes and later on flights linking Moscow and Havana non-stop. First Il-62 is being used for handling and systems tests; another will be assigned to automatic flight control and landing systems checkouts. Flight test gear installed in the passenger cabin of Il-62 is inspected (right) by Air Commodore A. N. Davis, British air attache in Moscow. Exterior of the airplane is shown below on the ramp at Vnukovo Airport, near Moscow, following a test flight. The Il-62 will fly a program of 1,400 hr. of development tests before being turned over to Aeroflot by the Government Test Center. Chief test pilot for the project is Vladimir Kokkinaki.



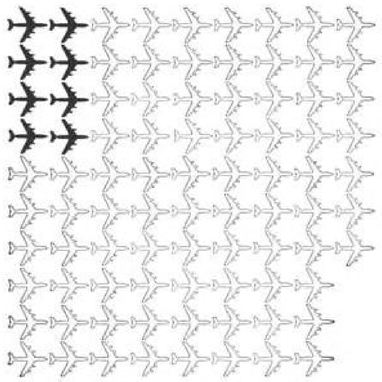
What's the score on fan-jets?

The American Airlines fan-jet story

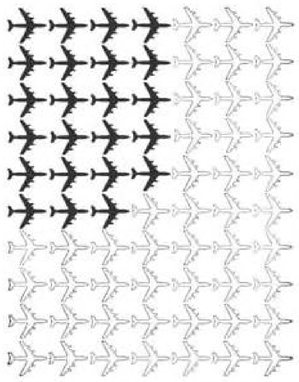
There seems to be quite a bit of talk about fan-jets these days. It isn't surprising.

Fan-jets are 30% more powerful than ordinary jets.

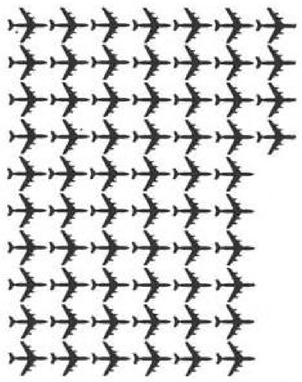
They take off faster and they climb faster.



United's jet fleet. 8 of them are fan-jets.



TWA's jet fleet includes 23 fan-jets.



American's entire jet fleet: 64 fan-jets.

{Fan-jet engines take in twice as much air as ordinary jets. This gives the thrust twice as much body.}

There's just one thing about fan-jets. You may not get one.

There are 24 airlines in this country. Yet only 2 have fan-jets on every jet flight.

One is Western.

The other is American. {We call our fan-jets Astrojets.}

The chart above will show you how many fan-jets the 3 major airlines have today.

It will also show you which airline guarantees you a fan-jet on every jet flight you take.

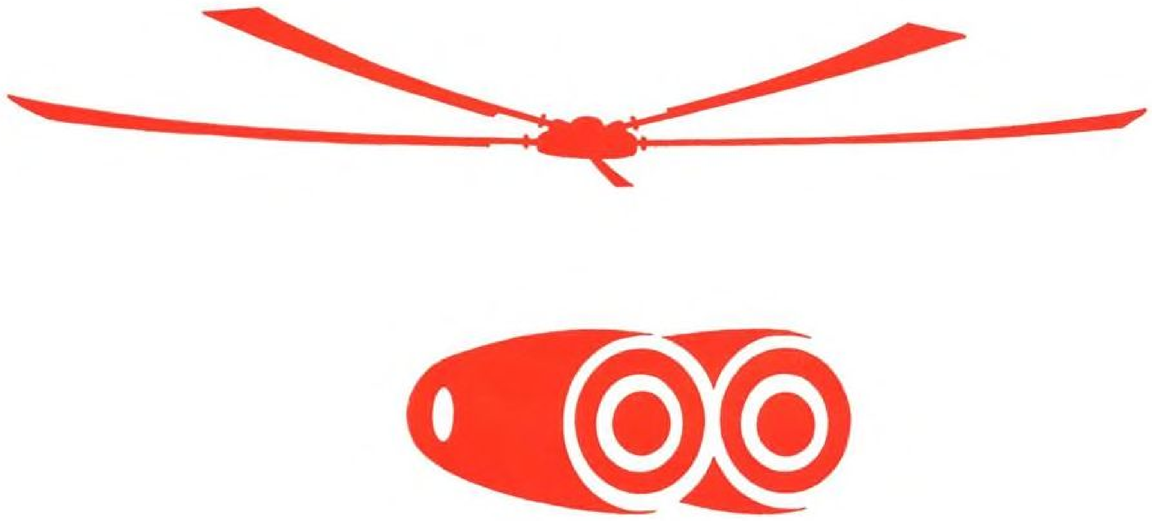
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Airline Income and Expenses—June 1963

	OPERATING REVENUES						Total Operating Expense	Net Profit (or Loss)
	Passenger	Cargo	Other Non-Mail	U.S. & For. Mail	Federal Subsidy	Total		
DOMESTIC TRUNKS								
American	41,304	3,232	136	783	.....	45,455	36,545	4,100
Braniff	6,974	378	112	203	.....	7,667	6,619	430
Continental	6,798	343	90	118	.....	7,349	6,253	955
Delta	16,347	1,001	115	320	.....	17,783	15,094	1,229
Eastern	24,308	1,172	260	425	.....	26,165	26,593	(923)
National	8,185	583	49	157	.....	8,974	7,830	92
Northeast	3,105	110	87	27	.....	3,329	4,034	(820)
Northwest	9,500	615	47	214	.....	10,376	7,898	1,238
Trans World	29,394	1,564	305	627	.....	31,890	27,439	4,009
United	51,689	2,868	464	1,450	.....	56,471	45,965	4,527
Western	7,498	254	87	73	.....	7,912	6,065	829
Domestic Trunk Total	205,102	12,120	1,752	4,397	.....	223,371	190,335	15,666
INTERNATIONAL								
American	512	54	30	6	.....	602	436	82
Braniff	797	105	42	48	.....	992	895	38
Caribair	417	28	4	11	.....	460	453	(11)
Delta	318	20	.....	1	.....	339	340	(3)
Eastern	3,816	186	1	85	.....	4,088	3,025	975
Mackey	306	5	11	.....	.....	322	252	65
Northwest	3,479	443	275	868	.....	5,065	3,835	564
Panagra	1,222	280	114	129	.....	1,745	1,749	(11)
Pan American	43,421	4,869	4,296	3,696	.....	56,282	42,793	6,231
South Pacific	56	1	.....	1	.....	58	130	(86)
Trans Caribbean	971	71	406	1	.....	1,449	1,213	350
Trans World	12,360	967	216	1,129	.....	14,672	10,405	3,378
United	3,662	66	46	94	.....	3,868	2,247	1,009
Western	671	15	5	7	.....	698	451	114
International Total	72,008	7,110	5,446	6,076	.....	90,640	68,224	12,695
LOCAL SERVICE								
Allegheny	1,534	116	39	29	510	2,228	1,989	154
Bonanza	730	18	12	4	270	1,034	903	48
Central	485	32	11	17	357	902	852	21
Frontier	914	59	24	17	666	1,680	1,421	94
Lake Central	574	45	16	13	325	973	890	71
Mohawk	1,873	79	58	23	403	2,436	2,168	114
North Central	1,733	104	26	37	689	2,589	2,214	154
Ozark	1,056	73	10	18	415	1,572	1,367	71
Pacific	673	22	8	18	315	1,036	933	26
Piedmont	1,339	57	36	26	461	1,919	1,750	62
Southern	793	41	34	22	507	1,397	1,246	58
Trans-Texas	600	37	9	16	382	1,044	976	32
West Coast	660	24	10	9	427	1,130	993	46
Local Service Total	12,964	707	293	249	5,727	19,940	17,702	951
ALASKA & HAWAIIAN								
Alaska Airlines	371	58	271	58	142	900	884	29
Alaska Coastal	159	25	10	15	72	281	304	(26)
Aloha	492	8	13	2	19	534	464	43
Cordova	30	14	43	7	31	125	139	(21)
Hawaiian	721	101	83	4	.....	909	710	186
Kodiak	24	3	10	1	4	42	50	(10)
No. Consolidated	127	49	24	74	66	340	311	11
Pacific Northern	1,182	194	50	102	37	1,565	1,264	117
Reeve Aleutian	144	44	93	58	.....	339	292	(11)
Western Alaska	11	2	6	2	10	31	29	2
Wien Alaska	200	59	147	104	94	604	660	(50)
Alaska & Hawaiian Total	3,461	557	750	427	475	5,670	5,107	270
HELICOPTERS								
Chicago	28	1	1	2	95	127	123	6
Los Angeles	99	18	2	13	148	280	194	45
New York	201	4	8	4	166	383	357	12
Helicopter Total	328	23	11	19	409	790	674	63
CARGO & OTHER								
Aerovias				Not Available				
Avalon[1]	35	1	2	1	.....	39	41	1
Flying Tiger	.....	807	3,067	.....	.....	3,874	3,334	159
Riddle	.....	720	415	.....	.....	1,135	1,261	1,719[2]
Seaboard	.....	942	1,052	362	.....	2,356	1,995	179
Slick	.....	.....	1,574	.....	.....	1,574	1,575	(113)
Cargo & Other Total	35	2,470	6,110	363	.....	8,978	8,206	1,945
Industry Total	293,898	22,987	14,362	11,531	6,611	349,389	290,248	31,590

[1] Avalon results one-third of second quarter. [2] Riddle profit reflects forgiveness of debt.

Prepared by Ray & Ra



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STRATFORD, CONNECTICUT

American Engineers Still Ask Pilot Rating

New York—Principal roadblock to negotiations between American Airlines and its flight engineers toward a new contract still is whether the engineers will receive company-paid pilot training.

American's chapter of the Flight Engineers International Assn. insists that commercial and instrument flight ratings for engineers are vital to the thing they want most—job security.

Flight ratings are especially important now, the engineers say, because they are being provided to flight engineers on Trans World Airlines and Pan American World Airways. For American's engineers to continue without the ratings constitutes an inconsistency in the qualifications of individual FEIA members and locks them out of the spreading industry trend toward three-man, pilot-trained cockpit crews, according to spokesmen for the engineers.

"If American offered us the same contract as that signed by TWA and Pan American, we'd be satisfied," said Asher Schwartz, general counsel for American's engineers.

Thus far, however, American has refused to finance the engineer pilot training, which would cost approximately $10 million. If anything, the airline's attitude has stiffened since the signing of a new contract with its pilots (AW July 15, p. 39).

Flight engineers originally conducted joint contract negotiations with American's pilots, and were agreeable to waiving the commercial and instrument ratings. But this was conditional on the engineers being accepted into the Air Line Pilots Assn., with job security provisions that would make up for their not being pilot-trained.

However, ALPA refused ratification of the proposed contract because the engineers, without the commercial and instrument ratings, wouldn't qualify under the pilot union's bylaws governing three-man cockpit crews. All those in a three-man crew, ALPA held, must be qualified pilots.

Consequently, when the pilot contract was signed, the flight engineers were not a part of it. And the company refused to negotiate with the engineers separately, questioning whether the FEIA was the proper bargaining agent in view of the earlier joint pilot-engineer negotiating arrangement.

This question was erased later by a U. S. District Court ruling (AW Aug. 19, p. 41). FEIA and ALPA both brought suit to enjoin American from dealing with the Allied Pilots Assn., formed by American pilots. The court decided that Allied was justified in claiming to represent American's pilots, but upheld FEIA as the engineers' legal bargaining agent.

The pilots' contract has brought complications affecting the FEIA contract demands. Pilots were granted reductions in monthly flight time requirements, from 85 to 75 hr., and received added retirement and insurance benefits. These concessions were initially agreed to by American in return for pilots working toward elimination of pilot training for the engineers.

Now the engineers want the training, and observers note that if the airline grants it, the effect would be the same as paying for it twice in view of the concessions to pilots.

Flight engineers, who have been without a contract since May 1, are also asking for a retroactive 9% wage increase for each of the last two years, which they say is to "compensate for unexecuted wage reopening provisions of the former contract." They have also asked for the same flight time reduction as granted to the pilots.

The job security question, the engineers feel, can be resolved if American will grant the Feinsinger Committee recommendations of Oct., 1961. Besides advocating flight training for engineers and guaranteeing them rights to the "third seat," the Feinsinger group also proposed one union in the cockpit.

"We're willing to talk with the Allied pilots about joining them," Schwartz said. "But we want our contract first. That's the way it was done on TWA and Pan American, where the engineers received their agreement and then began talks about going into ALPA."

One thing that American wants is a single cockpit union. But the thorny problem of the engineer pilot training remains the roadblock.

Flight engineers are hopeful that American's new vice president of personnel, J. O. Jarrard (AW Aug. 12, p. 39), can help unsnarl the stalemate. Jarrard was formerly head of industrial relations for Eastern Air Lines, and was a party there to offering Eastern's engineers the Feinsinger recommendations. However, Eastern's engineers, unlike those at American, rejected those terms, and Eastern endured a long strike, essentially broken when pilots trained as flight engineers took over the third seat.

The lesson of Eastern's experience is evident to both American and its engineers. Eastern lost an estimated $50 million in the strike, and its engineers, although still picketing, have little hope of ever attaining a settlement.

Engineers at American aren't talking of a strike, and reflect general optimism now that their representation rights have been upheld. But Schwartz did say that if talks with the company bog down, the engineers may ask for intervention by the National Mediation Board.

Aeroflot Replacing An-2s With An-14As

Moscow—After six years of waiting, Russia's Aeroflot is beginning to put its twin-engine Antonov short-haul transport in regular service to replace obsolete, single-engine An-2 biplanes.

The new craft, designated An-14A, is a much-modified version of the An-14, which was first unveiled in 1957. Both planes are known as the "Pchelka"—Little Bee.

Development of the An-14 took so long that Russia imported a number of Czechoslovakian Aero and Morava light twins to operate services originally intended for the Antonov craft.

Most significant modification in the An-14A is utilization of 300-hp. AI-14RF radial engines. The An-14 had 260-hp. AI-14Rs. Wing span also reportedly was increased from 65 to 72 ft. Increased power enables the An-14A to climb at almost 5 ft. per sec. on one engine and more than 17 ft. per sec. with both engines.

The An-14A carries seven passengers or 1,323 lb. of cargo 373-404 mi. at speeds of 106-112 mph. Range with a 1,235-lb. payload and a 1-hr. fuel reserve is 453 mi.

Six passengers are carried in the sound-insulated cabin, and the seventh rides in the cockpit next to the pilot. Special baggage compartments are in the tail section of the fuselage.

An-14A's takeoff distance fully loaded with normal atmospheric conditions is 295 ft., and landing run is 361 ft., the Russians say. This compares with 689 ft. and 591 ft., respectively, for the An-2 biplane. Takeoff and landing distances for the An-14A are cut almost in half with an 11-15 mph. head wind. Designer O. K. Antonov had hoped to reduce the An-14's takeoff run to 98-115 ft. under favorable conditions.

The An-14A can be converted easily for ambulance and agricultural work. Rear loading door makes the craft especially suitable for parachute jumping.



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CONVAIR PBYs still are used extensively in Greenland to transport personnel and equipment and to guide polar ships through iceberg-filled waters. Helicopters are regarded as likely replacements. Black object atop the cockpit is a radome mounting.

Helicopter Potential Cited for Greenland

Godthaab, Greenland — Planners struggling with Greenland's economic problems in this capital city are beginning to regard the helicopter as the most promising form of Arctic transportation since the dog sled.

These officials have the job of moving Greenland from the Stone Age to the Atomic Age so the standard of living on this icy island—the world's largest, with 840,000 sq. mi.—will compare favorably with Denmark's.

But aside from that general objective, approved by the Danish Parliament in 1950 and formalized in 1953 by a constitutional amendment that made Greenland a full equal with Denmark, there are few specific guidelines for the planners to follow. Therefore, they are willing to try new approaches.

Twin-Turbine Helicopters

New twin-turbine helicopters, with their greater safety and lower operating costs, make sense to the planners. Greenland's severe winters freeze ships out of the waterways; rocky, mountainous terrain makes air fields impractical, and the aging Convair PBY-5A Flying Catalina and de Havilland U-6A Beaver and U-1A Otter, still very much in use here, have their limitations. Since no fixed-wing, tri-phibious (aircraft capable of landing on snow, water and land) successors are in sight, the Danish government has turned its attention to rotary-wing aircraft.

Danish government officials, including representatives of Scandinavian Airlines System, already have approached U.S. helicopter manufacturers, and have visited Sikorsky to see the S-61N twin-turbine amphibious model and to Boeing-Vertol to study the 107II. Danish estimates of the ultimate helicopter purchase range from three to seven aircraft. There is a possibility that some will be used by the army and air force rather than in Greenland.

Just when the helicopter decision will be made is uncertain. Hans C. Christiansen, general manager of the Royal Greenland Trade Dept., predicts helicopters will be in use in Greenland "within three years." With Denmark already spending about $29 million annually on Greenland, the helicopter enthusiasts may have to stand in line for funds.

Regardless of when helicopters begin to serve Greenland, their operation will push back the horizons for rotary-wing aircraft a little farther. The all-year, passenger-cargo service envisioned for Greenland would be the most rugged in the world, both in terms of point-to-point distance and weather conditions. It also will provide experience, if Danish officials have their way, in the use of the same helicopter for cargo on some runs and passengers on others.

New Opportunity

One U.S. helicopter executive sees the intended use of helicopters in Greenland and their use in Pakistan as "an opportunity just beginning to crack" for the industry. Pakistan International Airlines announced in January that it was buying three Sikorsky S-61Ns to take passengers from Dacca, the capital of East Pakistan, to 20 towns and villages.

The helicopter service is slated to begin in October.

In language reflecting Denmark's similar hopes for Greenland service, Air Commodore M. Nur Khan, managing director of Pakistan International Airlines, said "the helicopters will bring about a revolution in the communications system of the area and will cause an upsurge in the commercial economic development of East Pakistan." PIA's S-61Ns will carry 25 passengers and cargo.

Operating Costs

Just how rapidly and widely helicopters are accepted as a tool to developing primitive areas depends largely on operating costs. Target for the Sikorsky S-61 is 8 cents per seat mile. Industry officials hope the next generation of passenger helicopters will halve that figure, bringing the cost to as low as 3 or 4 cents a seat mile.

Such a lowering of operating costs has special appeal for those Danish officials, who are now concentrating on keeping Greenland supplied the year round but who hope some day to turn

Modernization Rationale

Godthaab, Greenland — Denmark's chief administrative official in Greenland justifies his government's intervention in the island's mode of living by saying, "Once you give a man a gun, you never go back to the bow and arrow."

N. O. Christensen, chief administrator for Greenland, conceded that many Greenlanders would be happier to remain in primitive settlements where their lives depend on the success of the hunt. But he said the balance of nature in Greenland was so disturbed by modern hunting techniques and the migration of seals northward when the southern part of the island warmed slightly, that modernization became the only alternative to severe hardship or starvation during the winter.

Now the Danish government is trying to persuade Greenlanders to leave their hunting encampments and settle in villages where education, medical aid and even super markets are available.



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their attention to tourism. The dream is to let Scandinavian Airlines System fly tourists from Europe and the U.S. to its polar landing field at Sondre Stromfjord on the west coast of Greenland, where SAS maintains a modern hotel.

Tourists would be flown by helicopter to the primitive, picturesque villages along the west coast.

Holsteinsborg, on Greenland's west coast, is such a village. The first thing a visitor sees approaching the village by water is pastel-colored cottages, sitting like doll houses on the rocky hills rising from a harbor filled with boats and nets as colorful as those on a Maine coast.

Contrast Noted

A closer look shows the contrast of the old and new struck by Denmark's decade of effort to modernize Greenland—Greenland natives, who undoubtedly would rather be back hunting seals, standing on the production line in the fish factories; fish drying in back yards in the primitive Eskimo fashion while the woman of the household works over a modern sink; a homemade skiff, built along classic Eskimo lines, floating in the shadow of a modern apartment house occupied by technicians from Denmark; Eskimo huskies, resentfully stirring from the dusty road, to make way for a shiny Volkswagen bus; Greenlander women, not many years out of a primitive hunting settlement, carrying cod fish home for supper in a plastic shopping bag.

All this took place at surprisingly pleasant temperatures of about 50F. The Arctic sun does not fully set in summer but dips only long enough to let the mountains above Holsteinsborg cast a faint shadow briefly over the cold-blue fjord. Newsmen touring Greenland recently found the same scenes repeated in varying degrees of beauty in other towns such as Sukkertoppen, Egedesminde and Jakobshavn.

The last village has 1,500 people and 3,000 dogs and is the birthplace of giant icebergs that break off and float into Disco Bay. The icebergs are so large that they chill the face as the ship nears them—a sensor which some polar ship captains continue to prefer over radar.

Is all this, along with the promise of fine salmon fishing and trips to the ice cap which covers 90% of Greenland to a depth of as much as two miles, enough to draw tourists to Greenland? Is it, as some Danes claim, an undiscovered Arctic Riviera?

It is too early to tell, but it is obvious that Greenland's future is being shaped significantly by aviation. The aircraft, probably more than any one tool, is considered vital to Greenland's progress.

East Germany Reincorporates Flag Carrier; Name Is Changed

Geneva—East German government, tacitly conceding victory to its West German counterpart in the post-World War 2 dispute over the right to the name "Lufthansa," last week reincorporated its flag carrier under another name.

The action absorbed the carrier into a former subsidiary, Interflug Gesellschaft Fuer Internationalen Flugverkehr. Apparently it will be followed by further attempts to push routes beyond the Communist bloc.

Previous attempts to obtain landing rights, principally in Brussels, Amsterdam, Copenhagen and Vienna, have been blocked primarily by the carrier's insistence upon using the name Deutsche Lufthansa, the designation of Germany's pre-war flag line and the one adopted by West Germany's national airline.

The eastern carrier's efforts to move west in search of hard currency and prestige have been paralleled by law suits in each country by the West German airline. Results of most provided for the impounding of any Communist aircraft painted with the name "Lufthansa."

East Germany's latest move dissolving its own Lufthansa, is expected to be followed by new efforts to fly to the west. It was announced only three days before Interflug formally took over the East German Lufthansa's route structure on Sept. 1.

According to West German officials, Interflug itself owes its beginnings to earlier attempts by the East German government to penetrate the west. Thwarted on the use of the name "Lufthansa," the government in 1958 established Interflug as a subsidiary in hopes of at least gaining a charter flight service through Yugoslavia—which recognized West Germany's claim—to Albania and Vienna.

That step, however, precluded scheduled service. Now, as Interflug takes over Lufthansa's three Soviet Ilyushin Il-18 turboprop and 30 aging Il-14P piston-engine transports, East Germany at least has circumvented the legal tangle over its airline's name.

It is doubtful if the West German government would grant an East German carrier the right to overfly its territory under any name. With some diversion, however, Interflug should be capable of reaching its hoped-for destinations in the west without overflying the Federal Republic.

East German Deutsche Lufthansa, which began with a flourish in 1956 as a direct challenger to its western counterpart, even to the adoption of an identical blue-and-yellow color scheme, has traveled a rocky economic path since its inception.

Internal routes—primarily Berlin-Leipzig and Berlin-Dresden—have been less than successful in a country with a good rail and autobahn system and only 41,600 sq. mi. of land area. Its routes outside East Germany to such Communist capitals as Moscow and Warsaw have not fared much better than its internal routes.

A seven-year plan begun in 1958 predicted that the carrier would have a fleet of 170 aircraft by 1965. Instead, the fleet has remained relatively stable at about 50, with the majority of those utility aircraft used in such side duties as crop dusting.

Swissair Caravelle Crashes Near Zurich

Geneva—Swiss federal aviation officials are investigating the crash and resultant explosion of a Swissair Caravelle medium-range jet transport shortly after takeoff last week from Zurich's Kloten airport on a scheduled flight to Geneva.

Eyewitnesses said there appeared to be a fire in the tail section just before impact.

All 74 passengers and 6 crew members aboard died. The crash marked the third fatal accident in which a Caravelle has been involved since the aircraft went into scheduled service in 1959.

A total of 145 are now in service with 19 airlines.

The accident registered the first Swissair fatality since June, 1954, when three passengers were lost during the ditching of a Convair 240 in the English Channel after the aircraft had exhausted its fuel supply.

Swissair officials said radio and radar contact with the aircraft, which was on a flight to Geneva and Rome, was lost 10 min. after takeoff. An airline spokesman said that all communications with the crew until that time had been routine with no indication of any trouble.

Residents of a small village near Zurich subsequently reported that the aircraft had crashed in the area on relatively flat terrain. Witnesses said the fire appeared to have broken out in the tail section before impact, which touched off an explosion of the Caravelle's fuel tanks, destroying the aircraft.

AIRLINE OBSERVER

► Presence of Civil Aeronautics Board observers at the International Air Transport Assn. traffic conference at Salzburg, Austria (AW Sept. 2, p. 28), could deprive U. S. carriers of flexibility in negotiating rates and fares. Some Board staff members feel that TWA and Pan American were not as outspoken for lower fares at the Chandler conference as they might have been, but the airlines insist that they were led into supporting a higher fare through the necessity for compromise in the conference. In a letter to all U. S. IATA airlines, the Board has repeated its insistence that fares be reduced "substantially." With government observers watching over the shoulders of U. S. airline delegates to make certain that the low-fare position is rigidly adhered to, compromise bargaining will be difficult, and, since a number of foreign carriers will resist the drive for sharp fare cuts, a deadlocked conference may result.

► **Civil rights language in the federal aid to airports act is delaying congressional renewal of the aid program. Passed by a Senate aviation subcommittee, a bill to renew the act for three years is being held up by a House aviation subcommittee headed by Rep. John Bell Williams (D.-Miss.). Civil rights language has been in the act for several years, but the Federal Aviation Agency now considers it a primary requirement that must be met before funds can be allotted to any airport.**

► Local service airlines have reported impressive gains in the number of passengers carried during the 12 months ended June 30 compared with the same previous period. Of the 13 local service carriers, only West Coast failed to register an improvement. Biggest gain was reported by Piedmont, with a 39.7% increase in traffic, followed by Bonanza, with a 34.4% gain. Southern showed a 24.9% increase, Frontier 21.4% and Ozark reported a 20.3% improvement.

► **Leading issue to be raised during forthcoming negotiations on the revision of the bilateral air transport agreement between the U. S. and Canada (AW Sept. 2, p. 28) will be trans-border charter operations between the two countries. Canada claims that 158 U. S. charter operators are licensed to serve Canada while only 19 Canadian carriers are authorized to operate into the U. S. Canada holds that a heavy volume of cabotage has resulted and will demand an adjustment of the imbalance.**

► United Air Lines' single-class service, expanded recently to a total of 71 daily flights (AW Aug. 20, p. 50), continues to meet stiff opposition from United's principal competitors: American, Continental and TWA. American appears to be leading the fight and, last week, bluntly announced it had no plans to inaugurate single-class service in long-haul markets. American also criticized Continental's three-class service configuration on grounds that there is not sufficient room on aircraft to provide service in three separate compartments.

► **Legislation has been introduced in the House by Rep. Roman C. Pucinski (D.-Ill.) that would prevent the operation in the U. S. of supersonic transports that produce overpressures exceeding 1.5 lb. per sq. ft. on the ground directly beneath the flight path of the aircraft. Pucinski said his legislation was aimed at compelling designers in the U. S. and other nations to give noise control top consideration.**

► Administration concern over the "balance of payments deficit" is confusing the aviation industry. U. S. tourists who last year spent more than $1.4 billion with foreign airlines and countries have accounted for most of this deficit, the government claims. However, industry observers point out, little has been mentioned about the fact that in the same year this deficit was offset by the export of U. S. aeronautical products, payable in dollars. Increased travel by Americans on many international routes has been responsible for the improved financial health of both U. S. flag carriers. Now a resolution has been introduced before Congress asking Americans to stay home in 1964, as a means of relieving the balance of payments deficit.

SHORTLINES

► **Alitalia Airlines** showed a 15% increase in the number of passengers carried during the first six months of 1963 compared with the same period last year.

► **American Society of Travel Agents** has asked the International Air Transport Assn. for a substantial reduction of international fares. Specifically, the group seeks fewer special discount fares, lower off-season fares, a year-round excursion fare and abandonment of pro rata charter and affinity group fares.

► **CSA, Czechoslovakian Airlines,** which celebrated its 40th anniversary July 28, has reported its international route network now totals more than 37,260 mi. CSA serves 38 cities and 36 countries in Europe, Asia and Africa and operates flights into Cuba.

► **Irish International Airlines** generated a 90% load factor on eastbound transatlantic flights during the three months ended June 30. Westbound load factor during the same period was 85%.

► **National Airlines** said last week that if necessary, it can absorb 303 Northeast Airlines employes within the next six weeks. National said it could not hire pilots because 45 National pilots are currently on furlough.

► **North Central Airlines** has been awarded an $800,000 contract by the Agency for International Development to provide managerial and technical assistance to Lloyd Aero Boliviano Airline of Bolivia.

► **South American Travel Organization** has been formed in Miami to develop campaigns designed to promote travel to South America. Organization has enlisted aid of airlines, travel agents and hotels in hopes of increasing U. S. tourist expenditures in Latin America. Last year, only 2% of the U. S. tourist dollar was spent in South American countries.

► **Western Air Lines** has added three daily round-trip flights to its economy Thriftair service between San Francisco and Los Angeles, bringing the total to 14. An average of 1,400 passengers are using Thriftair daily, an increase of about 200 passengers a day since early July. Western reports a load factor of more than 70% on the flights, which are operated with 92-passenger Douglas DC-6B transports.



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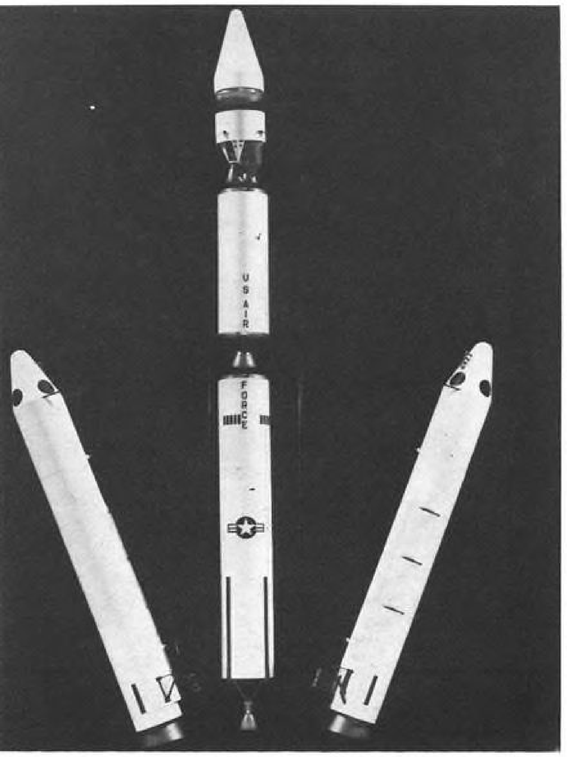
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EXPLODED MODEL OF TITAN 3C (left) shows solid booster stages, first and second stages of the core, transtage and standard payload shroud. Artist's concept (right) shows solid booster separation with two banks of retrorockets on each booster.

Air Force Stressing Operational Economy

By C. M. Plattner

Los Angeles—Anticipated operational economy of the USAF Titan 3 launch system is providing Air Force with an argument for continued support of the booster system as a national launch vehicle.

The projected low unit-booster costs, combined with a potential multi-mission capability ranging from lofting winged vehicles to establishing payloads into synchronous orbits marks the Titan 3 as a strong contender for payloads of other government agencies as well as for USAF's anticipated space defense role.

Complete release of Fiscal 1964 funds —$324.6 million—already has been obtained from Defense Dept., which has tended to spoon-feed funds in the past. This has been interpreted as an indication of greater confidence in the Titan 3 program, which was funded for an estimated $200 million in Fiscal 1963 and about $18 million up to and including Fiscal 1962.

The Titan 3 program is in the tenth month of a 45-month research and development program, which began Dec. 1, 1962. The first scheduled flight test has been set for August, 1964, with the launch of a Titan 3A (modified Martin Titan 2 plus transtage). The first Titan 3C (Titan 3A plus two 120-in.-dia. solid propellant strap-on motors) will be launched in the early summer of 1965.

The Titan 3A with a payload capability similar to the Atlas-Agena is viewed largely as a stepping stone to development of Titan 3C. Its availability is considered a bonus to the Titan 3 program. However, the expected short count-down time, reliability, economy, and 10-ft.-dia. payload attachment fairing are expected to make it an attractive vehicle for payloads within its capability.

The projected operational economy of the Titan 3C booster is expected to make it highly competitive cost-wise with boosters such as National Aeronautics and Space Administration's Saturn 1 and 1B boosters.

Results of recent Air Force-based studies, comparing expected operational costs of the Titan 3C booster with other launch vehicles, shows that:

• **An approximate $13-million** recurring cost of an operational Titan 3C is anticipated, based on limited production of eight flight vehicles for the X-20 (Dyna-Soar) program. Air Force estimates that for an equivalent production rate, the unit cost of a Saturn 1B would be approximately double the Titan 3C cost. Recurring costs do not include research and development costs nor the launch facilities and equipment purchased during the research and development program. Difference in cost of solid and liquid propellants and relative system simplicity are primarily responsible for the cost differences.

• **A recurring unit cost** of $9 million for Titan 3C could be achieved with a production rate of 25 boosters per year for five years (AW July 22, p. 221). This compares with $18 million for a Saturn 1B and $15 million for Saturn 1, both based on the same production rate. This $9 million figure also is estimated to compare roughly with the cost of an Atlas-Centaur.

Air Force spokesmen point out that given a high production rate and a $9 million unit cost, restrictions on payload weight could be lifted, gaining perhaps enough savings through reduced manufacturing costs to make the Titan 3C competitive in price with the Atlas-Agena.

Cost of an Atlas-Agena is estimated at approximately $7.5 million.

The Air Force studies, completed late this spring on the Titan 3C system, were undertaken in reply to a series of related technical and cost questions originated by DOD. Defense Dept. has continually indicated that support for the Titan 3 program depends on economical and efficient program management.

One question dealing with the effect of cancelling the Titan 3 program and continuing the Saturn program, was explored by the Air Force. In reply, it was pointed out that neither of the Saturn boosters had the multi-mission capability nor the economy of operation of the Titan 3C since they primarily were developed to support the Apollo program and were not designed to carry a wide variety of payloads.

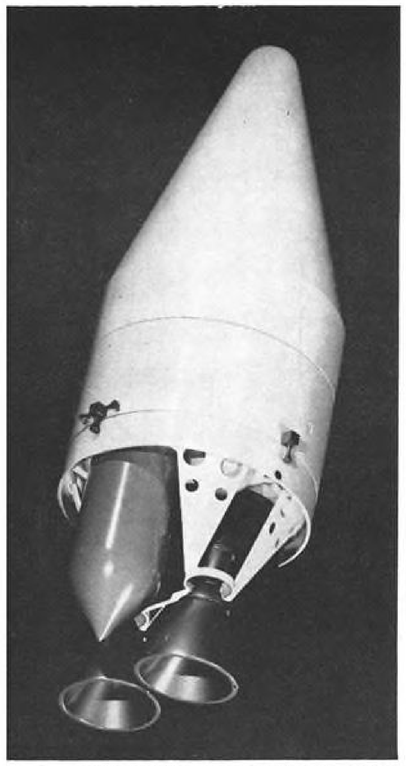
Neither of the Saturn vehicles has an upper stage with a multiple restart capability (S-4B has a single restart capability). Also, it was pointed out that the Saturn vehicles would require extensive modification if payloads such as lifting bodies were considered. In its present configuration, the Saturn 1B, for instance, could not be used to launch the X-20, because of unusual stress characteristics during the boost phase.

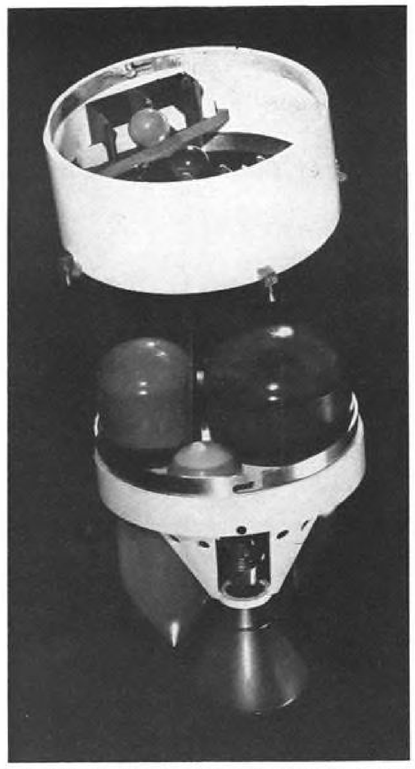
Payload capability of the Saturn 1B (32,000 lb. to 100-naut.-mi. earth orbit) exceeds that of the Titan 3C (25,100 lb. to 100-naut.-mi. orbit). Payload of the Saturn 1 is estimated at 18,000 lb., while the Titan 3A can loft 5,800 lb. to low earth orbit.

A Manned Space Flight Center study however, is investigating a restartable upper stage for Saturn 1B and Saturn 5 boosters. The upper stage, known unofficially as the S-6 stage, is called a multi-mission module (MMM), and is being studied primarily to support lunar logistics payload delivery. It would be powered by two throttleable RL-10 type engines.

Such an upper stage could provide the Saturn 1B, with synchronous orbit and orbit transfer capability. The MSFC study is a relatively small effort though and is not part of an officially-sanctioned mission investigation.

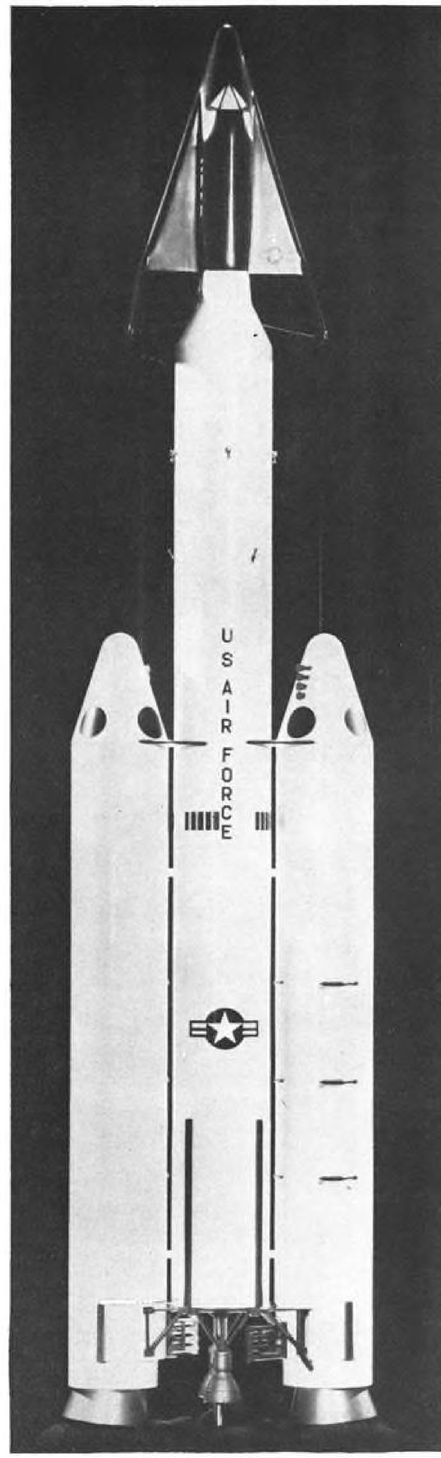
Meanwhile, NASA is showing increasing interest in the Titan 3 program





TWO VIEWS OF THE TITAN 3C'S transtage (above) show control and guidance module at the top and power module at the bottom of the transtage.

Of Titan 3 Launch System



DYNA-SOAR MODEL is mounted atop Titan 3C. Details of large solid booster separation rockets are shown for the first time. Two banks of four rockets are used on each of the boosters.



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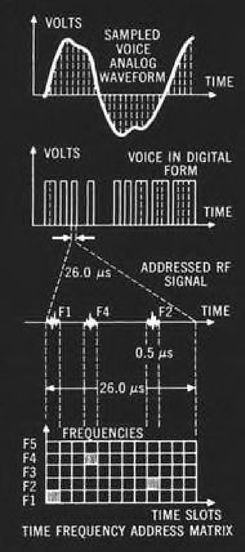
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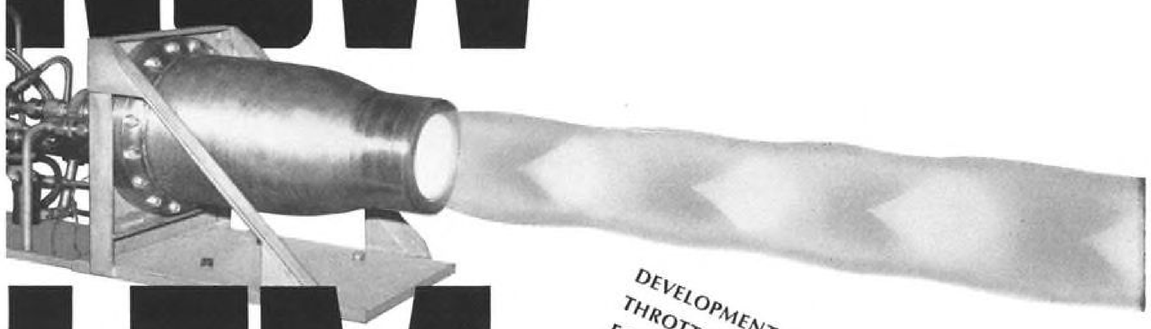
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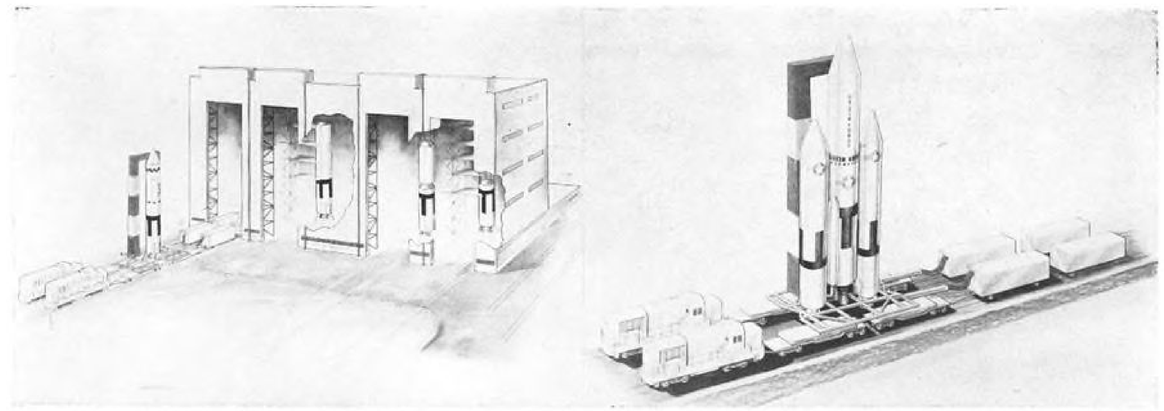


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VERTICAL INTEGRATION BUILDING (VIB) has four assembly bays. Transporter (right) uses diesel engines for power. Ground equipment vans accompany vehicle from assembly to launch site, eliminating the need for dual systems.

and all major centers have been briefed on the launch system by a special Air Force team. NASA planners are reported very interested in the Titan 3C. Langely Research Center recently sent out a contract change notice to Manned Orbiting Research Laboratory (MORL) study contractors (AW June 10, p. 37) adding Titan 3C to the launch vehicle list. The Titan 3C also is being considered as a booster for the advanced logistics spacecraft (AW July 29, p. 55).

Brig. Gen. Joseph S. Bleymaier, director of Titan 3 program at USAF Systems Command's Space Systems Div., underscored the importance of booster cost, when he noted recently that about one-half of the funds expended for space projects are for launch vehicles. The history of the Titan 3 program is indicative of an effort to provide a vehicle tailored directly to economical operation on a national basis.

Study Approval

Early in the program, DOD approved studies leading to development of the system after favorable recommendation by the Large Launch Vehicle Planning Group, a joint NASA-DOD board. The board suggested development of the solid-liquid Titan 3C as a standard national launch vehicle, as well as the Saturn 5 Apollo vehicle and the M-1 engine.

The development approach employed by the Air Force, at DOD direction, was to define completely the system on paper prior to starting a hardware program. This resulted in a 12-month study, called phase one, which began in October, 1961. During this period, areas of technical risk were identified and trade-offs between cost, performance, standardization, reliability and maintainability were considered. Following evaluation of the phase one study, DOD gave the go-ahead for a 45-month research and development program calling for launch of 17 vehicles—5 Titan 3As and 12 Titan 3Cs.

To ensure economy in hardware acquisition, USAF has insisted on cost-plus-incentive-fee contracts with all major contractors. Space Systems Div. spokesmen feel the CPIF contract plan has been beneficial and schedules and quality have been maintained. CPIF contracts were considered almost a necessity since SSD, in effect, is operating under a fixed-fee contract from DOD. Air Force feels that the Titan 3 program will continue to receive DOD support only if cost overruns and schedule slippages are held within program estimates. Total development cost for Titan 3 is estimated at $808.3 million. However, this figure probably will grow closer to $900 million before the end of the research and development phase.

Tight management control is facilitated through use of the PERT-Time cost system and all expenditures greater than $25,000 must be approved at program director level.

Associate contractors and their related responsibilities are:

- **Denver Div. of Martin-Marietta Corp.**—airframe, assembly, test and system integration.
- **Aerojet-General Corp.**—propulsion systems for the three liquid-fueled stages.
- **United Technology Center**—solid booster motors.
- **AC Spark Plug Div.** of General Motors—inertial guidance.
- **Aerospace Corp.**—technical supervision.
- **Ralph M. Parsons Co.**—architectural engineering and design of the integrate-transfer-launch complex.

As a rule, contractors will be assured of making a minimum of from 1% to 2.5% over their cost. For adequate performance, the average incentive fee is expected to run about 7% with expected range of approximately 2 to 12%.

The Titan 3 system, as Air Force prefers to call it, consists of two vehicles—Titan 3A and Titan 3C—and an integrate-transfer-launch (ITL) complex, designed for a high launch rate with a minimum countdown time. Although the only funded and approved payload publicly announced for the Titan 3C still remains the Boeing X-20 (Dyna-Soar), no research and development flights of either vehicle will be flown without payloads.

Payload Variety

The Titan 3 system has been designed to boost a variety of payload configurations, including:

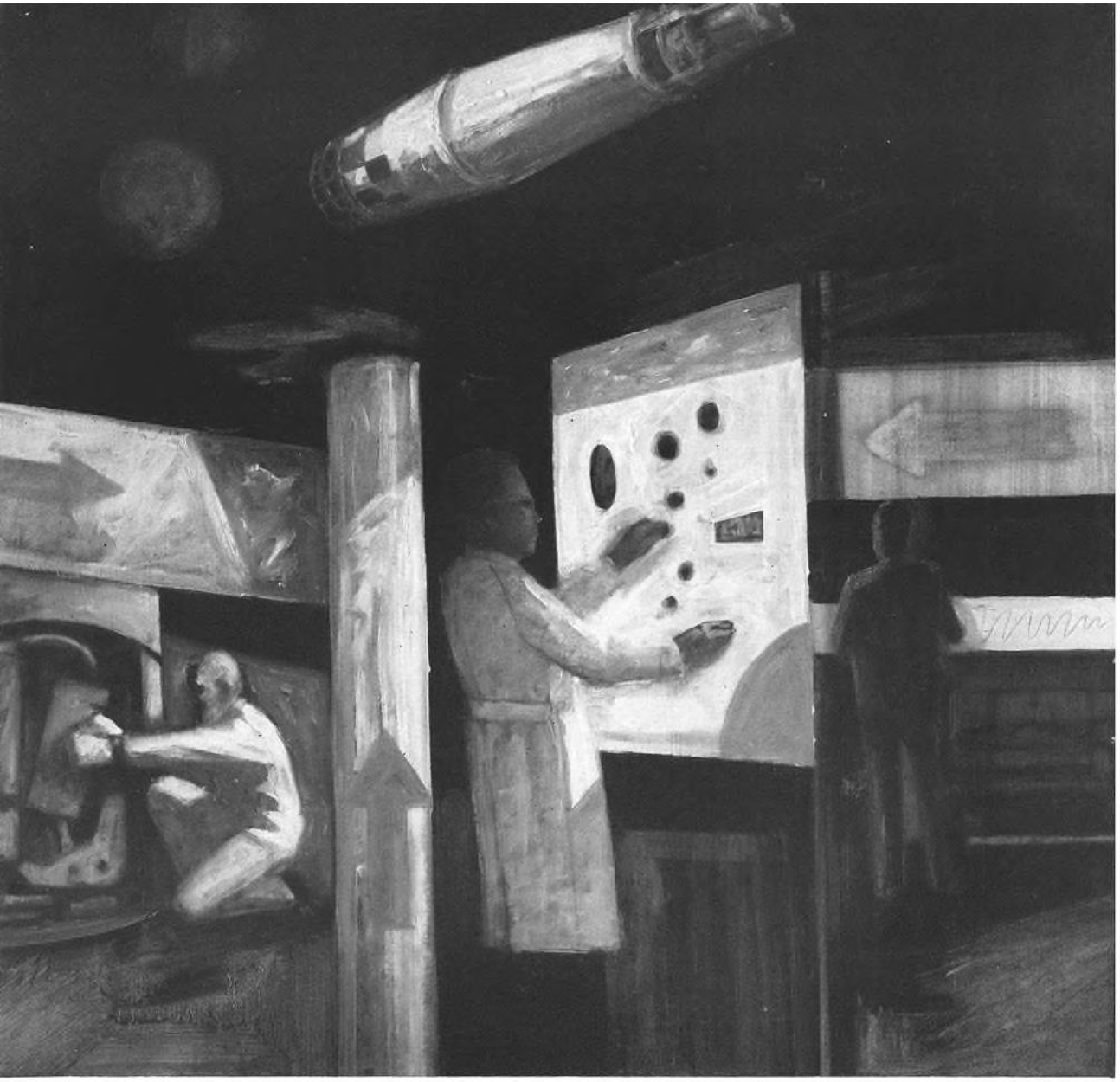
- **Lifting body vehicles** such as Dyna-Soar, which develop aerodynamic lift during boost, resulting in unusual stress and boost-trajectory problems.
- **Hammerhead loads,** such as the Apollo command and service module (154-in. dia., compared with 120 in. for transtage).
- **Standard payloads,** either mated directly to the transtage or enclosed in a 10-ft. dia. utility payload shroud.

Specific uses for Titan 3 boosters which have been studied include the following:

- **Air Force's** Military Orbital Development Station (MODS) and NASA's Manned Orbiting Research Laboratory (MORL).
- **Ferrycraft to support** a small space station, including Gemini, Apollo and modified X-20 vehicles (AW July 22, p. 230).
- **Blue Gemini spacecraft,** based on the now-doubtful USAF active role in NASA's Gemini project.

The versatility of the Titan 3 launch system makes it suitable for launching other spacecraft such as those which would be used for manned or unmanned satellite interception and inspection, space-based early warning and synchronous orbit communications. Titan 3C can place 2,140 lb. into a synchronous orbit (AW July 22, p. 221).

Neither of the Titan 3 boosters will



THE QUIET MEN AND THE MINIATURE REACTOR One of man's strongest motivating forces is his need to know. It is part of the sense of wonder in a child's eyes—an inborn desire for the answers that will add up to maturity. It is also a source of inspiration for the research scientists of America's aerospace industry.

Today—quietly—certain of these specialists are advancing down the byways of nuclear research, through the unknown realm of the universe, and into the very cosmos where facts and philosophy blend. Along the way, they find more new questions than answers. But already their answers are bearing fruit—for example, miniature new SNAP reactors from NAA's Atomics International Division, with myriad uses on earth, in space, and on the moon.

Research scientists like these are the explorers of the new Age of Space. Seekers for the headwaters of knowledge. Trail breakers whose unerring sense of direction can lead mankind to new plateaus of well-being.

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be recoverable, nor will any provisions for installation of partial or full recovery systems be incorporated. The extra weight of a recovery system, which would reduce payload capacity and require extra time and money to develop, are considered the primary drawbacks.

Key to the Titan 3 payload injection capabilities is the transtage. By coasting and restarting techniques, the following maneuvers may be performed:

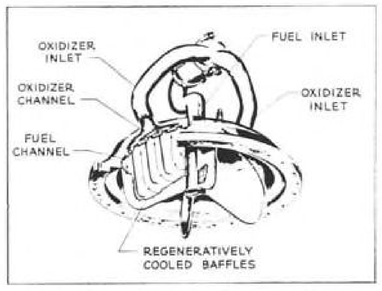
- **Orbital altitude change** using a transfer ellipse from a circular or elliptical parking orbit.
- **Orbital plane changes** up to 40 to 60 deg., depending on payload.
- **Circularization of orbits** following either direct injection or orbit transfer.
- **Highly-accurate escape** trajectory from a parking orbit.

The transtage is composed of two modules—a power module and a guidance and control module. The guidance and control module, located atop the power module contains a modified Titan 2 inertial guidance system, manufactured by General Motors' AC Spark Plug Div., and the reaction control system under development by Rocketdyne Div. of North American Aviation, Inc.

The high acoustic energy level generated by the Titan 3C solid motors and shock impulses generated from explosive bolts firing during booster staging have required that modifications be made to the inertial guidance gimbaling system to keep the accelerometers from bottoming out. Another problem area has been that the system will be in a hard vacuum for periods up to 6½ hr. This has required the addition of an environmental control system to maintain proper temperature and pressure.

The attitude control system consists of two clusters of three ablative-cooled chambers and two single downward-pointing nozzles. One nozzle of each of the three-chamber units points downward providing four 45-lb.-thrust rockets for propellant settling and pitch and yaw control.

The hypergolic propellant for the reaction control system is contained in



TRANSTAGE ENGINE injector baffles, regeneratively cooled with fuel, are used to prevent combustion instability.

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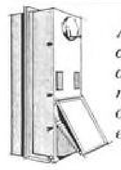
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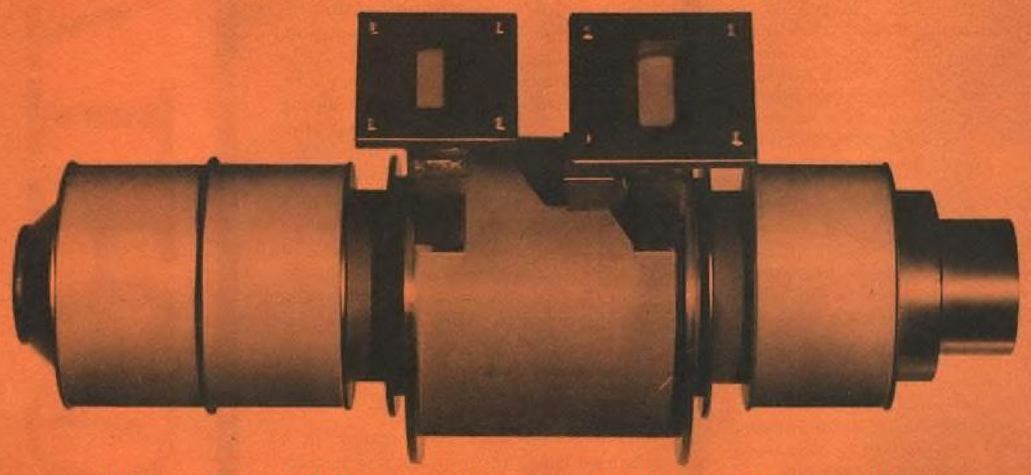
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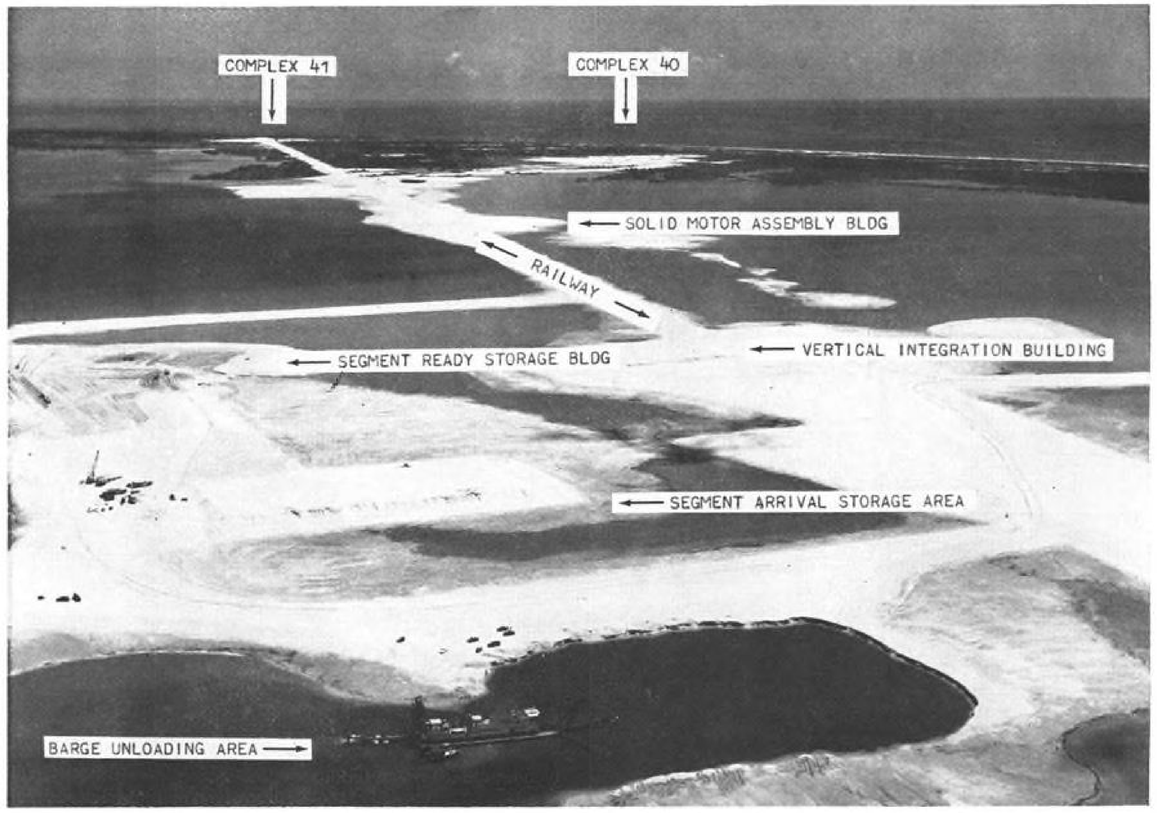
Other versions of this tube can be made to customer specifications with gain to 60 db, power output to 250 KW, and centered as required in X band.

For additional information contact Hughes Microwave Tube Division offices in: **Los Angeles,** 11105 S. La Cienega, SP 6-1515, Ex. 6124, 6125; **Woburn, Mass.,** WE 3-4824; **Red Bank, N. J.,** 741-1259; **Washington, D. C.,** 347-4505.

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Tube Type	P_o	Gain (S. S.)	Frequency Gc	Beam Voltage	Control Element	Duty
713H	100 kw	29 db	8.85 - 9.1	39 kv	Anode	5%
718H	100	45	8.75 - 9.0	39	Anode	2%
714H	40	20	9.3 - 9.5	25	Grid	1%
719H	40	50	9.3 - 9.5	25	Grid	1%

HUGHES TWT'S



AIR FORCE IS MAKING RAPID PROGRESS with the development of Titan 3 facilities in the Banana River immediately west of the Cape Canaveral missile test annex. Fill-in of the man-made islands is essentially complete and ground recently was broken for the start of construction on the 233-ft.-tall vertical integration building (VIB).

positive-expulsion tanks, which use a Teflon bladder to separate the nitrogen pressurizing gas from the propellants (hydrazine and UDMH with nitrogen tetroxide as the oxidizer).

Two nozzles of each three-nozzle unit are mounted in opposition and fire tangentially. These 25-lb.-thrust engines are used in opposite pairs for roll control and in like pairs to augment pitch control during powered flight.

In the power module, propulsion is provided by two Aerojet-General 8,000-lb.-thrust restartable engines. The first long-duration firing of the two transtage engines and integrated propellant system marked one of the major milestones of the Titan 3 program (AW July 29, p. 27).

To increase future performance of the engines, provisions have been designed into the system to use fluorine, rather than nitrogen tetroxide as the oxidizer. Tankage and fuel system is planned to handle fluorine and the only major change required would be development of a new thrust chamber. This propellant conversion could give both the Titan 3A and 3C greater payload capability.

Other features of the transtage engine include:

• **Ablative thrust chamber.** During long-duration runs up to 8 min., with combustion temperatures up to 5,200F, growth in throat area has averaged less than 1%. Specifications allow a 2% growth in throat area. Throat is designed so that a small increase in area actually increases thrust.

• **Columbium and titanium** alloy ration-cooled skirt. The skirt is bolted to the thrust chamber at the 6:1 expansion ratio. Original plans called for an aluminum oxide coating to prevent oxidation and increase emissivity but recent vacuum chamber tests have indicated the oxidation rate is so low that a coating may not be required.

• **Multi-orifice injector.** Fabricated of aluminum, the injector's baffling arrangement has been partially responsible for the excellent combustion stability reported in the test program. The engine has proved dynamically stable even when subjected to impulses from injected powder charges ("bombing"). The injector has approximately 4,000 metering orifices formed into nine concentric alternating fuel and oxidizer rings, the outer two rings being fuel. The angle of impingement of fuel and oxidizer has been varied and the propellant mixture ratio has been changed to an oxidizer-rich mixture in the center and a fuel-rich mixture near the outer perimeter in an effort to reduce hot spots on the wall of thrust chamber.

• **Multiple restart capability.** Engine is capable of three starts in a 24-hr. period.

Transtage engines are gimbaled to provide attitude control during powered flight. Both engines move in the same direction for pitch and yaw, but point in opposing directions for roll. Angle of movement of each engine is ±6 deg.

The main gimbal mount, developed by Utica Div. of Bendix Corp., is an annular flexural pivot ring around the throat area of the engine. The ring, in turn, is connected to the transtage framework. An actuator displaces the engine with respect to the flexural pivot to provide yaw. For pitch, the entire gimbal ring is displaced relative to the transtage.

Vertical titanium propellant tanks, manufactured by Martin, contain enough propellant for about 8-min. of

burning time. Propellant is pressure-fed to the engine, with nitrogen acting as the pressurizing agent.

The Titan 3 core, a modified Titan 2 ICBM, has been modified to withstand the acceleration forces from the solid boosters and unusual stress expected in launching lifting-body payloads. A wide margin of structural safety has been designed into the Titan core to provide a significant safety factor for man-rating. Tankage, for instance, has a safety factor of 2 compared with about 1.25 for the modified Titan 2 Gemini booster.

Core Modifications

Structural modifications to the core consist mainly of increasing the thickness of the propellant tank walls, although extra stringers were added to the outer skin and actuators and attachment points were beefed-up to handle the heavier loads. The lower wall of the first stage aluminum fuel tank, for instance, was increased in thickness from 0.178 to 0.330 in. The first stage tanks are pressurized to ensure airstart capability.

Two solid-propellant, 120-in.-dia. strap-on boosters of the Titan 3C form the vehicle's first stage, but are often referred to as stage zero by program engineers so the same stage number of the Titan 3A and 3C core can be retained. Early in the program it was thought that development of the 120-in. solid motors and the accompanying thrust vector control system might be a troublesome problem. Concern over difficulties expected in development of the thrust vector control system, however, has diminished in view of better than expected test results, including the recent test of the thrust vector control system during the firing of the large 120-in. motor July 20 at Coyote, Calif. Details of this test and the 120-in. motor were outlined in AVIATION WEEK & SPACE TECHNOLOGY, July 24, p. 52.

The 120-in. motor development program is on schedule at present and no serious trouble is anticipated. Two areas of potential concern, however, have been fabrication of the forward closure and the longitudinal weld in the steel cases of the motor segments.

The forward closure, mated to the top segment to seal off thrust at the forward end of the motor has four thrust termination ports and one rocket igniter port. The thrust termination ports, which would be opened only for emergency abort during the boost phase, are fitted with plates, approximately 3 ft. in diameter, explosively jettisoned to create reverse thrust. Some difficulty in heat treating the forward closure is anticipated and modifications have been considered, such as reducing the number of ports.

Difficulties also have been experienced in cracking of the longitudinal weld of the 10-ft.-long motor segment casing. The 0.354-in.-thick D6AC steel casings and the forward and aft closures are being provided by two different contractors to United Technology Center to ensure availability of cases and closures during the tightly scheduled test program. Companies are Curtiss-Wright's Aeronautical Div. and Astronuclear Div. of Westinghouse Electric Corp.

Each complete five-segment motor system now weighs close to 475,000 lb., but a reduction in the amount of insulation between the propellant and the case later in the test program is expected to bring this figure down toward the target weight of 450,000 lb. Each segment weighs approximately 75,000 lb.

Burning pattern within the solid motor is controlled by casting the propellant of each segment so that the circular core opening has a larger inside diameter at the top of the segment than at the bottom of the segment. This is accomplished by using a tapered steel mandrel during casting. In addition, the bottom surface of each segment is painted with a combustion-resistant paint so that initial burning starts only in the core area and at the top surface of each segment. A small gap is provided between each segment. Thus, burning action proceeds toward the lower outer perimeter of each segment.

Motor Nozzles

The nozzles of the 120-in. motor are canted outward 6 deg. from the vertical so that the thrust vector passes through the center of gravity of the Titan 3C.

During the 120-in. pilot propellant motor research and development program, consisting of 10 development and 39 PERT qualification and flight rating firings, a 95% reliability with a 90% confidence factor is sought.

The twin solid motors for each Titan 3C will be affixed to the core by a main support structure consisting of a braced cradle arrangement, with the core resting on the cradle.

Two support arms near the top of each motor keep the motor aligned with the core.

Jettison of the solid motors from the core is accomplished when tail-off thrust is sensed. First stage of the core is ignited approximately at the same time the explosive bolts are fired to jettison the solid stages. Two banks of four solid-propellant motors, one near the top and one near the bottom of the stage, are ignited to thrust the individual stages away from the core.

To launch the Titan 3 vehicles with a minimum countdown and checkout time on the pad, the integrate-transfer-launch (ITL) facility has been devised. Underlying philosophy is spelled out in the ITL facility title. Vehicle stages and payloads are first assembled and checked out or integrated in controlled-environment buildings, remote from the launch pad. They then are transferred by rail, with checkout equipment still attached, to the launch pad for fueling, final checkout and launch.

ITL Complex

Design of the ITL complex (AW Feb. 25, p. 27) has been accomplished with the following operations goals for the Titan 3 in mind:

- **Minimum reaction time** of two minutes following countdown, which can be accomplished well in advance of the intended launch. This minimum reaction time is projected primarily for possible satellite intercept and rendezvous maneuvers. Intercept goal is to be able to intercept a foreign satellite on the first pass around the globe.
- **Capability of launch** in 99% of expected wind conditions at the Cape. Operational availability is thus enhanced by being able to launch during almost all of the expected wind conditions at the launch site. This figure compares with 90% to 95% wind condition launch capability for ICBMs.
- **Launch rate** of 60 Titan 3C boosters per year utilizing three launch pads. Construction of only two launch pads, however, presently is approved and funded. Average launch rate of one vehicle every three weeks from the two pads is expected toward the end of the research and development phase.

Requests by Air Force for funding and approval of a third pad at the Atlantic Missile Range and another operational site at Vandenberg AFB were turned down early this year by DOD pending establishment of an operational requirement. Air Force would like to use Vandenberg to launch satellite inspector and surveillance vehicles into polar orbit with a Titan 3C booster. Although transtage vehicle has orbital plane change capability, it cannot dogleg a standard payload into a polar orbit.

The majority of the planning work for the Pacific Missile Range Titan 3 site has been completed and it is estimated that facilities and equipment for a two-pad complex would cost close to $100 million exclusive of the necessary land acquisition.

Micro-organism Study

Research in biological micro-organism detection will be conducted by Space-General Corp. under a $700,000 contract from U.S. Army's Biological Laboratories, Ft. Detrick, Md. Project will involve development of an automated air sampling device capable of rapidly detecting and identifying micro-organisms.

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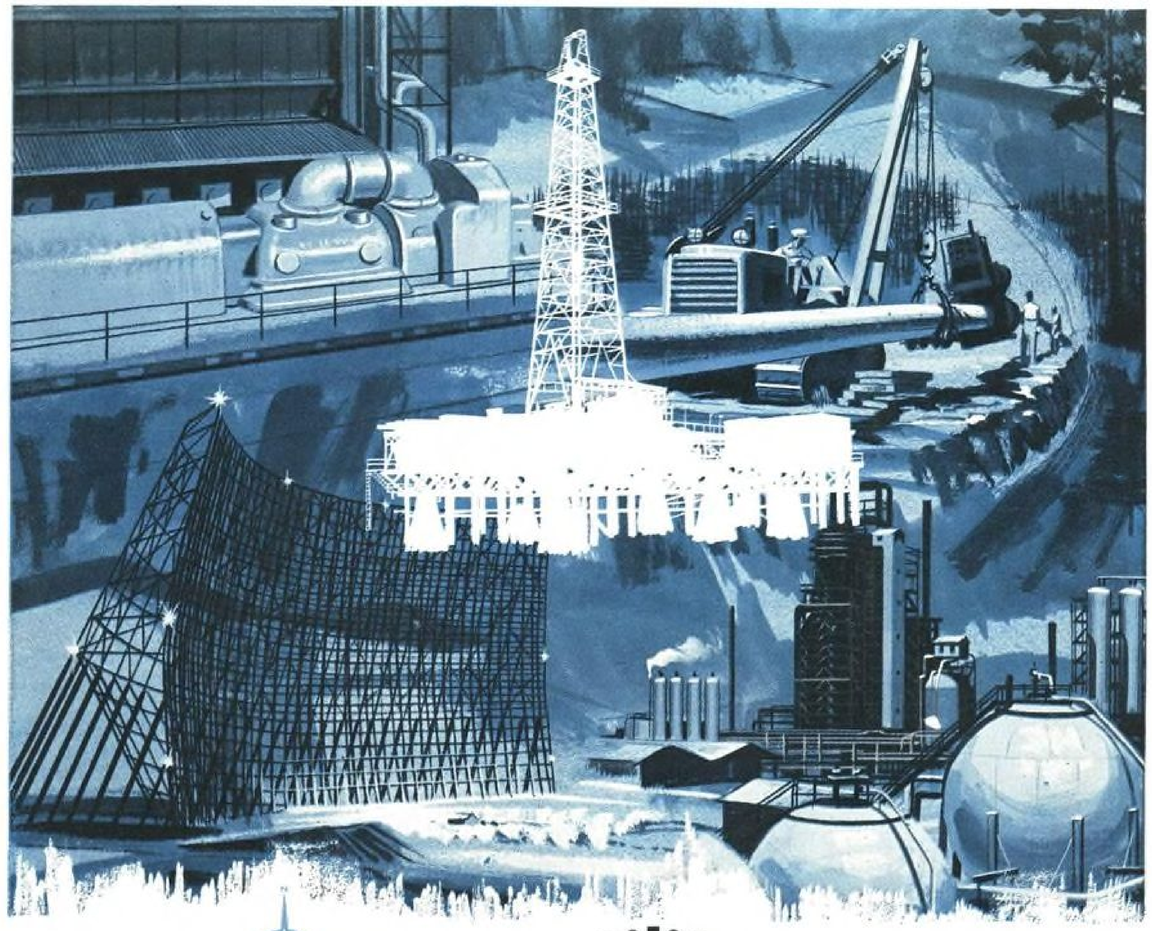


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Germany Links Technical Future to Space

By Warren C. Wetmore

Bad Godesburg—Germany's entry into the space arena has been prompted by the growing realization that its technological future is closely entwined with high-level scientific and technical achievements in this field.

Current feeling is that Germany cannot attain a leading position in the over-all area of space activity and therefore must concentrate on certain specialties, where it is more likely to reap economic benefits, in an attempt to fill possible gaps existing in the broad international spectrum.

Initial impetus for the German space program—which was not envisioned prior to 1960—stemmed from the establishment of the multinational European Space Research Organization (ESRO) and European Launcher Development Organization. The federal government elected to join them in 1961.

Conventions were signed in 1962, subject to Bundestag ratification.

Germany's contribution to ELDO will be the third stage of the ELDO booster, now under joint development by Boelkow and the Northern Development Group (ERNO). Boelkow is responsible for the guidance package, vernier engines and systems integration and testing, while ERNO—in particular Focke-Wulf—will build the structure, tankage and main engine.

Propellants will be a hypergolic combination of unsymmetric dimethyl hydrazine (UDMH) and nitrogen tetroxide. First live firing is scheduled for 1965.

Five-year ELDO program will bear a total price tag of $196 million, of which Germany will defray 22.01%, or $43.2 million.

Germany's 21.6% proportion of the total eight-year ESRO expenditure of $310 million amounts to $66.8 million. ESRO's data-processing laboratory is slated for construction at Darmstadt, near Frankfurt.

Responsibility for the promotion of space research was first assigned to the Ministry of Atomic Energy in January, 1962. Then, in December of that year, the ministry was reshuffled to form the Ministry for Scientific Research, having three general tasks:

- **Promotion of general sciences.**
- **Nuclear energy research.**
- **Promotion of space science** and technology.

The Space Research Dept. of the new ministry is headed by Max Mayer, and performs a function similar to that of the U. S. National Aeronautics and Space Administration.

A separate governmental space agency is not envisaged.

"Contributions to ELDO and ESRO cannot be effective without a national program in similar fields," Mayer says. "We don't want to make purely financial contributions, but rather to contribute technically."

To this end, the ministry has established six projects on the purely national level:

- **Project 620—Test facilities** will include an environmental simulation center now being established at Ottobrunn, near Munich. In addition to several small hard-vacuum chambers now in existence, a chamber 13 ft. in diameter—large enough to accommodate the full-scale third stage of the ELDO booster—is presently on the drawing boards. This unit is expected to be operational at the end of next year.
- **Project 621—Recoverable sounding** rocket is under development by Dornier's Systems Div. Re-usable vehicle will employ liquid propellants and, during re-entry, a paraglider (AW June 24, p. 75). Maximum altitude carrying an 11-lb. payload is estimated at 330,000 ft.
- **Project 622—High-energy third stage** for the second-generation ELDO booster is being designed by Boelkow. Possible propellant combinations are



S-1C Mockup Illustrates Saturn 5 Size

Soft mockup of thrust structure of S-1C stage nearing completion at NASA's Marshall Space Flight Center, Huntsville, Ala., (AW Aug. 19, p. 33) suggests magnitude of 350-ft. Saturn 5 moon rocket. Booster has 33-ft. dia., length of 138 ft. It will be powered by five F-1 engines, two of which are seen mounted beneath thrust structure in mockup form.

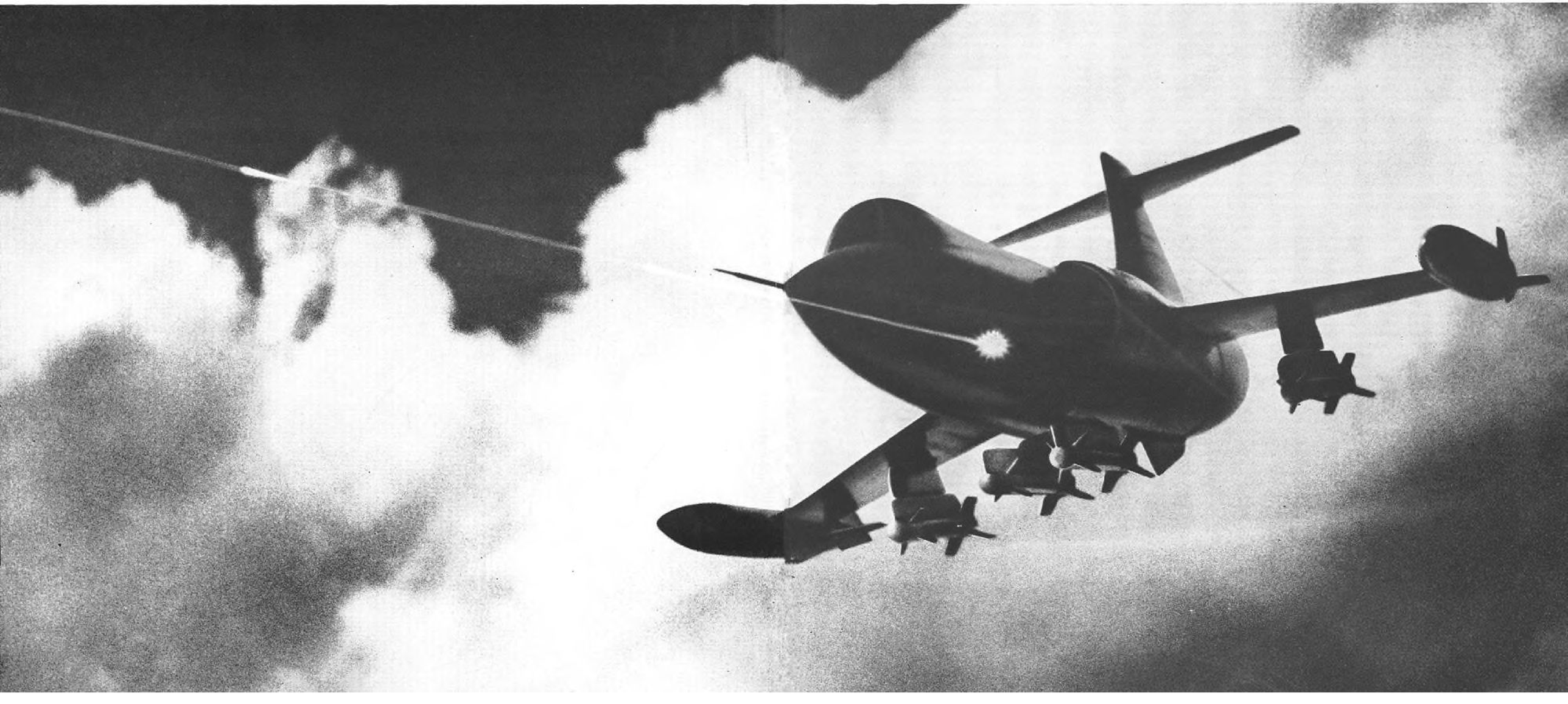
The F-104 Starfighter: fastest way to discourage intruders

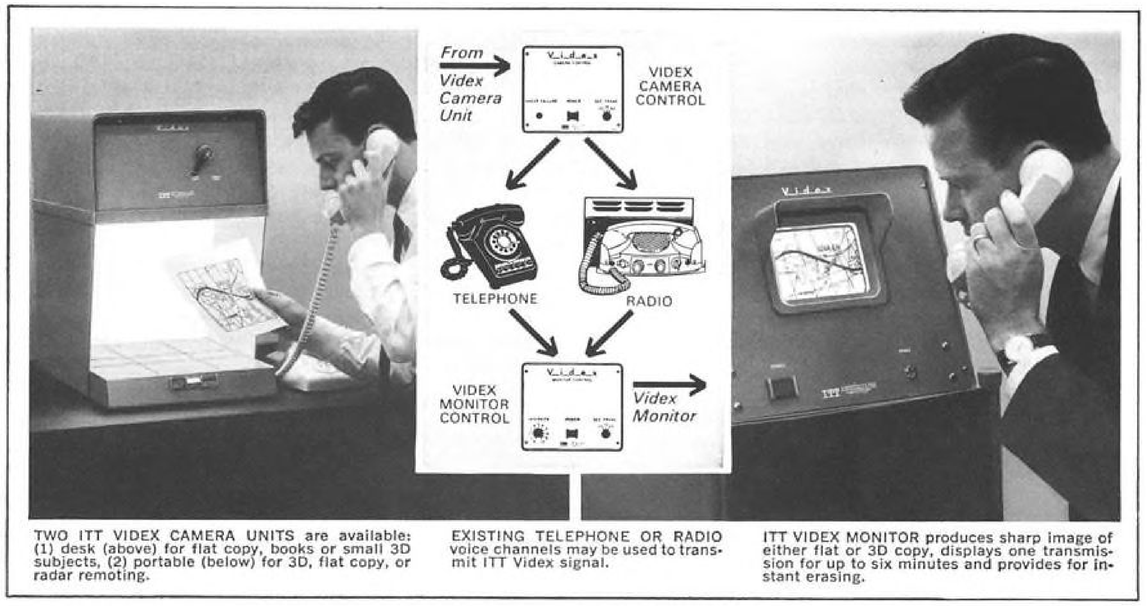
The F-104 is a real Mach 2 airplane—even with Sidewinders on it. It can accelerate from Mach 1 to Mach 2 in record time. Slam it into a 3 G turn, it's still Mach 2. That's the kind of performance an interceptor has to have today. In fact, the F-104 holds the official USAF time-to-intercept record.

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liquid hydrogen-liquid oxygen and liquid hydrogen-liquid fluorine.

• **Project 623—Space transporter** is Boelkow's name for its winged, recoverable aerospace plane, which is intended for logistics support of space stations. This indicates Germany's intention to move along relatively untrodden paths, but ultimately the cost of such a project would require international cooperation.

• **Project 624—Energy conversion** and electric propulsion will probably entail cooperation between the Space Research and Nuclear Energy departments of the Scientific Research Ministry. Nuclear generators for electric power supply are being considered, rather than nuclear rocket engines. Possible contractors include Siemens, Brown Bovery Co., Interatom, General Electricity Co. (AEG) and Krupp.

• **Project 625—Multipurpose satellite,** weighing approximately 300 lb., has been designed by Boelkow and the German Experimental Aerospace Institute (DVL). It is intended for both scientific research and commercial use; e.g., as a communications satellite. First generation models will use a solar-heated mercury boiler for power supply, while follow-ons will utilize nuclear generators as they become available from Project 624.

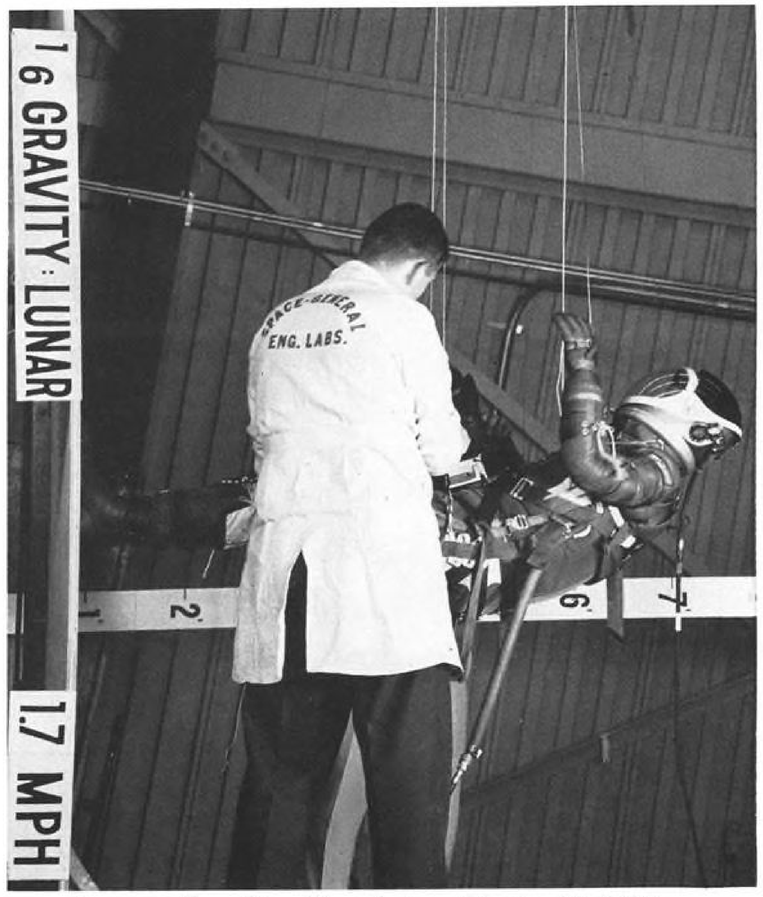
Present consensus is that Germany would be neither willing nor able to build a large booster as a part of the national program. The majority of first-generation launch vehicles, such as those now in use or contemplated by the U.S., Soviet Union, Britain and France, resulted from spinoff from a military ballistic missile program, which is non-existent in Germany.

Nor is there any military space program. "Germany is concentrating its space efforts, rather than diversifying them among Army, Navy, Air Force and a civilian agency," one German industry official said.

Timetable for the national program is still undefined, Mayer says, due to its comparative newness and to the fact that the bulk of the projects exist only as feasibility studies.

Moreover, there is no definite financial approval of the over all German program as yet.

All applications, including communications, weather and navigation satellites, are still well in the future, according to Mayer. When and if the decision is made to go ahead on a national comsat program, the Postal and Scientific Research ministries will collaborate very closely. Postal Ministry will deal with ground stations and the necessary equipment for handling communications traffic, while the Scientific Research Ministry, through its Space Research Dept., will be responsible for the flight hardware.



Lunar Gravity Simulator Tests Mobility

Prototype lunar gravity simulator has been designed by Space-General Corp. to test man's mobility in a space suit at ⅙ gravity of earth. Subject shown in a Navy Mark 4 full-pressure suit had no difficulty adapting to the simulator, the firm says. An 8 x 10-ft. floor is angled at about 80.5 deg. while subject is held by a harness and cables attached to head, arms, torso and legs. A 14-in. adjustable-speed treadmill is located in center of the "floor." More sophisticated unit is under development.

Meanwhile, Germany will be involved with the European investigation of a possible global comsat network. This will touch both ELDO and ESRO and probably will necessitate considerable cooperation with the U.S.

The German government has not concluded any bilateral agreements outside the framework of ELDO/ESRO, Mayer says, but scientific and technical contacts are being pursued with institutions in other countries, with the intention of establishing closer cooperation.

As things stand now, Germany is the only sizable Western nation having no cooperative agreement with NASA for launching of either sounding rockets or satellites (AW Aug. 12, p. 64).

In June, an official delegation from the Scientific Research Ministry, headed by Minister Hans Lenz, made an official visit to the U.S. There, it had a series of interesting and promising contacts, both with NASA headquarters and research facilities, including Goddard Space Flight Center, Marshall Space Flight Center, Ames Research Center and Lewis Research Center, according to Mayer.

"The hope is that out of this trip a close cooperation in various scientific and technical fields arises," he declares.

One possible area of cooperation is in the Tiros/Nimbus program. Germany is considering the establishment of Automatic Picture Transmission (APT) stations on its soil, although this has not yet received official government approval.

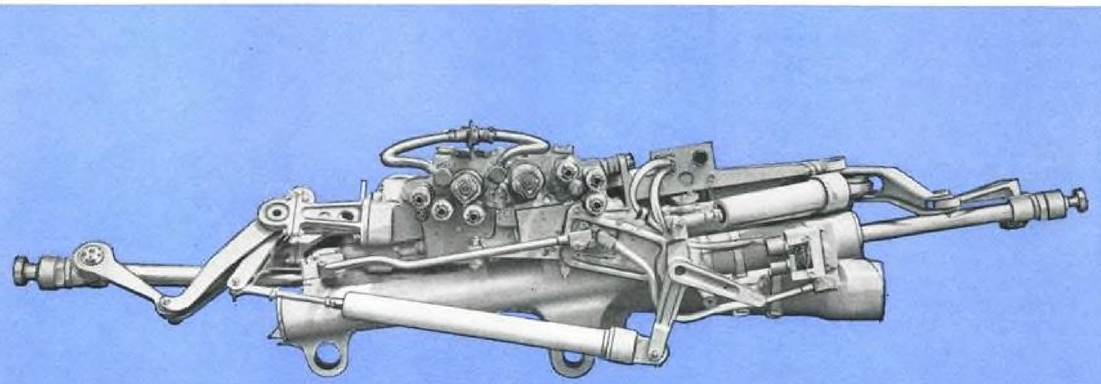
In its attempt to get off the ground, the German space program is confronted by a variety of obstacles, primarily financial.

Budget for space activities during 1962, the first year of the program,

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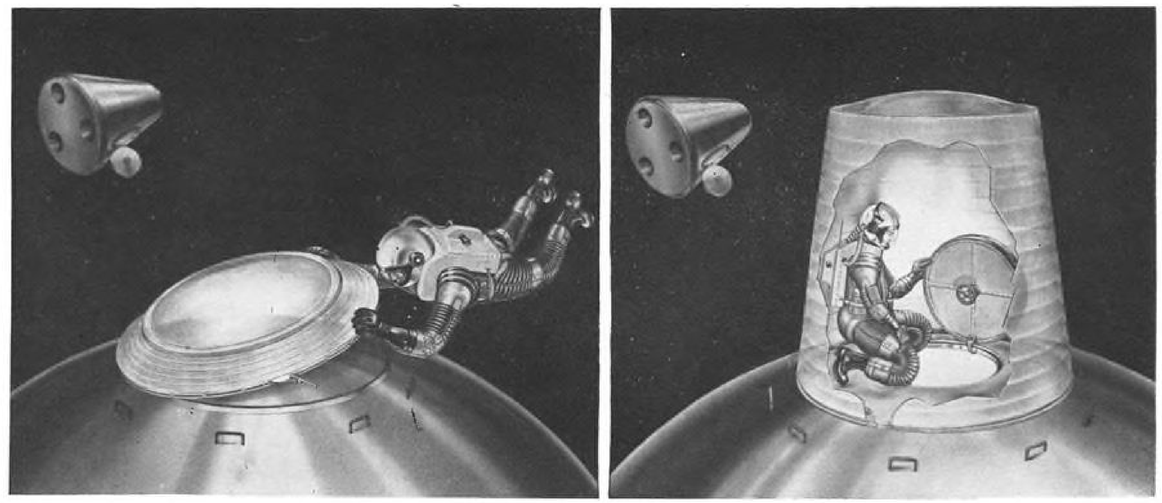
The manifold block has 42 different plug-in valves and pistons and over 300 cross-porting holes, making it look like a bright and shiny swiss cheese. These many different components control a complex list of functions plus some unique safety features introduced into the system.

When Jarry Hydraulics Limited, Montreal was awarded the contract they knew they had a "put-up-or-shut-up" undertaking, because both engineering and time demands were crucial. Using their own 3 plants and a variety of subcontractors they moved on a round-the-clock basis, pioneering every step of the way. They didn't have time for forgings so they machined all components from rough cut steel and aluminum blocks. Tool design and manufacture were programmed as they ran, so that tools were available at the precise moment required. Lucite duplicates of the manifold block were machined first to prove the tools prior to machining the aluminum. Four-and-a-half months after conception Jarry officials triumphantly flew the first system to Lockheed's Georgia plant.

Yes, this Canadian team of hydraulics engineers and manufacturers has been coming up with breakthroughs like this for some time now. Next time you have a hydraulics requirement get Jarry's thinking. A number of the world's most successful aircraft already incorporate it.

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Portable Emergency Spacecraft Airlock Proposed

Portable emergency airlock for spacecraft, designed by Lockheed Missiles and Space Co., is shown in use in drawings. The collapsible, 35-lb. airlock is made of flexible filament-wound material lined with gas-tight butyl rubber. One suggested use would be for crew transfer between spacecraft through an emergency hatch when the regular airlock has been damaged.

amounted to $8.87 million, of which $6.34 million was earmarked for ELDO/ESRO. Only $1.62 million of this was used, since the conventions had not yet been ratified by the Bundestag. The remaining $2.53 million was allocated to the national effort.

Space appropriation for 1963 was nearly tripled, to $25.1 million. ESRO's share is $5.65 million and ELDO receives $8.76 million, while the national program is alloted $10.65 million, representing a four-fold increase.

Budget Request

The 1964 budget request is in the process of being submitted to the Bundestag. Mayer is reluctant to give the exact figure, saying only that it represents "a substantial increase" over 1963. The requested amount probably will be pared somewhat by the legislators, as were the requests for 1962 and 1963.

One industry observer, however, believes the figure to be in the vicinity of $38 million, or some $22 million less than the current French space budget request (AW Aug. 12, p. 52).

A contributory factor to the uncertainty shrouding the 1964 space budget is the parliamentary battle looming between the federal government and the eleven German Lander (states) over the distribution of income tax revenues. At the present time, 65% of the taxes go to the Lander and the remainder to Bonn, which is attempting to have its share raised to 41.5% in 1964.

Another facet of the problem is that there is believed to be a popular resentment remaining from the war against things associated with rocketry, although this belief is not universally held. Subscribers to this opinion are generally divided into two schools of thought on the question of how to overcome this difficulty. Some believe that the government should go easy and underemphasize the space program, while others advocate a campaign to educate the people and their elected representatives into acceptance of the desirability of a space program.

On the manpower side, Mayer feels that German aerospace research is hampered by a shortage of experienced middle-aged scientists, a result of the postwar exodus of scientists to other countries in search of work that was forbidden Germany. Moreover, he does not believe that it will be possible to attract technical and scientific personnel back to their native land because of the opportunities and facilities which they have found in other nations.

New Generation

"The hope lies with the new generation of scientists and engineers," he says, and Germany will attempt to equip its aerospace research and development facilities to such an extent that they will be attractive to qualified young Germans beginning their careers.

Federal Assn. of German Aerospace Industries (BDLRI) estimates that the aerospace disciplines will require 3,700 scientists and engineers by the end of 1966.

In producing these, Mayer says, technical manpower training is somewhat handicapped because Germany does not have specialized technical colleges which concentrate on education in the aerospace field.

To build up Germany's technical and scientific forces in this area, NASA and the National Science Foundation will grant graduate fellowships to qualified German students. These students will study in the U. S. and return to Germany afterward.

However, this is only a stopgap measure until sufficient activity in the aerospace disciplines is generated in the German institutions.

Aiding Groups

Space Research Dept. of the ministry is actively aided in planning and executing its tasks by a variety of bodies, some of which were created especially for the space program. Included are:

- **Space Research Co. (GWF),** a nonprofit organization headquartered here, is the executive arm of the Space Research Dept. The company grants and supervises contracts to industry and research institutes according to the Space Research Dept.'s program and participates in the sponsorship of appropriate aerospace research installations. For the present, no in-house research and development activity is planned by GWF.
- **German Flight Sciences Society (DGF),** an old-line organization, is primarily concerned with space flight technology, rather than extra-terrestrial research. Projects are planned in low-speed mechanics; flight performance and control; chemical propulsion and advanced propulsion systems power supply; components; strength of materials; data transmission; applied mechanics; meteorology; space medicine; recruitment and training of personnel and documentation and information.
- **German Research Assn. (DFG)** pro-

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S-1C Booster Component Jig Shown

Large aluminum fixture with steel fittings is to be utilized by Boeing-Wichita in building two sizes of thrust rings for the S-1C first-stage booster of the Saturn 5 vehicle (AW Mar. 25, p. 50). Boeing has the prime contract on the S-1C. Large jig is adjustable for the two different sizes of thrust rings that the company will build.

gram concentrates primarily on interplanetary exploration, including such problems as extra-terrestrial meteorology, fundamental atmospheric and plasma physics research and space electrotechnology.

The group provides support for university research projects.

• **Max Planck Institutes** of aeronomy (Lindau/Harz), physics and astrophysics (Munich) and nuclear physics (Heidelberg) carry out space research in their respective disciplines.

• **German Space Research Committee,** a steering body consisting of leading figures from science, engineering and industry, was established on Sept. 6, 1962. It works in specialized groups on research and development projects and advises the ministry on promotion and planning of space research.

• **Space Flight Technology Committee** was founded jointly by the BDLRI and DGF in June, 1961. This committee drew up a four-year space research and development program for the DGF and for industry, which it submitted to the ministry. Problems to be investigated by the research establishments associated with the DGF as outlined by this plan include:

• **Kinetics**—High-speed flight at very high altitudes with extreme stagnation temperatures; dissociation and ionization; cooling and boundary layer problems.

• **Flight mechanics and control**—High-speed stability and control in vacuum and near-vacuum conditions; trajectory computation and trajectory control; radio command transmission; navigation, with particular emphasis on inertial navigation; high-reliability control and regulating mechanisms; measuring techniques and simulation.

• **Propulsion and power equipment**—Increased chemical propulsion efficiency employing liquid, semi-liquid and solid propellants; feasibility of nuclear propulsion; electrothermal, magnetohydrodynamic and ion engines for trajectory correction and spacecraft propulsion; chemical, solar and nuclear power sources and direct power conversion.

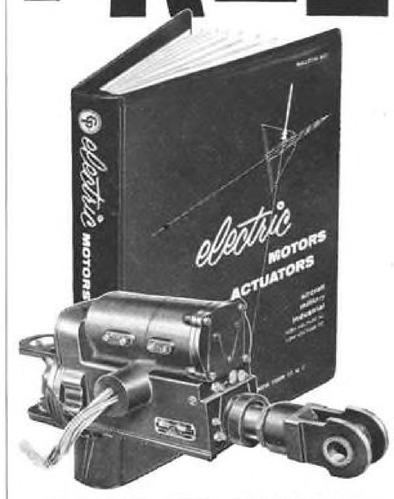
• **Structural design, strength** and materials—Thermal stress on spacecraft due to solar and re-entry heating; re-entry heat protection; denting behavior of thin metal skins of boosters; static and dynamic stresses; resistance to fatigue in vacuum; sonic pressure and behavior of materials under hyperthermal conditions.

• **Signalling and intercommunication** equipment—Built-in antennas for spacecraft; position finding and trajectory determination; navigation by means of satellites; signal reception problems; signal identification and utilization and optical and radar trajectory measurements.

• **Space medicine**—Integration of humans as functional elements in complex technical problems under the physiological and psychological strains of space flight; determination of ability to withstand such strains by simulation of actual conditions.

• **Meteorology**—Influence of upper atmosphere on spacecraft structural requirements; wind distribution, exchange conditions and vertical motions; diurnal pressure and temperature variations at high altitudes; direct and reflected solar

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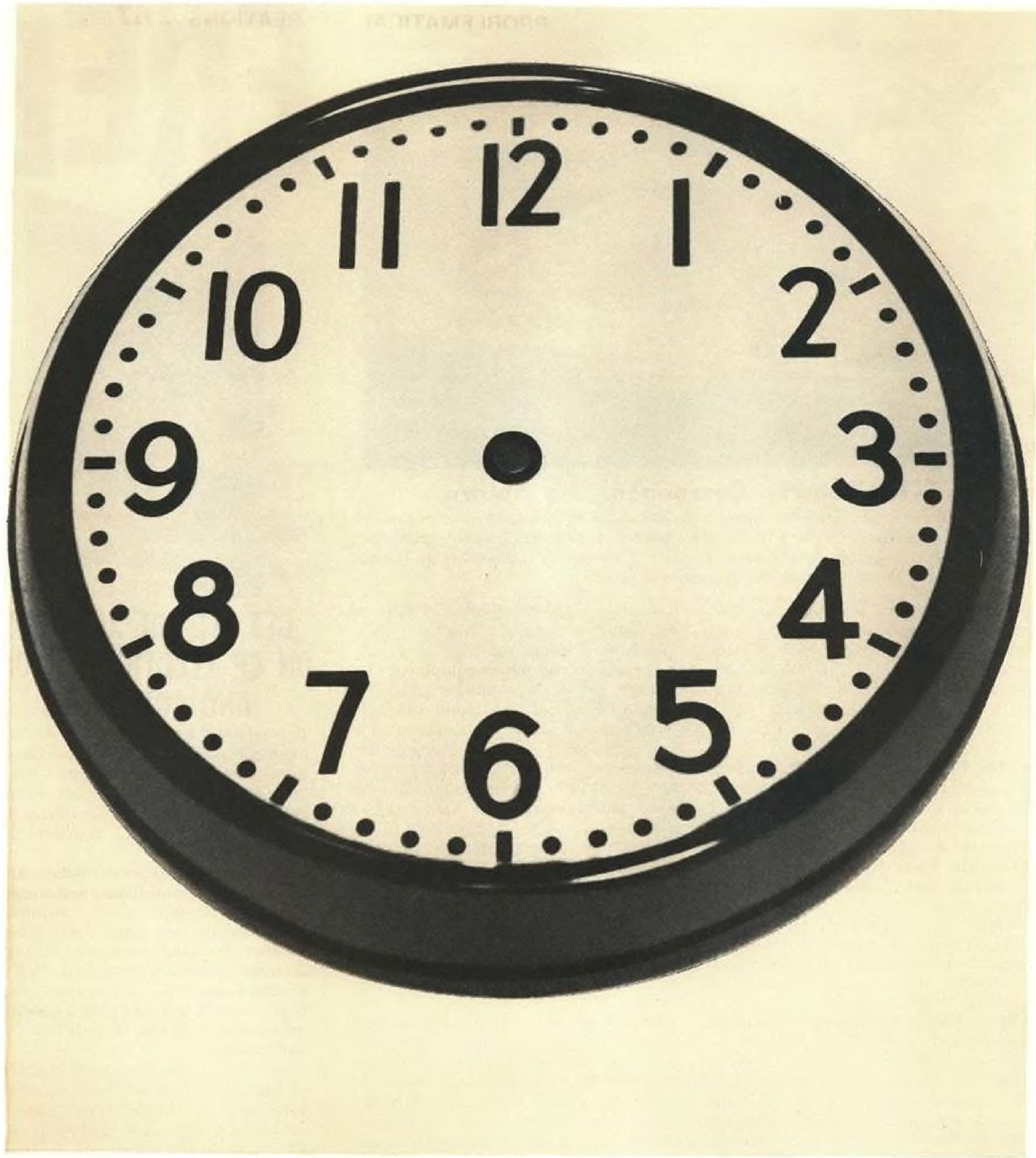
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radiation in various spectral ranges and solar influence on weather.

• **Applied mathematics**—Increased utilization, as required by space technology, of certain branches of mathematics, such as statistics, operational research, probability theory, group theory and LaPlace techniques.

• **Physics and chemistry**—Effects of space environment: hard vacuum, low temperatures, radiation, weightlessness.

Industrial projects suggested by the committee are included under the national and ELDO programs. German industry has given active support to the ministry, and has submitted a great number of unsolicited proposals, Mayer says.

The committee also laid down broad financial guidelines for the four years. Total cost is estimated at $236 million, with $47 million devoted to research and $189 million going to industry. However, these figures probably never will be realized completely. The first year of the program, 1963, called for $31.9 million, whereas only $25.1 million was appropriated.

Summarizing the tasks that lie ahead, Mayer:

"The ministry does not intend to use the taxpayers' money to carry out a thorough examination of the back of the moon. What matters in our opinion is to activate German science and technology through effective cooperation in space research in such a way that no one can later say that Germany has been eclipsed by other countries in the relevant fields."

Oxidizer Leaks Found In Titan 2 Missiles

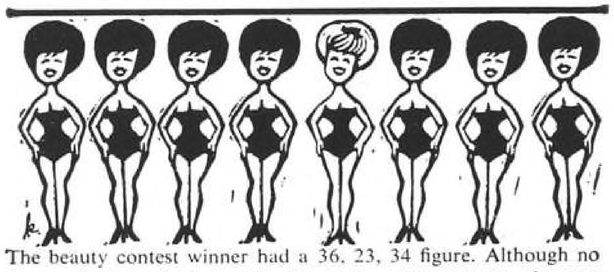
Washington—Slow leaks of nitrogen tetroxide oxidizer through second-stage joints are causing corrosion problems in some USAF-Martin Titan 2 ICBMs at operational sites.

Air Force last week said some of the missiles can be repaired on site by the installation of improved joints but others will be returned to the Martin-Denver plant for reworking.

When nitrogen tetroxide is exposed to water or water vapor, nitrous oxide and nitrous acid are formed. The weak acid corrodes the tankage, which is made of 2014ST aluminum. Titan 2 propellants are nitrogen tetroxide and an equal mixture of unsymmetrical dimethyl hydrazine and hydrazine. Leakage is so small that it took one week for a cubic centimeter of fluid to accumulate and be detected.

Titan 2 operational sites are at McConnell AFB, Wichita, Kan.; Davis-Monthan AFB, Tucson, Ariz., and Little Rock AFB, Ark. The squadron at Davis-Monthan has been declared operational and others soon will be.

PROBLEMATICAL RECREATIONS 187



The beauty contest winner had a 36, 23, 34 figure. Although no two contestants had exactly the same measurements, the two runners-up differed less than an inch in each measurement from the winner and the waist of each was ¾ the hips of the other. If the sum of the three measurements was the same for all three girls, what were the vital statistics of the two runners-up (the tape is accurate only to the quarter-inch). —*Contributed*

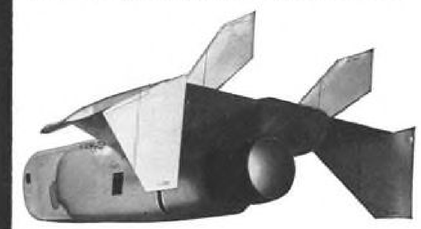
Figure we might see you this week, so here are the facts: *WHAT:* AFA Annual Convention and Aerospace Panorama. *WHEN:* Wednesday through Sunday. *WHERE*: Sheraton-Park Hotel, Washington D.C. Litton divisions will be on display in the Continental Room. Look for exhibits from RADCOM, Guidance and Control Systems and Data Systems. We hope you can make it.

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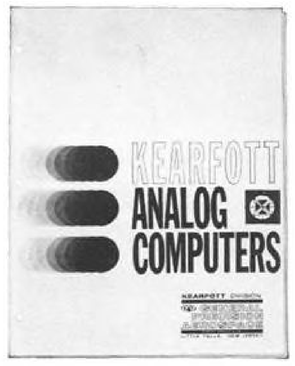


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MINAC-5 NAV COMPUTER. We'll spell the name again—MINAC.

These initials stand for Miniature Airborne Navigation Computer—the best available.

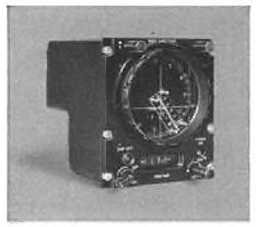
For the Doppler people, there is the MINAC 5. For those who prefer Inertial, we have MINAC 8.

The computer is small—occupying only ½ cubic foot. Weight is 30 pounds, including the control/indicator.

It's versatile, providing present position, wind speed and direction, distance to destination, bearing and ground track relative to true heading, true heading, ground track and ground speed. It can store two target destinations and accept alternate destinations without loss of primary data. Naturally it's accurate . . . ±0.25% of total path travelled or 1 NM/HR, whichever is greater.



A well engineered control/indicator goes with this flight-tested computer.



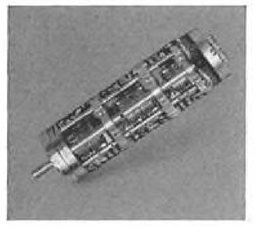
ASW COMPUTER. The AN/AYK-2 Computer with moving base capabilities further demonstrates Kearfott versatility. This computer is designed for Airborne ASW in fixed or rotary winged aircraft. The unit consists of computer and control/indicator, receiving data from any Doppler Radar set, Magnetic Compass and Air Speed Transducers. It computes N-S and E-W components of aircraft ground track and wind velocity, and of distance travelled

The AN/AYK-2 can also incorporate a supplementary function. It receives inputs of a moving base velocity and heading, then computes and displays the bearing plus N-S, E-W data needed for the aircraft's return to its repositioned base.

Further capabilities include continuous display of present position, heading relative to take-off point and distance, and bearing to any selected one of four stored destinations.



COMPUTER/INDICATOR. Ground speed and drift angle are computed and displayed with Kearfott's T8605-22N—specifically designed for rotary wing aircraft. Input signals to the 5.5 lb., internally lighted computer/indicator are from Doppler radar, representing heading axis and lateral axis speed. We then solve for hypotenuse and cosine functions of the input voltages by a buffered resolver servo and a ground speed follow-up servo. Accuracy and sensitivity are assured from 2 to 180 knots. Doppler radar noise is damped above 10 cps. The T8605-22N is complete with two transistorized servo amplifiers, two transistorized buffer amplifiers and their individual power supplies, packaged in little more than 1/20 of a cubic ft. Environmental performance of our compact computer package meets all applicable requirements for MIL-E-5400, MIL-E-5272, MIL-E-5422 and MIL-I-6181.



A/D CONVERTERS. Proving we're not really anti-digital—and because we know there's a good market for better products—we've developed the finest Shaft-to-Digital encoders available—all in the standard size 11 diameter. These encoders are complete with external logic, and provide BCD (8-4-2-1) shaft position output with overall accuracy of ±¼ bit.

They're available in ranges from 0-999, 0-9999, 0-99999, 0-3599, 2^5, 2^{13}, and ±89.9.

The converters can be read on the run, or on demand, at speeds up to 500 RPM, and sampling rates of 50,000 counts per minute without ambiguity. With proper maintenance, exceptionally long life is standard—$5x10^6$ cycles at 500 RPM with an increase of $3x10^6$ cycles possible.

Other characteristics include: low torque—0.3 oz. in.; low inertia—25 gm-cm²; power ±6VDC, 2 Ma per bit.

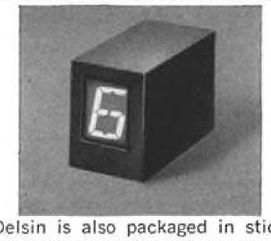
Each encoder contains "OR" gating, and is designed for serial interrogation to allow time sharing of selection logic and encoders.

Gold alloy tracks and brushes make for low noise and minimum wear.



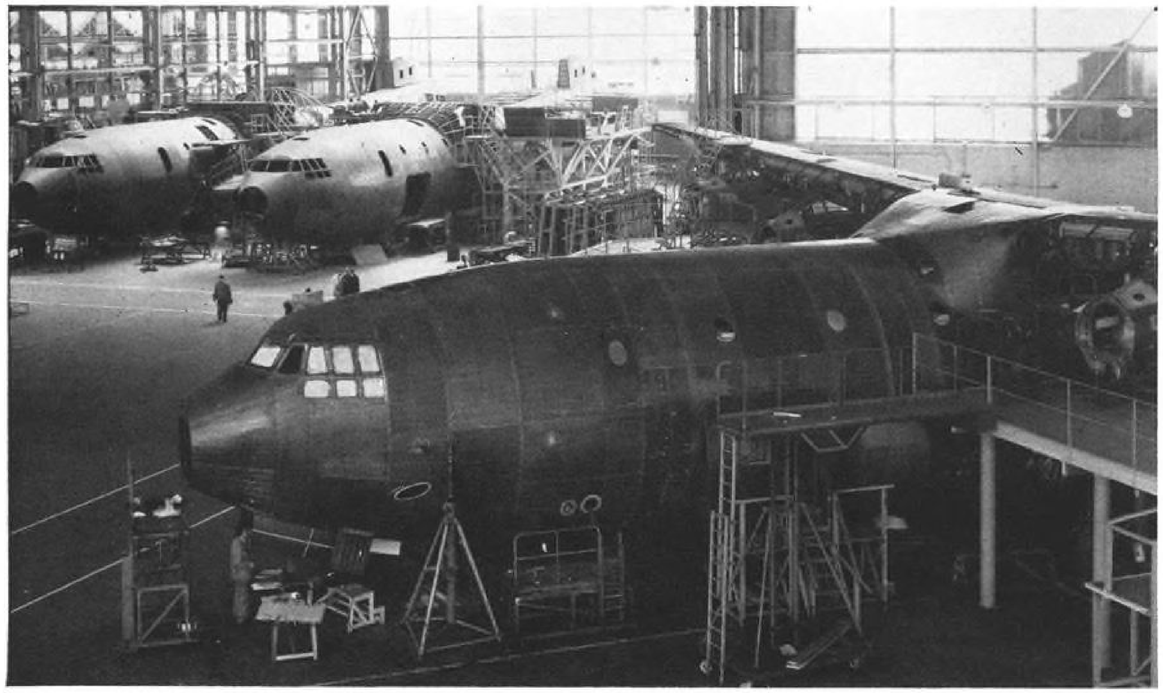
DELSIN. Another display problem is solved with Delsin, Kearfott's solid state indicator, accepting BCD input—displaying alpha-numeric values on a seven-segment electroluminescent panel.

The standard 3" indicator above contains a binary-to-decimal converter, driver, lamp encoding matrix, solid state switching matrix, lamp and associated electronics.



Delsin is also packaged in stick form, incorporating all necessary logic and switching circuitry and lamp, for individual alpha/numeric digits in a self-contained unit. Delsin sticks can be stacked side by side, developing a display of any word length. A typical 3-digit stick form display is about the size of a cigarette pack, and provides 7 ft. lamberts light output. It operates over a temperature range of −55° C to +71° C, and meets all applicable requirements for MIL-E-5400.

GENERAL PRECISION AEROSPACE
KEARFOTT DIVISION
LITTLE FALLS, NEW JERSEY
GENERAL PRECISION, INC



FIRST PRODUCTION BELFAST turboprop transport is nearing completion at the Short Brothers & Harland facility in Northern Ireland. Two more aircraft are shown in advanced construction stages in the background. Belfast will be rolled out late this month.

Argument Continues Over Belfast Future

By Herbert J. Coleman

Belfast—One of the most bitterly debated airplanes in the history of British aviation—the Short Brothers & Harland turboprop Belfast transport—rolls out late this month into an uncertain future.

After four years of development, the big Belfast is still the subject of rancorous argument between the Ministry of Aviation, in charge of development contracts, the Air Ministry, which will use the airplane, and a strong and vocal faction in the houses of Parliament.

So far, the government, which owns 70% of Short Brothers, has made its position on the Belfast quite clear—the order of 10 airplanes stands and will not be increased.

But the members of Parliament, particularly the powerful 14-member group representing Northern Ireland, are pushing for an increase in the order to 20 and there has been some quiet, behind-the-scenes, support for this in top echelons of the Royal Air Force. Another group in British Overseas Airways Corp. supports an order for five freighters for the transatlantic and Commonwealth routes.

Dominant factor in the sound and fury, overshadowing the technical merits or defects of the Belfast, is Northern Ireland, a chronic unemployment problem. Almost 8% of the adult male population is unemployed, and if Short went out of business, another 7,000 men would be laid off.

Right now, Short executives are fighting against the inevitable disintegration of its design team. C. E. Wrangham, the chairman, said the team's strength has fallen by 200 in the last 12 months. Over the last five years, employment at Short has dropped by 12.5%, compared with 8.3% for the aircraft industry as a whole.

Wrangham insists that if the company's aircraft design team decreases any further, the entire Belfast program will be endangered. He is pressing for an immediate decision on various projects submitted to Minister of Aviation Julian Amery.

Foremost of these, besides the request to increase the Belfast order, is government support for the Turbo-Skyvan twin turboprop transport program, now limited to a single prototype. Short wants a go-ahead on a production batch of at least 10 and is confident, on the basis of world operator interest, particularly in Australia and Alaska, that the airplane can have a wide sale.

Meanwhile, the company is actively selling its production capabilities through a number of international agreements that, as yet, have resulted in no hardware commitments. They include:

- **Sales and license production** of the Breguet 941 STOL transport. Short has submitted a VTOL design to the ministry, involving clip-on pods of Rolls-Royce RB.168 pure lift engines.
- **Deal with Chance Vought** to build the Crusader jet fighter in Belfast if the airplane is ordered in quantity by the Royal Navy (AW Aug. 5, p. 39).
- **Construction of Hiller** helicopters in Northern Ireland, another agreement based on potential military and civil orders in Great Britain and Europe.
- **Attempt to match** the Air Transport Assn. requirement for a DC-3 replacement with a twin-jet light transport now taking shape on the drawing boards of the preliminary design team, headed by Frank Robertson.

Robertson also is working on a STOL version of the Skyvan, probably centering on the tilt wing theory.

Government reticence to fully support the Skyvan has severely hampered the program since the day Short bought design rights from Hurel-Dubois and F. G. Miles, Ltd. First prototype was built with Continental GTS-IO-520 piston engines. Flight program, totaling 45 hr., was marred by heating problems contributing to a number of engine failures and a redesign of the pods.

Instead of building a second prototype, Short halted the flight program after initial drag tests and now is rebuilding the wing to take the Turbomeca Astazou 10 engine, producing 645 chp. and driving an 8 ft. 2.4 in. Ratier Figeac propeller.

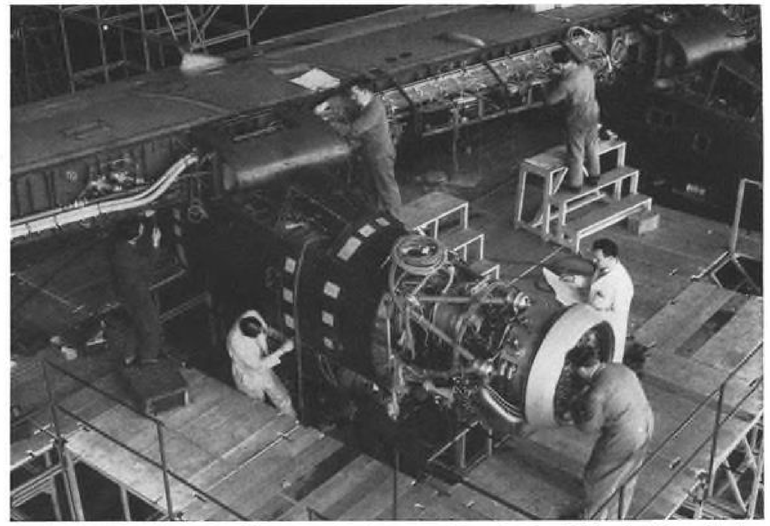
For initial flight testing, the airplane will be fitted with two Turbomeca Astazou 2 engines of 550 chp. However, development of the Astazou 10 is so advanced that Short will offer it for the production version and has accordingly increased the gross weight to 12,500 lb. for a maximum payload of 4,000 lb. The Astazou 10 has an additional axial stage in the compressor section to produce the extra power.

SFERMA also is developing the powerplant as a package project, along with Ratier Figeac, to reduce maintenance problems for the operator under field conditions. Engine will be secured with four bolts and five electrical connections. Astazou 2 time between overhaul now is 1,000 hr.

Only modifications necessary to transform the airplane into the Turbo-Skyvan are a wing beefup in the center section, and raising the tail section for better engine-out performance. Nose wheel steering will be added and Short is sounding out potential operators about necessity for additional fuel capacity by increasing the size of the tank in the top fuselage. There is a possibility that integral tanks will be fitted in the wing, depending on customer requirements.

Airplane was designed for single pilot operation, but Short plans to offer every fifth airplane with dual controls, again an optional item.

Military version of the Turbo-Skyvan will be powered by two Astazou 12 engines, rated at 690 shp. each, with reverse thrust selection available. Maximum power is selected by push-button on the control console, bringing the engine to a constant rpm. of 43,000 and power controlled by regulating the pitch. Military version will carry 18 fully-equipped troops in rear facing seats.



ROLLS-ROYCE TYNE 12 turboprop engine is mounted on the first Belfast freighter. Engine develops 5,730 ehp. and drives a 16-ft. propeller; 18-ft. prop is being considered.

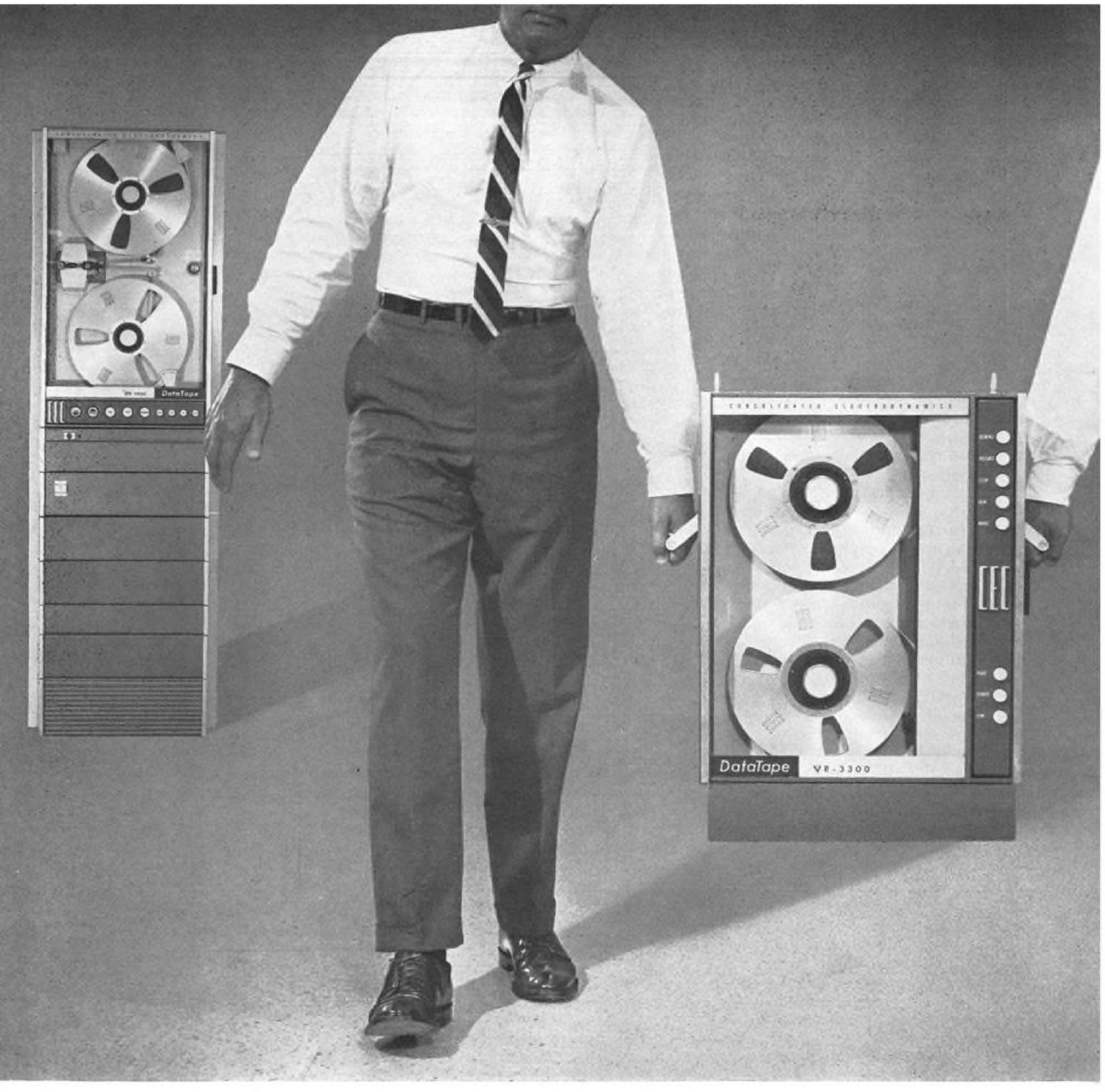
On the Belfast production line, the No. 1 airplane is rapidly approaching completion and four Rolls-Royce Tyne turboprop engines have been mounted. Four more Belfasts are in advanced stages and the rest of the 10-plane order is in the jigs.

Fuselage of the Belfast is built in eight major components, considering that the nose section is constructed in two sections and then joined. The rest are two fuselage sections, the center section, two aft sections and the tail section. Wings are built by Bristol Aircraft at Filton, England, and shipped to Belfast for final assembly.

For assembly purposes, the fuselage



SKYVAN, on test flight powered by two Continental piston engines, is being modified in an Astazou-powered Turbo-Skyvan version.



Smooth working team

Both have an eye on the budget

CEC's VR-2800 (general lab) and VR-3300 (portable) form an efficient team within CEC's complete and advanced line of recorder/reproducers. They are comparable solid state systems having interchangeable plug-in electronics, delivering high quality performance at relatively low cost. They can be used to complement one another in many applications.

Both instruments record 100 kc data at one-half conventional speeds. Thus, recording time of a single reel is doubled. They are currently serving on many critical military, lab, shipboard and van assignments.

Bandwidth of direct recording/reproducing is 100 cps to 200 kc; 0 to 20 kc with wideband FM techniques. IRIG PDM electronics are also offered.

Single cabinets of the VR-2800 and VR-3300 contain full 14-channel record and reproduce systems. Six standard speeds in three pairs (60, 30 ips; 15, 7½ ips; and 3¾, 1⅞ ips) are set by means of a simple belt and switch change. Both systems feature solid state electronics for reliability and low power consumption.

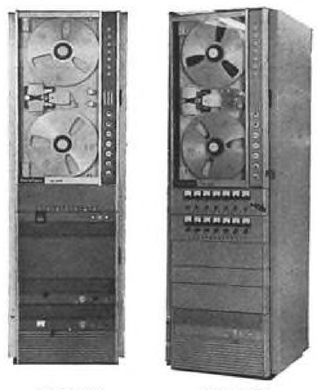
Other features include: all-metal-surface magnetic heads, automatic end-of-reel stop, and backlighted mode controls.

For complete information and specifications, call your nearby CEC office, or write for Bulletins CEC 2800-X13 and 3300-X13.

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VR-2600 VR-3600

For extra wide bandwidth, consider CEC's VR-2600 with 7- or 14-channels. Handles precision data from 400 cps to 600 kc, Direct; d-c to 80 kc, FM; IRIG PDM and PCM at 1000 bits/inch on each of 16 parallel tracks via saturation techniques.

CEC's VR-3600 is the first 1.5 mc recorder sold to working specifications. Has linear phase vs. frequency characteristics, 7- or 14-channels, six pushbutton selectable tape speeds. Call or write CEC for Bulletins 2600-X27 and 3600-X19.

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Short Turbo-Skyvan

(Performance based on two Turbomeca Astazou 10 powerplants)

Weights	
Aircraft prepared for service	7,600 lb
Maximum payload	4,000 lb.
Maximum fuel	1,400 lb.
Gross weight	12,500 lb.
Dimensions	
Span	64 ft. 1 in.
Length	39 ft. 9.5 in.
Height	15 ft.
Freight hold	16 ft. x 6½ ft. x 6½ ft.
Takeoff	
Ground roll	1,386 ft.
Distance to 50 ft.	1,969 ft.
Climb	
Sea level rate of climb (2 engines)	1,600 ft./min.
Single-engine rate of climb	400 ft./min.
Typical Cruise (10,000 ft.)	
Max. continuous	214 mph.
Max. economical	173 mph.
Max. range-max. payload	435 stat. mi.
Max. range-max. fuel	675 stat. mi.
Landing	
Distance from 50 ft.	1,800 ft.
Ground roll	1,020 ft.
Distance from 50 ft. (reverse thrust)	1,570 ft.
Ground roll (reverse thrust)	765 ft.

sections, nose section and tail are brought to the center section for joining into a complete fuselage. Services are installed in wings before mating with the airframe, and entire unit is moved forward for installation of the Tyne engines and interior equipment.

Jet Belfast

Short Brothers is still proposing its jet Belfast transport in the world market, using a wing based on a Lockheed design for the C-141 jet freighter (AW June 10, p. 28). After losing the RAF competition for a V/STOL freighter to the Whitworth Gloster 681, the company has been promised subcontract work on that airplane and on the RAF's five Vickers VC.10 aft-mounted jet transports.

However, no contracts have been signed and, in the case of the WG-681, the work is four or five years in the future at any rate.

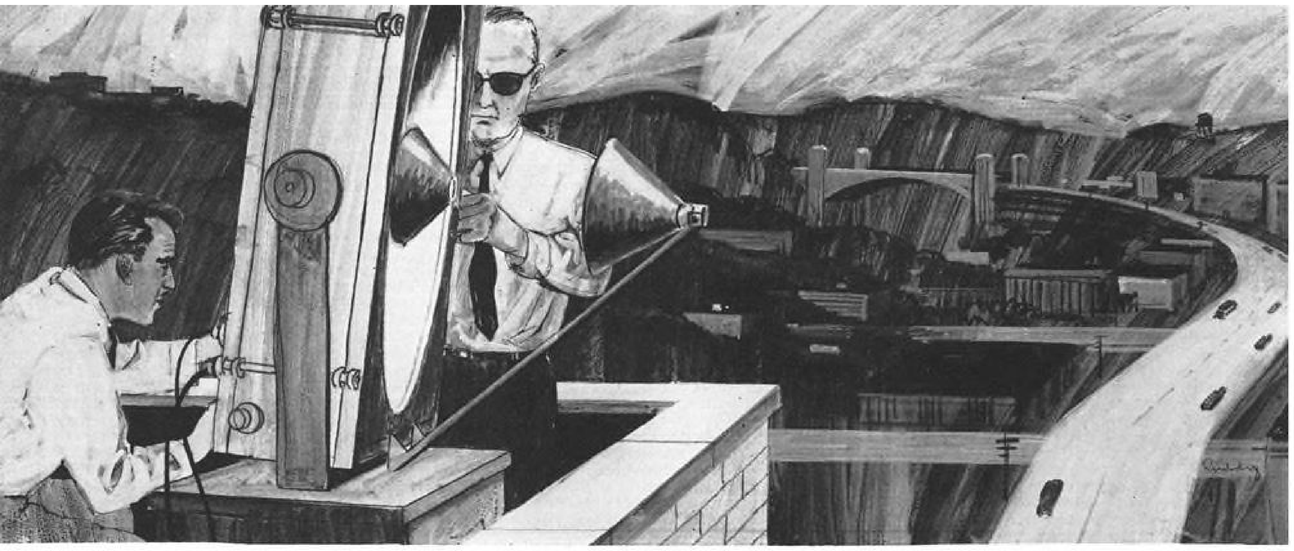
In the VTOL field, Short is limited to Ministry of Aviation study contracts on its two SC.1s, one flying at Royal Aircraft Establishment (Bedford) in an exploration of VTOL cockpit instrumentation for blind landing, and the other in a series of tests on autostabilization devices. Latter is now testing an electronic control system in free flight after a number of gantry tests had proven the feasibility.

Prime money-maker for the company is the Seacat shipboard anti-aircraft missile which has been sold to six foreign navies, including Chile. Tigercat version for land forces has met with little success since British Army has shown little interest in adding the weapon to its inventory; sale to the Army is considered a vital step in interesting foreign governments.

Cost Reduction

Design team primarily is involved in a cost-cutting program, mostly in the area of components manufactured by other firms. One aim is wider use of miniaturization and solid-state devices in the missile's guidance system. Another is completion of a new simulator for crew training at Belfast with the unit and instructors part of a sales package deal.

Least known aspect of Short Brothers work is in construction of home vacuum cleaners, a department which barely broke even last year. Newest diversification scheme is a computer-controlled laundry sorter and racking device which will be offered for sale shortly.



1933 target: vehicles on a highway



1963 target: vehicles in space

Thirty years ago, Westinghouse engineers in East Pittsburgh beamed radio waves from the plant roof and detected moving autos a block away. They didn't call it "radar"—the word hadn't been invented yet.

Radar development at Westinghouse has traveled many paths since 1933. Defense Center scientists have consistently pioneered in advancing the art—from the rooftop experiments to detecting enemy planes approaching Pearl Harbor to tracking vehicles in space.

Systems in action today include radars for airborne and space missions, search and weapon control, tactical and fixed air defense, shipborne and ground-based acquisition and tracking. Typical of current projects of the Westinghouse Defense Center are the AN/SPG-59 shipboard fire control radar for the Navy's TYPHON program and the land-based AN/FPS-27, a long-range air defense radar in the Air Force's SAGE system.

Continuing Westinghouse leadership in radar research and development emphasizes a unique capability for the future. It is a capability to be reckoned with in any serious discussion of advanced radar systems. Write to Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. You can be sure . . . if it's Westinghouse. J-02351-A

We never forget how much you rely on Westinghouse

FINANCIAL BRIEFING

Fairchild Stratos Corp. had losses of $572,000 on sales of $28.6 million for the first six months of 1963. Same period last year showed earnings of $1.5 million on sales of $35.9 million. Fairchild's losses were reduced by a second-quarter profit of $714,000 on sales of $15.5 million.

Moog Servocontrols, Inc., had a net income of $584,137, equal to $1.17 per share, on sales of $19.2 million for the first half of the year. Comparable period last year showed net earnings of $469,750, equal to 94 cents per share, on sales of $14.2 million.

Burroughs Corp. earned $3.4 million, equal to 51 cents a share, on sales of $185.2 million for the first six months of 1963. Comparable period last year showed earnings of $4.5 million, or 67 cents a share, on sales of $207 million.

Marquardt Corp. reports sales of $25.2 million with earnings of $113,285, equal to eight cents per share, for the first 28 weeks of 1963. First 28 weeks of 1962 showed sales of $26.7 million with earnings of $947,997, equal to 66 cents a share. The company's 1963 sales figure did not include Bomarc missile ramjet work—worth $10 million last year. Marquardt management attributed this year's drop in earnings to high start-up costs on new projects associated with its diversification program (AW Aug. 13, 1962, p. 115).

International Telephone and Telegraph Corp. reports earnings for the first six months of 1963 of $21.5 million—$1.25 a share—on sales of $532.4 million. Comparable period last year showed earnings of $19 million—$1.11 a share—on sales of $488 million. Order backlog stood at $812 million on June 30.

Grumman Aircraft Engineering Corp. reports first six months' earnings for 1963 of $3.7 million, equal to $1.67 a share, on sales of $214.6 million. First half of 1962 earnings totaled $3.2 million, or $1.45 a share, on sales of $186.9 million. Order backlog on June 30 was $820 million, including the seven-year Lunar Excursion Module (LEM) project.

Thiokol Chemical Corp. earned $5.1 million, equal to 62 cents per share, on sales of $136 million for the first six months of 1963. Earnings for the same period last year totaled $5.1 million after adjustment for a 4% stock dividend. Per-share earnings were 60 cents, and sales were reported at $120.6 million.

Gilfillan Corp. reports unaudited earnings of $760,000, equal to 65 cents per share, on sales of $33.8 million for the fiscal year ended May 31. Earnings for the previous year were $1 million—90 cents a share—on sales of $39.2 million.

Lear Siegler, Inc., reports sales of $193 million with earnings of $4.8 million, equal to $1.20 per share, after preferred dividend requirements for the year ended June 30. Sales for the previous year totaled $190.8 million with earnings of $6 million, equal to $1.51 per share.

Giannini Controls Corp.'s unaudited figures for the first six months of 1963 show earnings of $401,396 on sales of $13 million. Same period last year showed earnings of $429,000 on sales of $11.7 million.

Thompson Ramo Wooldridge, Inc., reports net sales of $240.8 million with earnings of $7 million, equal to $1.84 per share, for the first six months of 1963. Same period last year showed net sales which totaled $232 million with earnings of $6.4 million, equal to $1.68 a share.

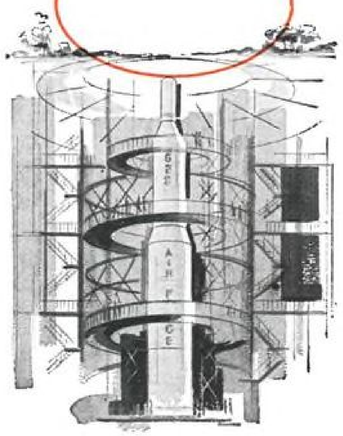
Packard Bell Electronics earned $805,000, equal to 94 cents per share, on sales of $38 million for the nine-month period ended June 30. Comparable period last year showed earnings of $333,000—39 cents per share—on sales of $36 million.

Melpar, Inc., reports sales of $35 million and net earnings of $732,047, equal to 29 cents a share, for the first six months of 1963. Comparable period last year showed sales of $17.2 million and net earnings of $444,732, equal to 18 cents a share.

Chicago Aerial Industries, Inc., had a net profit of $222,980, equal to 40 cents a share, on sales of $6.7 million for the first half of 1963. Comparable figures for last year showed a loss of $265,564 on sales of $4.2 million. June 30 order backlog stood at $11.8 million.

Federal-Mogul-Bower Bearings, Inc., earned $8 million, equal to $1.63 a share, on sales of $85.7 million for the first six months of 1963. Figures for a comparable period last year showed earnings of $7.6 million, equal to $1.56 a share. Sales were reported at $79.3 million during the 1962 period.

UNDERGROUND CORROSION PROBLEMS?



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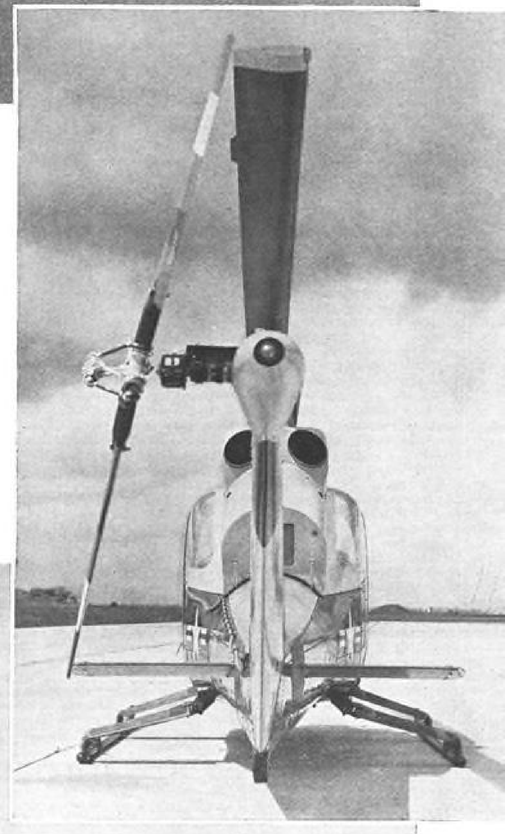


Bell, Hiller LOH Modifications Shown

Bell Helicopter's OH-4A entry in Army's light observation helicopter (LOH) competition is shown (above and below) in its latest configuration during contractor flight testing. Federal Aviation Agency certification trials currently are being conducted. Modifications made on the original airframe include a 10-in. extension of the nose to reduce drag, addition of a vertical fin on the tail boom to improve directional stability and addition of an external brace on the underside of the fuselage at the tail boom attachment point. The horizontal stabilizer (top photo at midpoint of tail boom) was moved forward 30 in. to improve longitudinal stability. Curved air vents on the sides of the forward rotor mast cowling have been replaced since the photographs were taken with vents in the front. This improves the airflow for transmission cooling. Engine exhaust deflectors (bottom photo at rear of exhaust ports) also have been added. The OH-4A is powered by a 250-shp. Allison T63-A-5 turboshaft engine.







Hiller Aircraft Co.'s OH-5A prototype developed for Army's LOH (light observation helicopter) competition is shown above during recent high-speed tests. The OH-5A, Bell's OH-4A and Hughes Aircraft's OH-6A will be evaluated by Army early next year as a preliminary step in a program which is expected to result in orders for about 4,000 light observation helicopters. No changes have been made in the prototypes since the flight test program began, but they do have minor external differences from the aircraft used to make the first flight (AW Feb. 4, p. 35). Up-tilted exhaust deflectors on the rear of the engine exhaust ports have been eliminated (above) and fairings have been added to cover the tail rotor power shaft, which runs along the top of the tail boom, and to cover the tail rotor transmission assembly. Rear view (right) shows closeup of the tail rotor streamlining and the narrow engine compartment, which permits rear-view windows. Bottom photo shows a formation flight of two OH-5As, which currently are being used in Federal Aviation Agency flight certification tests. Hiller design is fitted with an automatically stabilized rotor system similar to that being produced for the company's L4 piston-engine helicopter. The OH-5A also is powered by the Allison T63 turboshaft engine.





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And that's only the first leg of the journey: to the people at NASA/Huntsville and Chrysler Corp., prime contractor on the Saturn S1 Booster.

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Right now, we are producing all the major machined parts of the Saturn S1 thrust structure.

We have also tooled and manufactured lightweight waffle-skin cylinders for other NASA projects. And dozens of tooling and test fixtures for future Saturn vehicles.

We handle every NASA job with speed, as well as care. Tasks that should have taken weeks have been delivered in days. We've produced some over weekends. Even turned out a few overnight. And all of them to tight specifications.

When the call comes for fast work we can respond with the most sophisticated production machinery available anywhere. Supported by technicians and engineers who thrive on rush-and-hustle.

And NASA knows it.

Which is one reason why, when the countdown for the moon begins, some of Republic's packages will be on the pad.

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AVIATION CORPORATION
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A reminder: your CARE packages help the needy abroad. Send a check to CARE, New York, today.

Velocity Sensors Apply Mossbauer Effect

By Philip J. Klass

Middle River, Md.—Unusual type of velocity sensor, expected to exhibit remarkable accuracy and sensitivity in measuring relative speed between two objects, is under intensive investigation here for a variety of aerospace applications by the Martin Co.'s Electronic Systems and Products Div.

The technique is based on the Mossbauer Effect, discovered in 1958, which until recently had seemed to be an ethereal phenomenon of interest primarily to basic researchers. It utilizes gamma radiation from a relatively low intensity radioisotope which can pass through solid objects, suggesting interesting new applications.

Martin currently is using cobalt 57 and iron 57, materials which exhibit the Mossbauer Effect. Iron 57 is a stable isotope formed when radioactive cobalt 57 decays. Martin believes these materials may ultimately permit measurement of relative velocity of two objects to a resolution of 0.01 cm./sec. (0.0023 mph.). In theory, at least, measurement of velocities to even greater resolution should be possible using refined techniques and/or other materials.

Possible Applications

Martin already has pinpointed 18 different possible applications for the new technique which it calls by the acronym-abbreviation of GARD-TRAK (Gamma Absorption and Radiation Detection Tracking.) Most of these applications, however, either are classified because of existing government contracts or the company is reluctant to discuss them because of its desire to get the jump on competition.

One possible application which Martin mentions is the use of the technique for rendezvous-docking guidance between spacecraft. Other uses suggested by the extreme accuracy and sensitivity of the technique, which Martin neither confirms nor denies, include control of the rate of descent of a Lunar Excursion Module (LEM) and measurement of the initial acceleration of a rocket booster at liftoff to check the operation of its powerplant.

Martin scientists were scheduled to discuss their work at the Third International Mossbauer Effect Conference held late last week at Cornell University under Advanced Research Projects Agency sponsorship. Dr. Rudolph L. Mossbauer, who received the Nobel Prize in 1960 for his discovery and now is a professor at the California Institute of Technology, was scheduled to deliver the introductory paper at the conference.

Mossbauer's discovery provided a relatively simple method by which to measure the Doppler shift of gamma rays emitted by a radioactive material when such material is in motion. Viewed from the standpoint of conventional electromagnetic theory rather than quantum mechanics, the new technique gains its extreme sensitivity from the fact that the amount of Doppler shift increases with the frequency of the carrier. For gamma rays, at the upper end of the spectrum, this is approximately ten-million-million megacycles or roughly a billion times the carrier frequency used in conventional Doppler radars.

If a small cobalt 57 radioactive source is mounted on one of two objects whose relative velocity is to be measured and the thin film of iron 57 is mounted on the other to act as an absorber, the iron 57 will become radioactive by absorbing gamma rays emitted by the cobalt 57 so long as there is no relative motion between source and absorber. This condition, known as "nuclear resonance," will not occur, however, when there is relative motion between the two. When nuclear resonance occurs, the absorber itself will emit gamma rays as its atoms return to their original non-radioactive state.

Detection Methods

The existence or absence of nuclear resonance, indicating the absence or presence of relative motion between source and absorber, can be detected in two ways. If a scintillation counter (which counts gamma ray photons) is placed in line with the cobalt 57 source and behind the iron 57 absorber, the counter will be exposed to gamma rays emitted by the source which are not absorbed by the iron 57 (see sketches, p. 91).

Thus, under non-resonance conditions there will be a maximum number of such photons impinging on the in-line counter, while resonance causes the number striking the in-line counter to



EXTREMELY ACCURATE and sensitive velocity measurement system, which utilizes the recently-discovered Mossbauer Effect, is under investigation by Martin Co. for variety of aerospace applications, including spacecraft rendezvous-docking. Experimental set-up at Martin shows radioactive isotope cobalt 57 taped to lead focuser (1), the iron 57 absorber (2) which is caused to vibrate by loudspeaker (3) and the scintillation counter (4) used to detect presence of nuclear resonance in iron 57.



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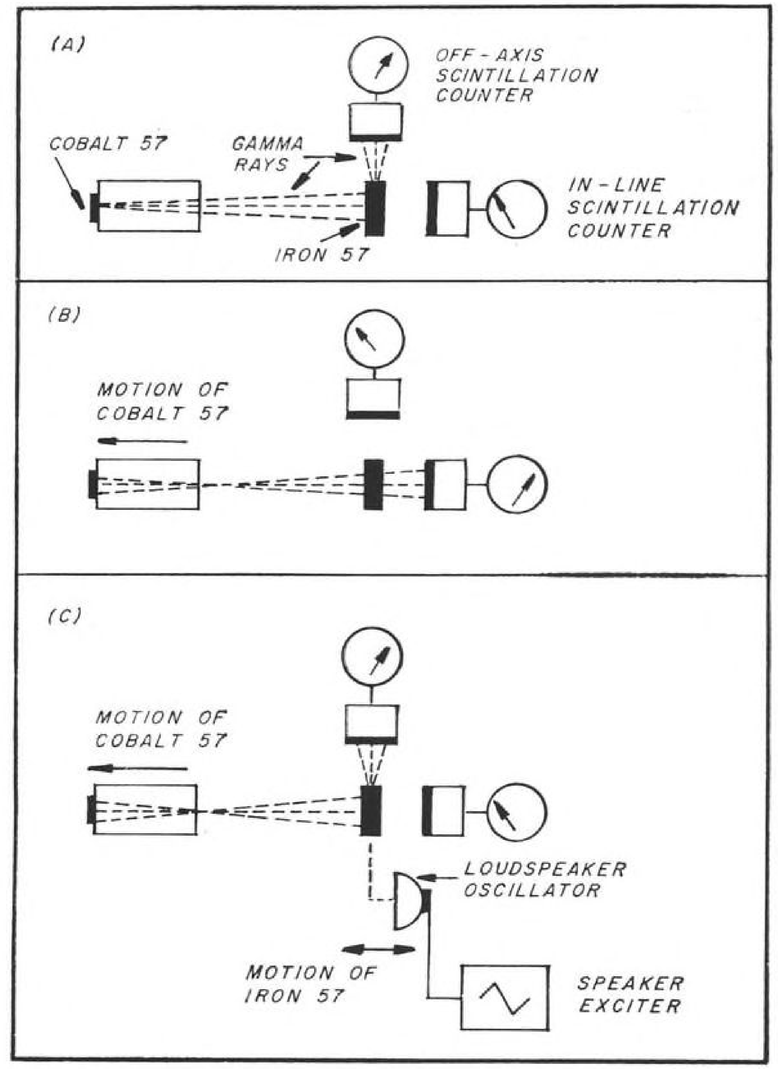
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MOSSBAUER EFFECT, as applied to Martin velocity sensing system, is shown above. When both cobalt 57 source and iron 57 absorber are stationary, gamma rays emitted by source are absorbed by iron 57, resulting in nuclear resonance and gamma ray radiation by the iron 57 which is detected by off-axis scintillation counter (A). If, however, the cobalt 57 source is in motion, resonance does not occur and its gamma rays pass through absorber to be detected by in-line counter (B). To determine velocity of cobalt 57 source, the iron 57 can be attached to loudspeaker cone, excited by triangular-shaped wave whose frequency is varied until nuclear resonance occurs. Second coil on speaker cone (not shown) indicates cone velocity, hence cobalt 57 velocity, at resonance condition.

be greatly reduced because of absorption by the iron 57.

Because the iron 57 emits gamma rays during nuclear resonance, it is also possible to detect the condition by placing a second scintillation counter off-axis where it is not exposed to gamma rays from the cobalt 57. When resonance occurs the gamma rays reaching the off-axis counter increase sharply, being reduced to near zero when relative motion between source and target destroys the resonance condition.

By using the outputs of both scintillation counters in the form of a ratio, it is possible to obtain a relatively sharp maxima, or minima, when resonance exists, depending upon which is used in the numerator of the ratio. This provides a system which detects motion between source and target but added provisions are needed to make it measure the magnitude of this velocity. One way to do this is to mount the iron 57 on cone of a loudspeaker. When an alternating signal with a linear (tri-

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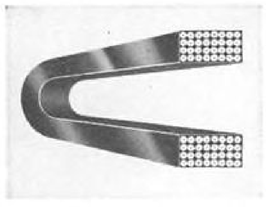
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Broader band operation, attenuation stability at higher ambient temperatures, lower attenuation per nanosecond of delay, and greater stability at microwave frequencies are established factors. Note uniform cable spacing.



A 6' diameter cable delay line package used in a nuclear application was replaced by this Phelps Dodge Electronics envelope measuring only 26" x 15" x 12". 500' of ½" 50 ohm Styroflex® coaxial cable was used.



Designed for use in missile checkout equipment, this delay line consists of 285' of ⅜" diameter, 50 ohm Foamflex. The small, lightweight package is 16" in diameter by 6" high. Delay accuracy tests to ±.1 nanosecond.



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angular) wave-shape is applied to the driving coil of the speaker, the cone and attached iron 57 absorber will oscillate in the direction of the cobalt 57 source and the object to which it is attached. By varying the frequency and amplitude of this applied signal it is possible to find one point in the excursion at which the iron 57 is moving at precisely the same speed, and in the same direction, as the cobalt 57 source, as indicated by a resonance condition in the iron 57.

By equipping the loudspeaker with a second coil, which serves as a sensor of cone velocity, the voltage induced in this coil will be proportional to the velocity of the iron 57 and at resonance to the relative velocity of the cobalt 57 source and the object to which it is attached.

Moving Object

Naturally, the concept works equally well if the iron 57 absorber is attached to the moving object and the cobalt 57 source remains fixed, or if both are moving. Martin currently is using a loudspeaker oscillator for some of its experimental work. However, company engineers are designing more sophisticated and accurate techniques for performing the equivalent function which use rotary rather than oscillatory means.

For some years prior to Mossbauer's discovery, the theory of nuclear resonance had been known. In some ways it bears some resemblance to the process that takes place in setting the stage for laser action. In the familiar ruby laser, external energy supplied by a flash tube is absorbed by chromium atoms, raising them to a higher energy state. These excited atoms then drop to their original level, radiating photons of light in the process.

Similarly, the atoms of non-radioactive iron 57 can be elevated to a higher energy (radioactive) level by means of energy supplied from an external source. Then they quickly revert to their original ground state, giving off gamma ray photons in the process. For iron 57, half the atoms drop to the ground level in 0.1 microsecond, an interval referred to as the half-life.

But where the ruby atoms can accept energy over a relatively broad band of wavelengths for laser action, to achieve nuclear resonance the match between the external source and the target material must be exceedingly close. The logical source for supplying the "pumping" energy to raise iron 57 from its stable to a radioactive state would be the cobalt 57 radioactive isotope since the wavelength of gamma rays emitted by cobalt 57 in changing to radioactive iron 57 and then to non-radioactive iron 57 might appear to be precisely that needed to raise the latter back to its radioactive state.

However, when most radioactive isotopes eject a gama ray photon, there is a recoil action within the material which causes the photon to emerge with slightly lower energy than it otherwise would have. Expressed in another way, a very slight Doppler shift occurs in the frequency of these gamma rays at ejection.



RADIOACTIVE COBALT 57 source, with strength of 2 millicuries, is deposited between 2 thin sheets of copper (left), while iron 57 absorber is thin film deposited on copper sheet, shown enclosed in plastic holder (right). The cobalt 57 poses no hazard unless exposed to blood through broken skin tissues, according to Martin's Mossbauer study group leader, Roy Matthews. However, longer-range use would require more intense radioactive source.

When this photon impacts on a non-radioactive isotope derived from the source material, recoil action also occurs in its nucleus which results in an additional Doppler shift. Small as this effect is, the resultant Doppler shift is vastly greater than the mismatch which can be tolerated and so nuclear resonance can not occur in the target material.

British scientists in 1953, at the University of Birmingham, conceived the idea of using external motion to compensate for this Doppler shift to achieve nuclear resonance. With a stable isotope of mercury mounted on a stationary fixture and a radioactive mercury isotope source mounted on the arm of a centrifuge, the British scientists obtained resonance when the component of velocity produced by the centrifuge in the direction of the absorber cancelled out the Doppler shift caused by internal recoil.

It was not until five years later, however, that Dr. Mossbauer, while studying the characteristic radiation of crystal structures at gamma wavelengths, discovered how to eliminate the Doppler shift due to recoil. He found it was possible to anchor some of the source nuclei in a semi-rigid crystal and that the rigidity of the anchor could be increased by crystal cooling. Using iridium 191 cooled to liquid air temperature, Mossbauer achieved nuclear resonance without external motion between source and target such as that needed previously.

Since that time, at least 15 such Mossbauer Effect materials which exhibit low recoil have been reported. The cobalt 57/iron 57 that Martin uses are particularly convenient because they have sufficiently low recoil losses at room temperature.

The amount of rigidity required depends upon the recoil energy of the gamma ray photons emitted. The crystal binding force must be higher than the recoil energy to prevent the structure from tearing loose. Where Mossbauer's original iridium 191 emits photons with an energy of 129,000 electron volts (e.v.), the photons needed to produce resonance in iron 57 have an energy of only 14,320 e.v., requiring far less crystal binding force, Martin's Roy Matthews points out. Matthews is leader of the company's Mossbauer study group.

An important parameter of Mossbauer materials is their "resonant line width" which indicates the maximum allowable deviation of the gamma ray frequency, or photon energy level, which will still produce nuclear resonance in the target material. For iron 57, the resonant line width is about 4.5×10^{-9} e.v. That is to say, if the energy of the impinging photons deviates by more than this amount from the 14,320 e.v. needed by iron 57, roughly one part in three thousand-billion (3×10^{12}), resonance will not occur.

Intrinsic Sensitivity

The ratio of gamma ray energy to resonant line width, referred to as Q, is an important figure-of-merit in evaluating the intrinsic sensitivity of a Mossbauer material to relative motion between source and absorber. In fact, for materials such as iron 57 which have Qs above 10^{12}, it is necessary to isolate the source and target from external vibration for satisfactory operation or to devise compensatory techniques.

However, there are other Mossbauer materials such as thulium 169, with lower Q-values (7.4×10^{10}) which are far less sensitive to external vibration yet still should provide extremely accurate velocity measurement capability. However, thulium 169 requires cryogenic cooling.

Other factors which affect the choice of materials include the following:

• **Half-life of the source**—the time required for intensity of its gamma radiation to drop 50%, must be adequate for the particular application. Cobalt 57 has a half-life of 270 days, the longest of the known Mossbauer materials. Other Mossbauer materials have shorter half-lives ranging down to 24 hr.

• **Photon energy**, which is a factor in determining basic sensitivity to small increments of velocity as previously described, also is a factor in determining the maximum useful range between the



Through the wringer

Since September, 1961, when the U.S. Army began a gruelling series of tests on their CH-47A Chinook helicopter, they have really put it through the wringer.

When the Army completes development testing on it this fall, the Chinook will be as thoroughly tested as a helicopter can be. They have flown it in desert heat where the aircraft was hovered continuously for four hours in a dust cloud at an outside air temperature of 116°F. The Chinook has been operated at temperatures down to minus 65°F, it has been subjected to severe static tests and many of the environments it will encounter. They've packed it full of troops and weapons, and with Pershing missile components and vehicles such as Gama Goat in compatibility tests. They have carried heavy loads and punished it to see if Chinook can take it.

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two objects whose relative velocity is being measured. Because gamma rays are scattered and absorbed in the atmosphere, the effective range may be only a few hundred yards under certain conditions. In space, ranges of several miles appear possible, depending upon the source material used, according to Martin engineers. Presently known Mossbauer materials have proton energies ranging from 8-140 kev. The system is not basically sensitive to variations in amplitude of photon density providing a sufficient number are received by the absorber.

Martin engineers currently are making measurements to determine the minimum number of photons needed for satisfactory operations.

Secondary Effects

While the principal factor that determines whether or not resonance occurs is the relative velocity between source and absorber along a line connecting the two, there are other secondary effects. This suggests that the Mossbauer Effect might find use as a means of measuring acceleration, temperature, pressure or the magnitude of a magnetic or electric field.

Some idea of the relative sensitivities of nuclear resonance to these factors can be gained by comparing them with the primary longitudinal Doppler Effect. For iron 57, a velocity of 1 cm./sec. causes a shift of 10 resonant half-line widths, normally expressed as "10 gamma," according to Dr. Lorain Bittman, principal staff scientist for the division. In theory, the upper limit of resolution in detecting the presence of nuclear resonance appears to be about 0.0001 gamma, but Martin's Matthews says "we will be happy to achieve a 2-gamma resolution since that provides more than enough accuracy for most applications."

Here are comparative sensitivities for secondary factors influencing nuclear resonance:

- **Temperature:** 0.0015 gamma/deg. K.
- **Acceleration:** 0.0003 gamma/g.
- **Pressure:** 8.32 x 10^{-6} gamma/atmosphere.

Magnetic Field

The presence of a magnetic field of more than roughly 1,000 gauss or an electrostatic field of 1,000 kv./cm. across the source or absorber also produces a slight shift in resonance, but the precise relationship has not yet been reported if it has been measured.

For velocity measurements between two objects in relatively close proximity, the strength of the cobalt 57 need be only a few millicurie. The gamma radiation flux density at this level is so light that the material can be handled without any risk of biological radiation damage unless the radioactive material were somehow to enter the bloodstream through an open wound, Matthews says.

For use over longer ranges, say in space, a more intense radioactive source would be required. For example, to achieve a range of two miles in a cooperative satellite rendezvous-docking system might require a source of 50 curie. This, Matthews concedes, would require shielding to protect a spacecraft passenger and on the ground would require the use of manipulators to handle such a source. Generally speaking, the size of the radioactive source needed goes up with the second power of operating distance between it and the absorber.

The presence of gamma rays from cosmic or other sources constitutes for the new technique the equivalent of "background noise" in a radio communication system. However, Martin engineers say it is possible to filter out many extraneous gamma rays by making the iron 57 absorber sufficiently thin so that it does not produce scattering of gamma rays above the desired energy level. Also by choice of the thickness of the sodium iodide crystal in the scintillation counter, photons below the energy level of interest will not penetrate the crystal while those above the level of interest have so much energy that they will pass right through without producing light photons to actuate the counter. In addition, pulse height discrimination techniques are employed in the system to discard gamma ray energy levels which are not of interest.

Martin spokesmen are bullish over the potentialities of the Mossbauer Effect. Although there are several hundred scientists working in the field, the company believes it is one of the first to attempt to apply it to functional tasks other than basic research.

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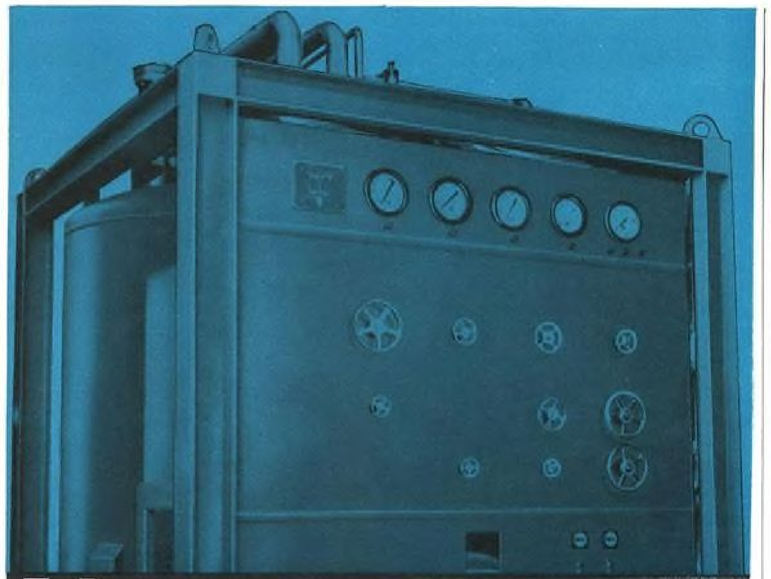
► **Lightweight X-Band Backward Wave Oscillator**—A permanent magnet focused backward wave oscillator weighing less than 1 lb. and capable of providing between 50 and 60 mw. output between 7.5 and 11 gc. (kmc.) is being developed by Microwave Electronics Corp. The oscillator scales 15.9 oz. (21 oz. with magnetic shielding), two thirds of which is accounted for by a magnet that supplies a 550-gauss field. The device operates at a low efficiency (1%) but provides enough power to run a mixer.

► **Underwater Interceptor**—A small, deep-diving research vehicle known as Moray, for the savage eel of that name, being developed by the Naval Ordnance Test Station, China Lake, Calif., may be the forerunner of a new class of naval underwater interceptors designed to track down and destroy hostile nuclear submarines. Moray is intended to be fast and maneuverable and to carry a small crew, probably no more than two men. As a high-speed research vehicle it is aimed primarily at exploring new concepts applicable to anti-submarine warfare vehicles, such as power sources, hull and structural materials.

► **Satellite Inspection Ferret Study**—A study of passive countermeasures sensors which may be necessary for any satellite inspection vehicles the Air Force builds will be conducted for the Air Force's Space Systems Div. by HRB-Singer, Inc. The study is one of several in a recent series to come out of SSD as part of its revamped Project Saint (706), or satellite inspector program (AW July 29, p. 17). The ferret equipment probably would be used to help determine the nature and intent of alien spacecraft by spotting such things as power level and the frequency and character of any RF signals generated within the unknown satellite.

► **Multi-Navigation Sensor**—A stellar inertial Doppler system (SIDS) which may have wide possible uses as a navigation system aboard future Air Force aircraft (AW June 17, p. 23) will be developed by Litton Systems under contract to USAF's Aeronautical Systems Div. SIDS will combine three types of navaids designed and built to be mutually compatible parts of a single integrated navigation sensor.

► **USAF Moves Toward Standard Satellite Avionics Packages**—Details of an integrated satellite avionics package, combining command, telemetry and tracking functions, being built by Space Technology Laboratories for the Air Force's Space Systems Div., were revealed this week, confirming reports (AW Feb. 18, p. 41) that STL had won competition for this coveted work. With this pioneering effort, the Air Force is aiming at more standardized avionics systems with variable and large capacity applicable to many of its satellite systems. Known as SGLS (Space Ground Link Subsystem) the STL subsystem will consist of a single unit combining all three important avionic functions into a smaller, lighter, lower-power package than previously required by separate subsystems. The package will be modular to permit capacity and component changes to accommodate different satellite missions. It will be capable of handling conventional PAM or FM/FM telemetry, and have capacity for digital telemetry at rates above those



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►**Large Space Collector Petals Fabricated**—Lightweight, electroformed reflector petals which are suitable for a 42-ft. dia. furlable parabolic collector, or mirror, of the type that could be used with a solar dynamic or thermoelectric energy conversion system in space were fabricated recently by Electro-Optical Systems. The petals, each 22½ ft. in length, are made almost entirely of nickel and are larger versions of those used in a 12-in. dia. solar collector built by the company two years ago (AW Aug. 14, 1961, p. 81). Made by the same electroforming process as their smaller predecessors, the large petals have higher specific weight (under 1 lb./sq. ft. of reflecting area). In a typical possible application, a collector like this, aboard a space vehicle, would unfurl from a closed launch configuration, gather the sun's heat rays and focus them onto an energy conversion medium, such as thermoelectric cells, at the focus of the collector. The work was sponsored by the Air Force's Aero-Propulsion Laboratory of Aeronautical Systems Div.



Laser Metalworker

Laser metalworking machine, which can weld, perforate or perform precision metal removal, delivers energy equivalent to 10 megawatts per square inch. The mobile unit uses 3-in. ruby rod and has built-in power supply. Power and firing rate are adjustable for manual or automatic operation. Viewing screen provides up to 100-fold magnification of working material. Manufacturer: Maser Optics, Inc., 89 Brighton Ave., Boston 34, Mass.

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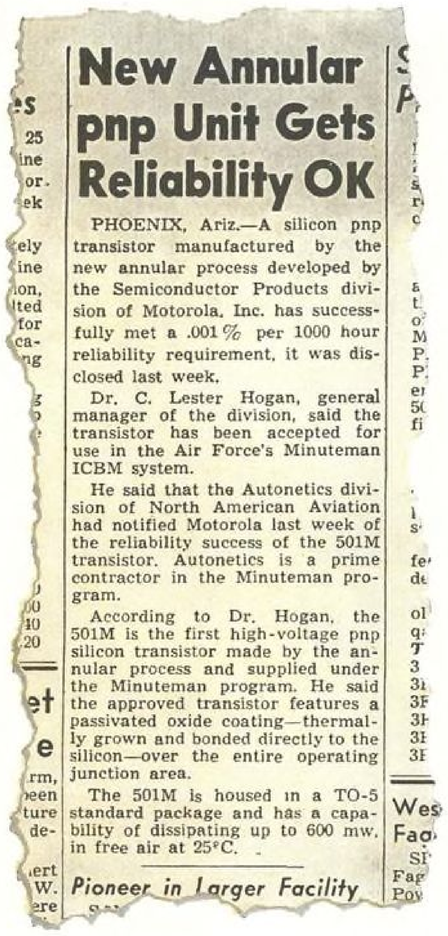
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New Annular pnp Unit Gets Reliability OK

PHOENIX, Ariz.—A silicon pnp transistor manufactured by the new annular process developed by the Semiconductor Products division of Motorola, Inc. has successfully met a .001% per 1000 hour reliability requirement, it was disclosed last week.

Dr. C. Lester Hogan, general manager of the division, said the transistor has been accepted for use in the Air Force's Minuteman ICBM system.

He said that the Autonetics division of North American Aviation had notified Motorola last week of the reliability success of the 501M transistor. Autonetics is a prime contractor in the Minuteman program.

According to Dr. Hogan, the 501M is the first high-voltage pnp silicon transistor made by the annular process and supplied under the Minuteman program. He said the approved transistor features a passivated oxide coating—thermally grown and bonded directly to the silicon—over the entire operating junction area.

The 501M is housed in a TO-5 standard package and has a capability of dissipating up to 600 mw. in free air at 25°C.

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The .001 % / 1000 hour reliability level achieved by the Motorola silicon PNP transistor for the Minuteman Program is indicative of the quality inherent in Motorola's new Band-Guard* transistors made by the annular process.

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Gimbal-less Design May Reduce Gyro Cost

An unusual gimbal-less two-axis displacement-type gyro, which performs the functions of two single-axis precision floated integrating gyros at about one-tenth their cost, has been developed by the Kearfott Div. of General Precision Aerospace, Little Falls, N. J.

The new type gyro, called Gyroflex, has limited freedom of displacement, which requires that it be used on a stabilized platform, similar to the requirement for a floated integrating gyro.

An experimental model of the new gyro has demonstrated a drift rate of 0.015 deg./hr. with its axis vertically oriented and 0.02 deg./hr. in a horizontal direction, with a one-sigma standard deviation, Kearfott says. However, improved versions are expected to have long-term drift rates as low as 0.002-0.005 deg./hr., according to project engineer Fred Litty.

The experimental Gyroflex weighs 4½ lb. and measures 3½ in. in diameter, using a gyro rotor spinning at 24,000 rpm. Litty believes that size and weight can be reduced appreciably without significant loss of gyro accuracy. The basic Gyroflex concept also can be applied to a low-cost rate-sensing gyro.

Kearfott currently is building prototype units for test in company's Mins miniature inertial platform and has made proposals on the unit to the Army Ballistic Missile Agency, National Aeronautics and Space Administration and other agencies.

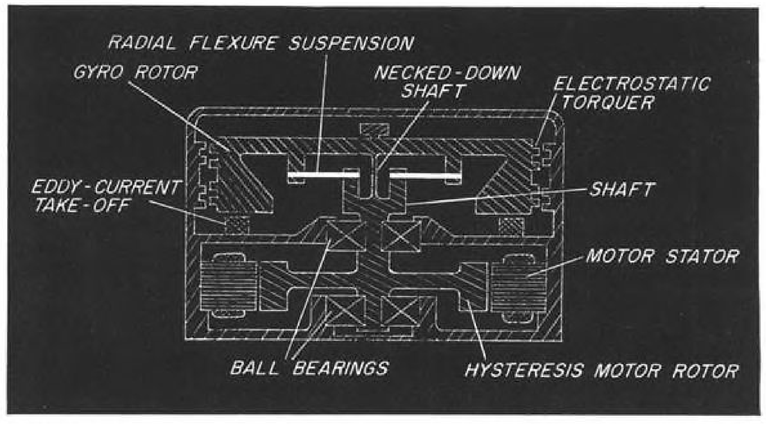
By eliminating the need for gimbals and associated gimbal bearings of a conventional two-axis displacement gyro, or the float, pivot and flexible leads of a floated integrating gyro, the new design provides a less complex unit which is far less critical to fabricate and assemble, Litty says. For example, the unit can be assembled in an ordinary laboratory type environment rather than requiring assembly in special "clean rooms."

The gyro rotor is supported in a cantilever fashion and driven through a semi-rigid necked-down shaft attached to the main shaft of the hysteresis motor (see sketches). So long as the gyro case remains stationary, the gyro rotor will spin in a plane which is parallel to the plane of rotation of the motor and perpendicular to the main motor shaft.

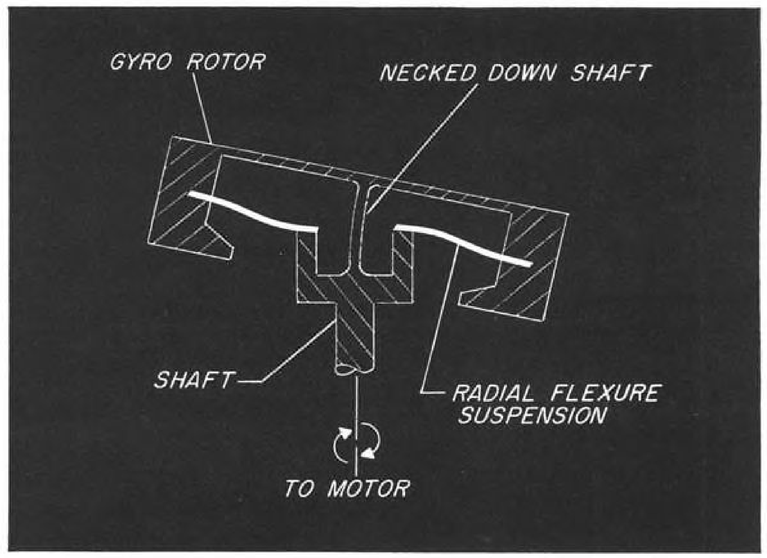
If, however, the gyro case is rotated slightly due to an angular displacement of the vehicle in which it is mounted, the motor and its shaft will be displaced through the identical angle because it is secured to the case through the spin bearings. But the angular momentum of the gyro rotor at the other end of the cantilevered shaft will cause it to attempt to maintain its original position in inertial space, at least initially. This it can do because its cantilevered shaft is intentionally made only semi-rigid (see sketch). A thin spring flexure suspension, attached both to the inside of the gyro rotor and to the non-cantilevered portion of the motor shaft, produces a reaction torque which then causes the rotor to precess at right angles to the original displacement.

This gyro rotor displacement is detected by eddy current pickoff coils which provide a signal to the servo system of the stabilized platform on which the device is mounted, resulting in angular displacement of the platform about the appropriate axis to move the gyro case through an angle equal and opposite to the displacement of the carrying vehicle which initiated the cycle. This will return the spinning gyro rotor to a plane which is again parallel to the spinning motor rotor and perpendicular to its shaft.

There are two torque constants associated with the Gyroflex design which must be compensated for to prevent



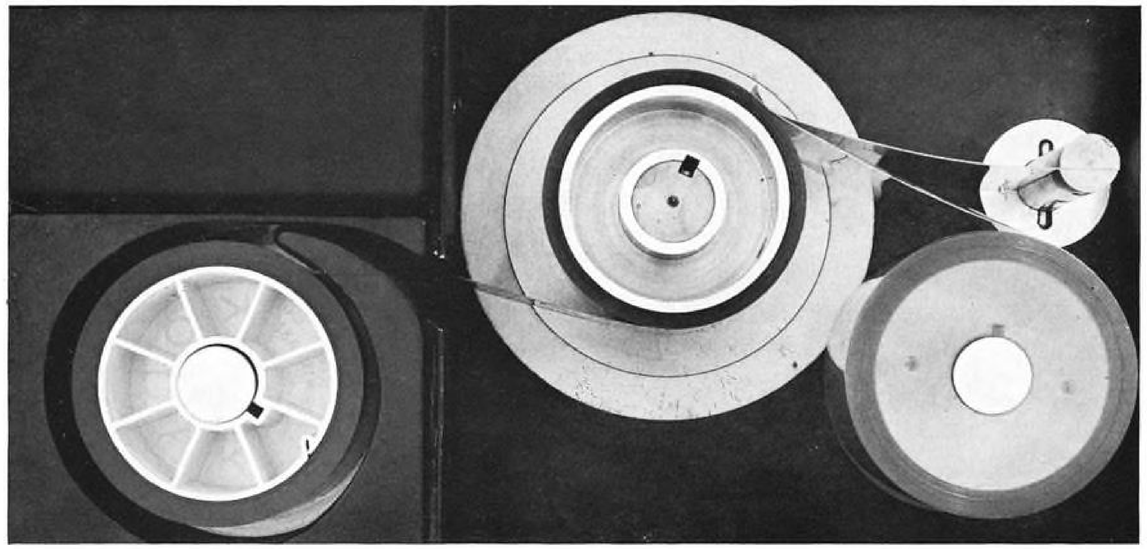
TWO-AXIS DISPLACEMENT gyro without gimbals has accuracy comparable to floated integrating gyro, but costs only about one-tenth as much as two floated units needed for two-axis operation. Spinning gyro rotor is at end of cantilevered semi-rigid shaft (above). When gyro case is displaced (sketch below), gyro rotor tries to keep original position but reaction of radial flexure suspension causes it to precess at right angles to case displacement. Eddy current pickoffs sense displacement and generate signals which cause platform to move through displacement angle.



Kodak **reports on:**

processing and printing long film by dampness . . . mail-order infrared optics

Just roll them up together



This represents the principle of either intermittent or non-intermittent processing and printing of long rolls of film by dampness—mere dampness. The principle is quite simple and not quite revolutionary any more. In its new manifestation it delivers not only an immediate positive but a first-class negative for future positives. Perhaps the message will strike right between the eyebrows of some reader who has been struggling hard with the pesky details of apparatus for photographing our too rapidly shrinking planet for the ultimate purpose of making it more livable for our burgeoning species and/or of peacekeeping. (Probably the peskiness of the details has diverted his attention from ultimate purposes.)

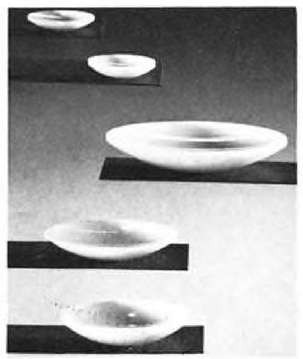
We are wide open. We can play guiding angel to this new but well-proved technique for broadening the scope and feasibility of photographic surveys, supplying nothing more billable than hospitality and encouragement, hoping that the eventual consumption of our negative materials will reward us for improving the quickness and quality of aerial photography. We can, on a special order basis, supply just the KODAK BIMAT Film, which imbibes solution, applies it to the negative film, and comes away bearing the positive image. We can similarly supply just the KODAK BIMAT Imbibant. We can likewise supply suitable negative films. We can supply the whole works. We can design the hardware, build the hardware, or shake the hand of him who intends to prosper by proving in fair competition that he can outdesign or outbuild us.

Book an appointment for a preliminary discussion by a letter to Eastman Kodak Company, Special Sensitized Products Division, Rochester 4, N. Y.

IRTRAN menisci

KODAK IRTRAN 2 *f*/1 Lenses for 1-14μ seem to be permeating infrared technology, probably for their thermal, mechanical, and chemical ruggedness. There is no chance of getting a poorly annealed one because they simply don't require annealing. If you can use any specified here, just send the purchase order to Eastman Kodak Company, Apparatus and Optical Division, Rochester 4, N. Y. We can probably ship in a week. If you need more data or more special lenses, phone 716-562-6000, Ext. 5166.

	EQUIVALENT FOCAL LENGTH (mm.)	MEASURED BLUR CIRCLE* (mm.)	**
1. IR-100	25.2 computed at 1.5μ 26.4 computed at 10μ	0.36	$ 77
2. IR-101	25.4 computed at 3μ 26.7 computed at 10μ	0.15	$235
3. IR-301	76.2 computed at 4.26μ 79.5 computed at 10μ	0.38	$395
4. IR-200	50.6 computed at 1.5μ 53.8 computed at 10μ	0.61	$168
5. IR-201	48.8 computed at 4.26μ 50.9 computed at 10μ	0.20	$325

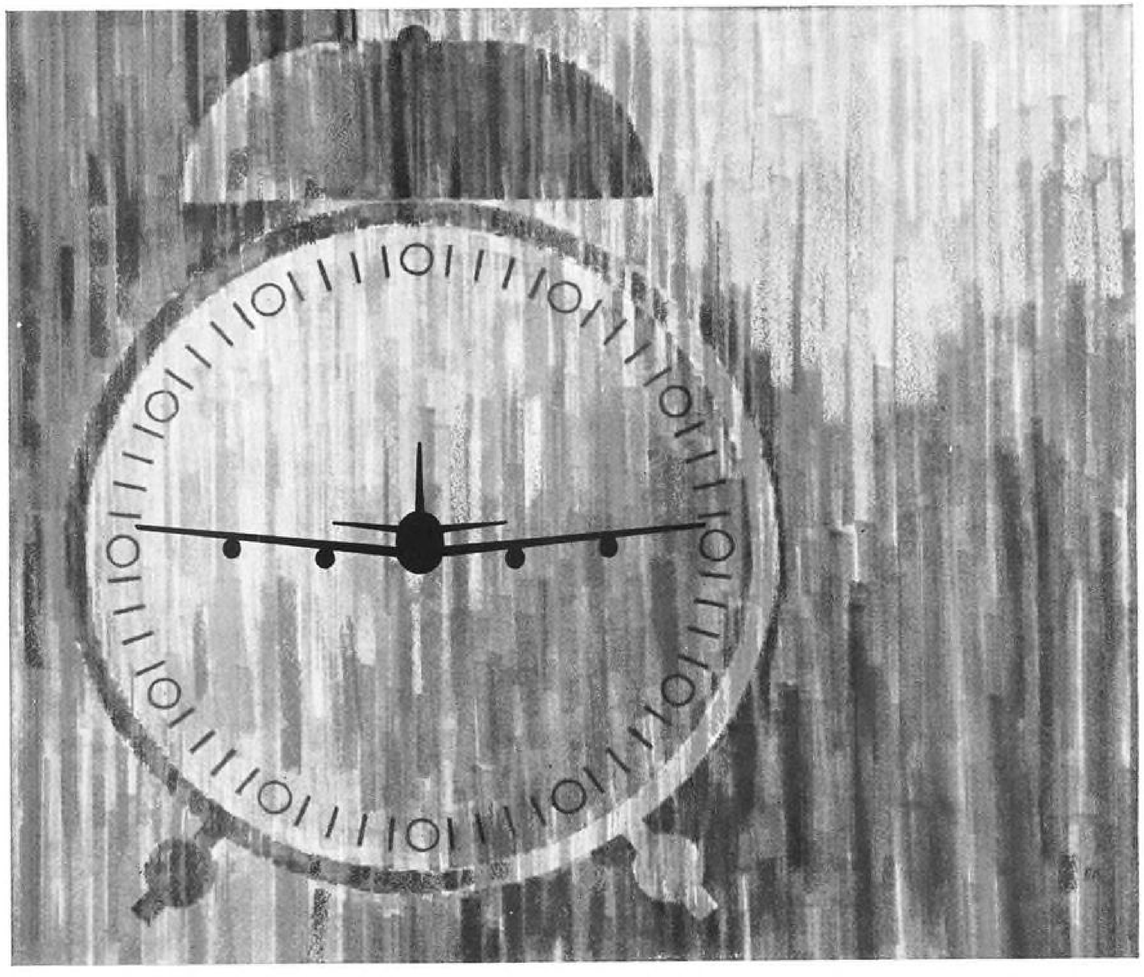


*diameter of axial image of point source at which measured intensity drops to 5% of center peak intensity, for 2 - 4.5μ range.
**net price each in 1-10 quantities, subject to change without notice.

This is another advertisement where Eastman Kodak Company probes at random for mutual interests and occasionally a little revenue from those whose work has something to do with science

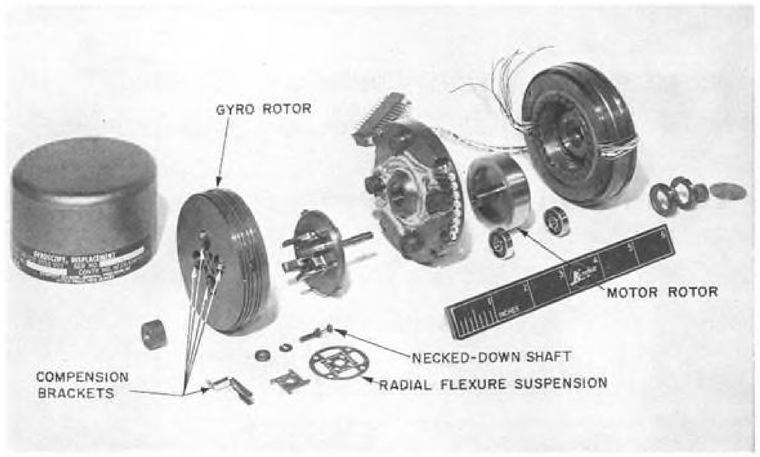
Freight-to-passenger ratio for airlines gives strong evidence of following railroad patterns. Fifty years showed freight increasing from 20% to 88% of total railroad business. Cargo by air has grown from 3% to 9% in the past fifteen years. Freight-by-air is a sleeping giant which could awaken with a roar as a result of important shipping economies being made possible by the new Douglas jet freighters now entering service. □ And Douglas is helping awaken the giant on several other fronts. These include coordinating a study of freight movement statistics in conjunction with several major airlines; designing improved terminals and cargo handling systems; analysis of terminal-to-terminal control; and, of course, continuing production of jets with lowest possible operating costs.

SLEEPING GIANT
...AND WHAT DOUGLAS IS DOING ABOUT IT



Douglas research programs involve 23 technological areas relating to aerospace and defense systems. Major Douglas divisions are located in Santa Monica and Long Beach, California; Tulsa, Oklahoma; and Charlotte, North Carolina.

DOUGLAS



EXPLODED VIEW of new Kearfott Gyroflex two-axis gyro shows simple construction which permits low-cost fabrication. Also shown are the radial flexure suspension, compensation brackets and necked-down shaft which give gyro its unusual characteristics.

excessive drift errors, Litty explains. One is the torque reaction of the flexure suspension which causes the gyro rotor to precess at right angles to the deflection. This is compensated for by mechanical means which Kearfott is not willing to disclose until it has applied for patent coverage.

The other potential disturbing torque, which would attempt to return the gyro rotor to its original position relative to the motor rotor and shaft, arises from viscous drag of air set into motion by the spinning gyro rotor. This is reduced to a negligible amount by evacuating the gyro and then sealing it.

To make the gyro performance relatively insensitive to its position with respect to gravity and to external g-forces, the center-of-gravity of the gyro rotor is located at the geometric centers of the necked-down shaft and the radial flexure suspension. The stiffness of the two support members is designed to provide equal axial and radial compliance to make the gyro isoelastic and therefore relatively unaffected by high external g-loads. Gyroflex suspension has been designed for 30-g operation.

Accuracy of Gyroflex degrades slightly when used as a heading reference because mass shifts along the spin axis will move slightly the location of the gyro rotor center-of-gravity. However, unlike a conventional two-axis displacement gyro, Gyroflex has no gimbal bearings which can allow mass-shift in all directions under high-g loads, with resultant increases in gyro drift.

The original version of the Gyroflex contained an electrostatic torque motor to react with the spinning gyro rotor and provide a means for introducing navigation corrections or for erecting the gyro initially. A newer design will incorporate a more powerful electromagnetic torquer.

To assure dimensional stability, the gyro requires an electric heater for initial warm-up and temperature stabilization. Once gyro has reached synchronous speed, however, power consumption averages only 5 w. total, Kearfott says.

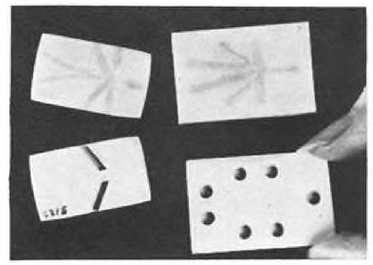
NEW AVIONIC PRODUCTS

• **Thin film microbalance,** Model 701, capable of measuring evaporated films as thin as 10 billionths of a gram per square centimeter (10^{-8}), operates by measuring change in resonant frequency of crystal on whose surface the film has been deposited. Direct measurement is possible without correction for other physical properties. Accuracy is within 1% for films between 0.05 and 40,000 Angstroms. Device weighs 8½ lb., uses solid-state circuitry and is simple to operate. Manufacturer: Westinghouse Scientific Equipment Dept., P. O. Box 868, Pittsburgh 30, Pa.

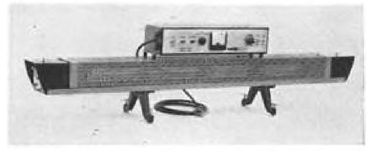
• **Precision synchro angle indicator,** Type API-8025, designed primarily for use with 400 cps. synchros, is accurate to within 6 min. of arc and has repeatibility of 30 sec. of arc, according to manufacturer. Readout is digital in degrees and minutes with 10-sec. response for a 180-deg. step input. Device operates from 115 v., 400 cps. single-phase power. Manufacturer: North Atlantic Industries, Inc., Plainview, N. Y.

• **Broadband image orthicon,** new line which is sensitive from 2,400 Angstroms to 7,000 Angstroms with response greater than 50% of peak value over this range, will reproduce images of a 200-300 line test pattern with a highlight radiant power density of only 10 micro-micro-watts/sq. cm. incident on the photocathode when tubes are operated in a standard 30-frame TV system. Manufacturer: Westinghouse Electronic Tube Div.

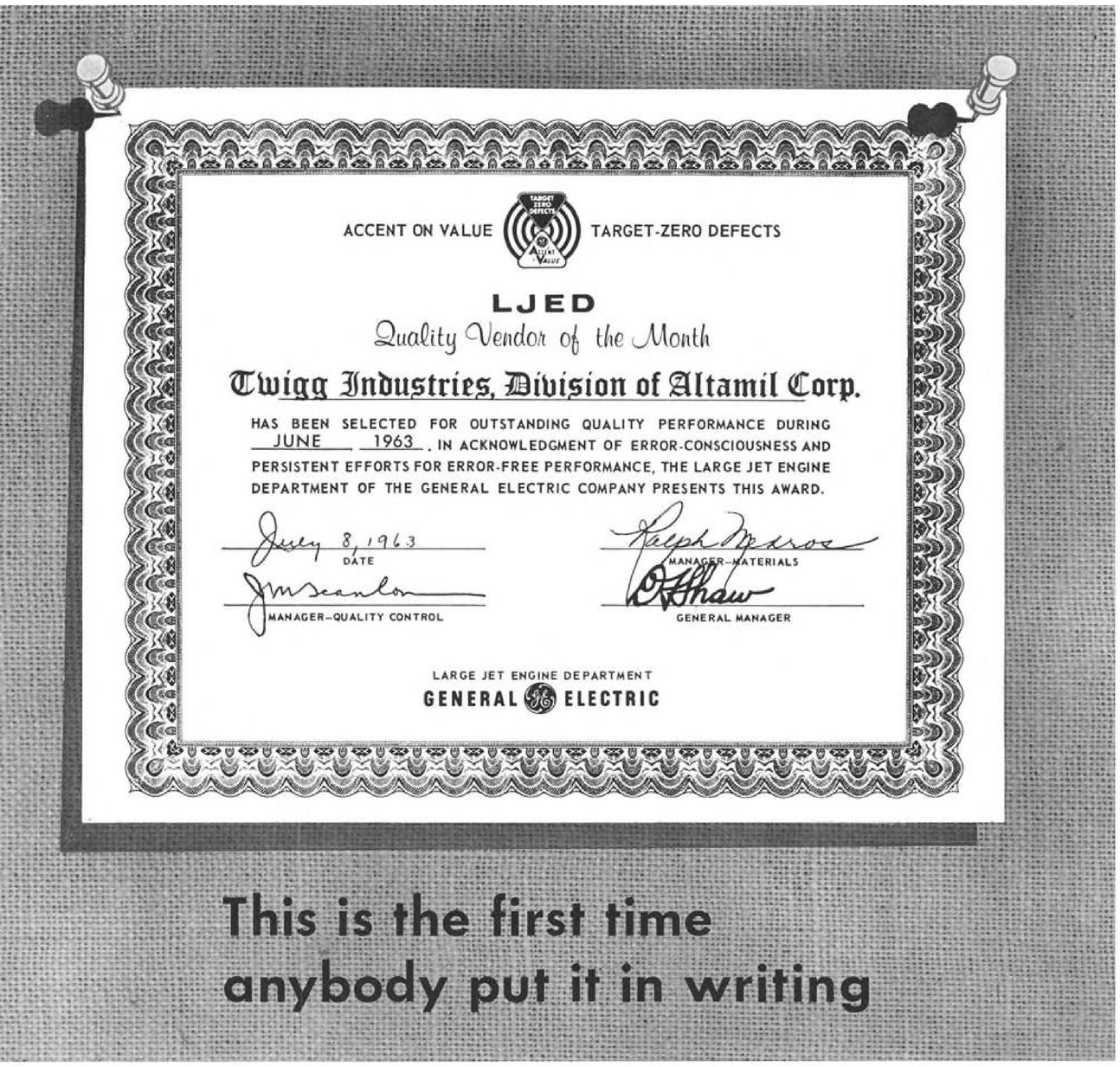
• **Fluid-amplifier devices,** digital flip-flops and proportional amplifiers, fabricated from photosensitive glass layers which are fused together in a hermetic seal, are now available in sample quantities. More complex six-layer units, made to customer specifications, measure 5 x 4 x 2 in. Fabrication tolerances are quoted at within one mil. Fluid amplifiers made of glass can operate at temperatures up to 250C, or up to 500C when fabricated from ceramic plates. Manufacturer: Corning Glass Works, Corning, N. Y.



• **Portable CW laser,** helium-neon type, has easily interchangeable mirror assemblies to permit selection of 0.6328 or 1.153 micron radiation without disturbing basic laser adjustment. Power outputs up to 3 mw. are available from both ends. Device, including self-mounted power supply, weighs less than 35 lb. Manufacturer: Admiral/Palo Alto, Stanford Industrial Park, Palo Alto, Calif.



• **Radiation-resistant potentiometer,** miniature wire-wound, Model 3040, operates at temperatures up to 350C with derating from 5 watts at 70C, and is designed to function in high flux nuclear environment of 150 megarad total gamma radiation and fast neutron radiation of 5 x 10^{15} n/cm², according to manufacturer. Device is available in resistances of 500 to 20,000 ohms, with tolerance of 10%. It measures 0.37 x 0.29 x 1.25 in., weighs ¼ oz. Manufacturer: Bourns, Inc., 1200 Columbia Ave., Riverside, Calif.



This is the first time anybody put it in writing

In competition with more than 500 suppliers, our Twigg Industries division is the first company to be recognized with a General Electric "Quality Vendor of the Month" award.

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For complete details write to Defense Products Sales, Altamil Corporation, 1201 South Ohio Street, Martinsville, Indiana.

TWIGG DIVISION ALTAMIL CORPORATION

Wide-Range Attack Angle Indicator Shown

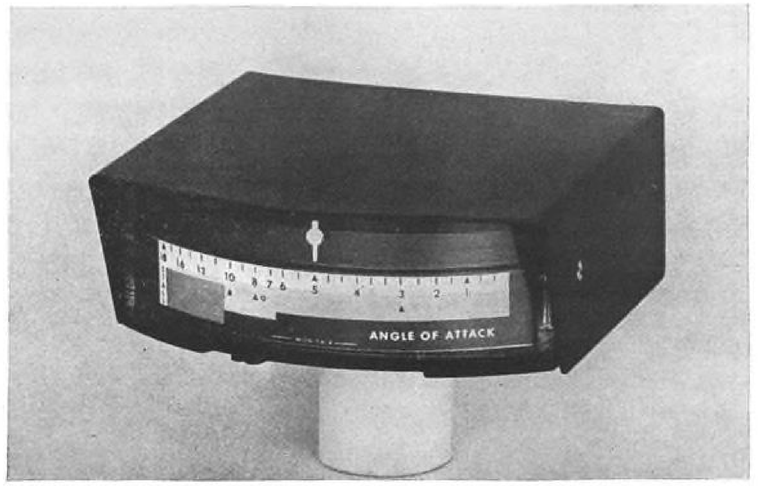
By David A. Brown

Teterboro, N. J.—Angle-of-attack indicator for general aviation aircraft, which provides accurate wing incidence information at the high as well as the low end of the aircraft's speed range, gives light aircraft pilots information needed to obtain best cruise and range performance.

Manufactured by Monitair Corp., a division of Van Dusen Aircraft Supplies, Inc., the indicator is a simple balanced vane mounted on a wing pylon and attached to a potentiometer.

It measures optimum angle of attack for each different wing for each maneuver and displays this on a simple linear indicator in the cockpit.

Attached to the leading edge of the wing within ± ¼ in. of the mean aerodynamic chord line (MAC), the vane provides a linear motion for each change in the wing's angle of attack.



MONITAIR ANGLE OF ATTACK INDICATOR, here configured for Piper Comanche use, shows optimum angle of attack for each maneuver and allows pilot to maintain this angle precisely. Indicator shows low angles for cruise as well as high angles for low-speed maneuvering. Indicator installation in aircraft takes 10-15 hr.

Cockpit Scale

This is read in the cockpit on a calibrated scale that shows angle of attack from zero to the stall angle, which may differ with different wings. Currently, the indicator has Federal Aviation Agency Supplementary Type Certification and is being flown on Cessna 170/172 and 180/182 aircraft and Piper Comanche and Apache series planes. It is being evaluated at present on Beech Bonanzas and is scheduled for evaluation on Beech Baron and Cessna 310 aircraft.

In line with the move to light twins, the sensing unit currently is being redesigned to put the potentiometer inside the wing, where it may more readily be heated for cold weather operations.

At the same time, the size of the sensing vane is being reduced from its present 1 x 2-in. size to 1 x 1 in.

The indicator was demonstrated to this Aviation Week & Space Technology pilot by Monitair President Allan B. Heinsohn in a Piper Comanche, N 110KS.

Until the aircraft is flying, the indicator does not work. As soon as the Comanche was airborne and the gear up, Heinsohn rotated it to the best angle of climb, in this case a 10-deg. angle of attack. This produced what at first appeared to be an excessively nose-high condition, but climb rate was steady, and the air speed did not drop off.

Delay of .6 sec., built into the circuit, eliminates variation caused by gust loading, which normally lasts from .25 to .3 sec., Heinsohn said.

At altitude, Heinsohn set the Comanche up for cruise, maintaining the best range angle of 3 deg.

Although steady because of the circuit delay, the angle-of-attack indicator is more sensitive than the airspeed indicator.

Heinsohn rocked the control yoke back and forth and the air speed needle varied approximately ± 2 mph. from a steady 140 mph.

The attack indicator, however, swung through several degrees of angle of attack on either side of the 3 deg. setting.

Slow-Flight Demonstration

Slow-flight demonstration showed it was possible to fly for extended periods near the stall angle—in this case 18 deg.—simply by referring to the angle-of-attack indicator. Since the wing will stall at this angle regardless of airspeed, the airspeed indicator and the stall warner can both be ignored.

With gear and flaps down, it was possible to fly the aircraft at a 17-deg. angle of attack, maintaining an airspeed of 74 mph.

Landing approach was flown at the optimum angle of attack for that maneuver, 8 deg. It can be flown with the angle as low as 6 deg. or as high as 10 deg. Below 6 deg. the aircraft cannot be flared; above 10 deg. the safety factor is reduced.

The threshold was crossed at approximately 10 deg. angle of attack, and the aircraft rotated until it completed a full-stall landing as the indicator needle touched the 18-deg. stall angle.

The indicator is powered directly off the aircraft's electrical system, which can be either 12 or 24 v. A 6 v. version has been developed and is being evaluated by Snow Aeronautical Corp. on its agricultural aircraft.

Finer Reading

The vane swings through an arc of up to 70 deg. on some aircraft, giving better than a 3:1 expansion of the wing angle, permitting a finer reading to be presented on the cockpit indicator.

Each wing, of course, has different flight characteristics, but this requires only that the indicator card in the cockpit be different for each make of aircraft. There is no change in design of the system.

In the event of electrical failure, the needle swings to the high angle of attack side of the scale and remains there. Current drain is .02 amp.

Heinsohn said installation time varied between aircraft, but generally took about 10-15 hr., with low-wing aircraft taking more time than high-wing models.

The company currently is studying modification of the dial to permit it to

When you can't see a thing...



it's comforting to know that Honeywell is doing your looking for you. Comforting to know that your instruments are backed by the stature, skill and experience of Honeywell, a leader in the aircraft and aerospace instrument field. Over the years, we have pioneered many advanced aircraft instruments and mechanisms to meet the most baffling demands of weight, size, readability, stability, ruggedness, as well as precise electrical characteristics. On countless occasions, new materials, configurations — even new concepts — have been developed. All this makes us at Honeywell confident that we can custom-design an aircraft instrument or mechanism to match your specifications, and in a surprisingly short time, too!



TYPICAL HONEYWELL MECHANISMS

Each mechanism was custom-designed to answer a particular application problem. Honeywell versatility is suggested by the variety of mechanisms illustrated . . . ranging from subminiature sealed indicators to the more elaborate bar indicators. The unusual flexibility of Honeywell's plant facilities permits rapid design, testing and manufacture of specialized work. Whether you want a miniature mechanism or a complex system, Honeywell can help you. Write Honeywell, Precision Meter Div., Grenier Field, Manchester, New Hampshire.

"WHERE ELECTRONICS MEETS THE EYE"

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be mounted in the instrument panel. Current installation has it mounted above the panel just below the pilot's line of sight.

The system has a 500-hr. warranty. Price is less than $350, plus installation. Potentiometer is manufactured by Spectrol Electronics Corp. of San Gabriel, Calif., and the indicator is produced by International Instruments of Orange, Conn.

The company also is working on an advanced system which would be coupled to the aircraft's autopilot and navigation instruments to provide automatic flight control through landing.

Approximately 100 of the current model angle-of-attack indicators are in operation. Beech is making a company evaluation of the system.

Aerospace Companies Report on Salaries

Washington—Following is a list of aerospace industry directors and officers with 1962 salaries above $30,000, and their stockholdings, as they were reported to the SEC:

Martin-Marietta Corp.—G. M. Bunker, president, $150,000 salary, 183,471 shares of common stock; W. B. Bergen, president—aerospace divisions, $100,000 salary; J. F. Donoho, vice president, $60,000 salary; G. M. Hermann, chairman of the board, $50,000 salary, 25,083 shares of common stock, 183,340 shares of 4½ p.c. cumulative preferred stock; Dr. H. N. Huntzicker, president—construction materials divisions, $70,000 salary (plus $30,000 deferred compensation accrued during 1962); M. J. Leckey, vice president—chemical products divisions, $75,000 (plus $15,000 deferred compensation accrued during 1962. According to the terms of an agreement between the corporation and Mr. Leckey, Mr. Leckey is to accrue in deferred compensation $7,500 for each full or fractional part of a month during the active part of the agreement, which expires Mar. 31, 1971, and, in addition, is to be paid the lump sum of $270,000 upon termination of active employment with the corporation. If the agreement runs to its full term, this will make a total of $1,117,500. This deferred compensation is to be paid to Mr. Leckey in installments over a period of up to ten years following termination of his active employment with the corporation); C. W. Miles, general counsel, $80,000 salary, 13,984 shares of common stock; J. E. Muckley, vice president, $73,750 salary; W. T. Ragland, Jr., president and general manager—Superior Stone Co. div., $40,000; W. A. Burns, director, 1,000 shares of common stock; L. R. Gignilliat, Jr., director (elected 1963), 1,272 shares of common stock; E. H. Pixley, director (elected 1963), 333 shares of common stock; A. B. Royce, director (elected 1963), 660 shares of common stock; D. M. Spencer, director, 1,300 shares of common stock; J. L. Sullivan, director (elected 1963), 26,006 shares of common stock. All stock beneficially owned, as of Feb. 1, 1963.

The Marquardt Corp.—R. E. Marquardt, president and director, $73,500 salary, 57,536 shares of capital stock; D. L. Walter, vice president and director, $51,500 salary, 3,894 shares of capital stock; W. H. Schwebel, vice president, treasurer, director, $42,500 salary, 648 shares of capital stock; B. A. Gillies, director; H. A. Klagsbrunn, director, 638 shares of capital stock; F. Lindvall, director; W. Littlewood, director, 615 shares of capital stock; C. B. Millikan, director, 3,512 shares of capital stock; P. B. Taylor, director, 206 shares of capital stock; C. E. Unterberg, director, 1,545 shares of capital stock; T. F. Walkowicz, director, 100 shares of capital stock (in addition, Mr. Walkowicz is a partner in 30 Rockefeller Plaza Associates & Co., which owns beneficially 2,575 shares of the corporation's capital stock); H. Woodward, director, 3,347 shares of capital stock (in addition, Mr. Woodward is a partner in 30 Rockefeller Plaza Associates & Co., which owns beneficially 2,575 shares of the corporation's capital stock. Mr. Woodward is also a general partner in Kin & Co., which owns beneficially 1,030 shares of the corporation's capital stock). All stock beneficially owned, as of Mar. 1, 1963.

North American Aviation, Inc.—J. L. Atwood, president and director, $164,000 salary, 10,000 shares of stock; C. J. Gallant, executive vice president, 89,400 salary; J. H. Kindelberger, chairman of the board (deceased July 27, 1962), $125,000 salary; R. A. Lambeth, senior vice president, treasurer, director, $79,200 salary, 2,950 shares of stock; J. S. Smithson, senior vice president and director, $79,200 salary, 3,200 shares of stock; A. V. Call, director, 1,000 shares of stock; H. B. du Pont, director, 3,466 shares of stock; H. G. Fales, director, 2,800 shares of stock; R. A. Lovett, director, 1,200 shares of stock; H. T. Mudd, director, 400 shares of stock; W. C. Mullendore, director, 234 shares of stock; C. A. Rude, director, 350 shares of stock; L. R. Taylor, director (elected 1963), 2,000 shares of stock. All salaries are for the fiscal year ending Sept. 30, 1962. All stock beneficially owned, as of Nov. 30, 1962.

Northrop Corp.—W. C. McDuffie, chairman of the board, $71,250 salary, 2,000 shares of stock; T. V. Jones, president and director, $150,000 salary, 12,100 shares of stock; W. F. Ballhaus, executive vice president, director, $105,005 salary, 17,670 shares of stock; R. R. Miller, senior vice president and director, $87,000 salary, 22,800 shares of stock; R. E. Horner, senior vice president, $87,000 salary; J. Allen, vice president and assistant to the president, director, $53,667 salary, 400 shares of stock; L. L. Austin, director; E. W. Carter, director, 1,000 shares of stock; E. M. Jorgenson, director, 4,000 shares of stock; R. W. Millar, director, 500 shares of stock; J. O'Melveny, director, 684 shares of stock; A. E. Ponting, director, 1,000 shares of stock; A. C. Rubel, director, 200 shares of stock. All salaries are for the fiscal year ending July 29, 1962, and amounts include incentive compensation payments. All stock beneficially owned, as of Oct. 1, 1962.

Piper Aircraft Corp.—W. T. Piper, chairman of the board, $40,731 salary, 131,996 shares of common stock (including 25,000 shares held by The Piper Investment Co. and 45,000 shares held by Castanea Realty Co., Inc.), 65,616 shares of common stock held as trust under a voting trust which includes 9,845 shares beneficially owned by W. T. Piper, Jr. (included under his stock ownership as shown below), 14,773 shares beneficially owned by minor children of Howard Piper, and 11,246 shares beneficially owned by minor children of T. F. Piper, Mrs. W. T. Piper owns 7,005 shares of common stock, various amounts of common stock held by members of the Piper family (as shown under the individual names below), 4,237 shares of common stock held by the Piper Foundation; N. J. Greene, director, 1,100 shares of common stock, 300 shares of common stock held of record as trustee (but without beneficial interest therein), R. K. Griffin, director, 606 shares of common stock; E. N. Hunting, director, 502 shares of common stock (includes shares held in joint ownership with his wife); W. C. Jamouneau, director, 220 shares of common stock; Howard Piper, vice president in charge of research and development of the corporation, director, 21,326 shares of common stock (including shares held in joint ownership with wife), 4,831 shares of common stock owned by Mrs. H. Piper, 2,773 shares of common stock owned by minor children of Howard Piper, 14,773 shares of common stock held in a trust (as mentioned above



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CHERRY AIRCRAFT LOCKBOLTS
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For technical information on Cherry Aircraft Lockbolts, write Townsend Company, Cherry Rivet Division, Box 2157N, Santa Ana, California.

*Licensed under Huck patent Nos. 2,531,048; 2,531,049; 2,527,307; 2,754,703.

Cherry Rivet Division
Santa Ana, Calif.

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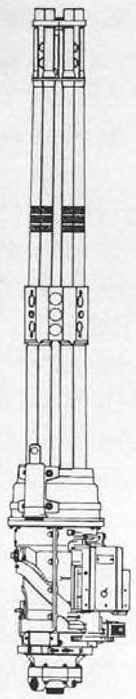
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under W. T. Piper) beneficially owned by minor children of Howard Piper; T. F. Piper, vice president and director, 22,551 shares of common stock (includes shares held in joint ownership with wife), 1,612 shares of common stock owned by minor children of T. F. Piper, 11,246 shares of common stock held in a trust (as mentioned above W. T. Piper) beneficially owned by minor children of T. F. Piper; W. T. Piper, Jr., executive vice president and director, 23,158 shares of common stock (including 9,845 shares of common stock held in a trust, as mentioned above under W. T. Piper), 684 shares of common stock owned by Mrs. W. T. Piper, Jr.; C. W. Pool, treasurer and director, 200 shares of common stock (including shares held in joint ownership with wife). All salary amounts are for the fiscal year ending Sept. 30, 1962. All stock beneficially owned, as of Nov. 23, 1962.

Republic Aviation Corp.—Mundy I. Peale, president and director, $152,666 salary, 15,878 shares of common stock; H. S. Jones, executive vice president and director, $151,800 salary, 11,000 shares of common stock; A. Kartveli, vice president and director (retired June 1, 1962), $65,600 salary (from June 1, 1962, has received a pension of $2,011 per month under the contributory retirement plan); R. L. Clarkson, director, 292 shares of common stock; W. H. Moore, director, 1,210 shares of common stock; L. Platt, director, 584 shares of common stock; W. V. Platt, director, 200 shares of common stock; J. Stack, vice president, director (elected June 1, 1962), 100 shares of common stock; H. N. Taylor, director, 400 shares of common stock; R. C. Taylor, director, 522 shares of common stock; O. V. Tracy, director (elected Jan. 24, 1963); J. J. Tuohy, director, 200 shares of common stock; L. Wilkinson, director (elected Jan. 24, 1963), 100 shares of common stock. All stock beneficially owned, as of Feb. 1, 1963.

Radio Corporation of America—J. T. Cahill, director of RCA, NBC, and RCA Communications, general counsel to RCA, $3,350 in fees, 618 shares of common stock (note: the firm of Cahill, Gordon, Reindel & Ohl, of which Mr. Cahill is senior partner, received fees of $300,000 for various legal services rendered to RCA, NBC, and other subsidiaries of RCA during 1962. The firm is rendering similar services during 1963); Mrs. E. N. Case, director of RCA and NBC, $2,200 in fees, 105 shares of common stock, 400 shares of preferred stock; E. W. Engstrom, director of RCA, NBC, and RCA Communications, president of RCA, $160,000 in salary and fees, $24,000 incentive award for 1962, paid in 1963, $96,000 incentive award for 1962 payable over the next four years, 15,490 shares of common stock; F. M. Folsom, director of RCA, NBC, RCA Communications, RCA Sales Corp., RCA International Ltd., and RCA Victor Co., Ltd., $25,000 salary and fees, $2,976 incentive award for 1962, paid in 1963, $12,024 incentive award for 1962 payable over the next four years, 10,531 shares of common stock; H. C. Hagerty, director of RCA and NBC, $17,700 in salary and fees, 108 shares of common stock; J. H. Hammond, Jr., director of RCA, $1,000 in fees, 100 shares of preferred stock (John Hays Hammond, Jr., and Hammond Research Corp., of which Mr. Hammond is president, under agreements with RCA, received $44,617 in 1962 toward the maintenance of a research laboratory, for consulting and engineering services, and for rights under inventions. Similar services are being rendered during 1963); H. C. Ingles, director of RCA, NBC, and RCA Communications, consultant to RCA and RCA Communications, $12,650 in salary and fees, 111 shares of common stock; A. L. Malcarney, director of RCA, group executive president of RCA, director and president of RCA Defense Electronics Corp., $85,000 in salary and fees, $15,000 incentive award for 1962, paid in 1963, $60,000 incentive award for 1962 payable over the next four years, (in addition, following designation of Mr. Malcarney as group executive vice president on May 15, 1962, the corporation entered into an agreement with him providing for his employ-





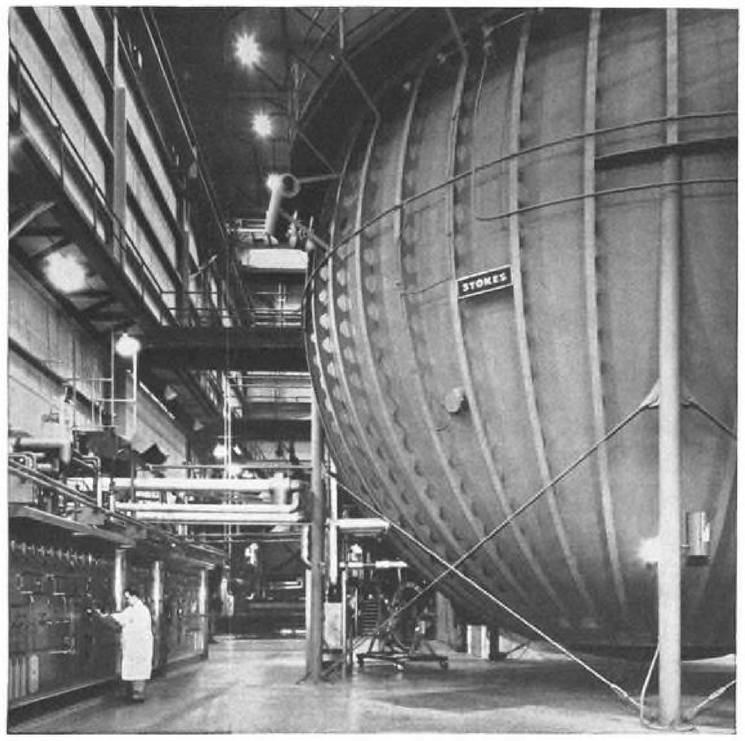
FASTEST GUN

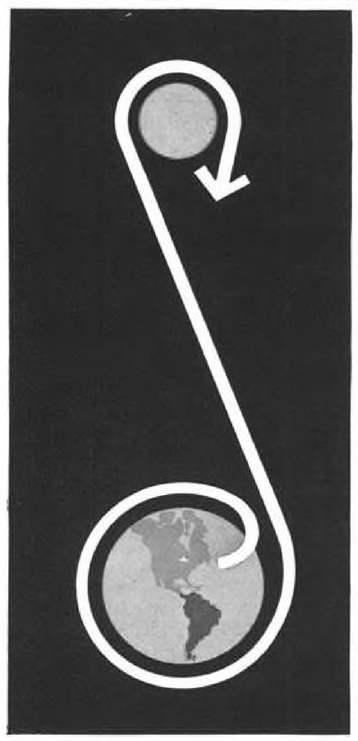
Firing 20mm projectiles at the astounding rate of 100 rounds *a second*, General Electric's M61 Vulcan *is* Top Gun. Newly holstered, as an externally mounted airborne gun system called VULPOD, it is designed to meet USAF armament-versatility requirements for close support firepower on the F-100, F-105, and F-4C.

Since 1956, General Electric has produced over 2,700 Vulcans for supersonic fighters and bombers flown throughout the Free World. Adapting its revolving six-barrel principle from the famous Civil War Gatling, successive generations of the Vulcan have bettered each of the original requirements for *reliability, firing-speed,* and *accuracy*: in a continuing series of over 200 systems tests, the M61 has demonstrated a 97.8 percent probability of firing a complete 1000-round complement; is rated at over 6,000 rounds per minute (tested up to 7,200); has a verified dispersion of under 6 mils.

The VULPOD takes more than its name from the performance-proved Vulcan. By incorporating guns identical to current USAF applications, the VULPOD program takes full advantage of the Vulcan Gun's in-place, worldwide inventory—extra evidence of the *Accent on Value* at G.E.'s Missile and Armament Department, Burlington, Vermont.

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Stokes designed and built the first Goddard space chamber, NASA's "8 by 8." This thermal-vacuum chamber, capable of a simulated 200-mile altitude, is still in full-time use for satellite systems check-out prior to launch. Other important Stokes first-of-a-kind facilities:

G. E. Missile and Space Division: Four 5′ x 5′ component testing chambers regularly attaining vacuums in the 10^{-9} Torr range, using 20°K cryopumping.

G. E. Missile and Space Division: Three 39′ diameter spherical chambers, utilizing the dense gas helium cryopumping techniques proved in the 5′ x 5′ chambers. These large units (one of them is shown above) reached 10^{-10} Torr during initial operation.

Bell Telephone Laboratories: 9′ diameter, 13′ long environmental-simulation chamber with liquid nitrogen cooled shroud. 10^{-9} Torr has been demonstrated.

NASA, Goddard Space Flight Center: Vacuum and cryogenic systems for two chambers, 35′ in diameter and 60′ high. These SES and DTC facilities are used for proof-testing complete advanced NASA space vehicles and probes. SES chamber cryopumped to 10^{-10} Torr during acceptance tests.

Douglas Aircraft Corporation: Three earth-orbit simulators, the largest a 39′ sphere, for testing spacecraft scheduled for manned flight. (In construction.)

Working in close association with CryoVac as supplier of cryogenic systems, Stokes is able to offer more "in house" capability than any other supplier in the specialized field of space simulation facilities. This capability covers engineering design, construction, field erection, acceptance and performance testing.

Stokes will gladly put this integrated capability and its practical experience at your disposal on a project management, single source or turnkey basis. Write: **Space Systems Department, F. J. Stokes Corporation, 5500 Tabor Road, Philadelphia 20, Pa.**

STOKES

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Cessna Skywagon Certificated with Amphibious Floats

Cessna 185 Skywagon has been certificated to operate with Edo Corp. Model 597 amphibious floats. Floats, larger than previously available, were designed by Edo to allow the aircraft to operate at high gross weights. Each float displaces 2,790 lb. Landing gear retraction is hydraulic. Cruise speed of the Skywagon with the Edo Corp. floats is 145 mph.

ment from Oct. 1, 1962, to Sept. 30, 1967, at a base salary of $80,000 per annum, with provision for payment in ten annual installments after termination of employment of an additional sum equal to $1,666.67 a month for each month of employment under the agreement, pursuant to certain conditions agreed upon between Mr. Malcarney and the corporation), 10,607 shares of common stock; P. M. Mazur, director of RCA and NBC, $3,300 in fees, 762 shares of common stock; A. Meyer, director of RCA and NBC, $1,150 in fees, 17,058 shares of common stock; C. V. Newsom, director of RCA and NBC, $1,950 in fees, 204 shares of common stock; C. M. Odorizzi, director of RCA, RCA Communications, RCA Sales Corp., and RCA Victor Distributing Corp., chairman of the boards of RCA International Ltd., RCA Victor Co. Ltd., RCA International Service Corp., and RCA Institutes, Inc., group executive vice president of RCA, $125,000 in salary and fees, $15,000 incentive award for 1962, paid in 1963, $60,000 incentive award for 1962, payable over the next four years, 24,911 shares of common stock; D. Sarnoff, chairman of the boards of RCA and RCA Communications, director of NBC, $200,000 in salary and fees, 30,745 shares of common stock; R. W. Sarnoff, chairman of the board of NBC, director of RCA, $180,000 in salary and fees, $20,000 incentive award for 1962, paid in 1963, $80,000 incentive award for 1962 payable over the next four years, 16,874 shares of common stock; L. L. Strauss, director of RCA and NBC, $17,650 salary and fees, 530 shares of common stock; W. W. Watts, director of RCA, chairman of the board and president of RCA Sales Corp., chairman of the board of RCA Victor Distributing Corp., group vice president of RCA, $125,000 in salary and fees, $15,000 incentive award for 1962, paid in 1963, $60,000 incentive award for 1962 payable over the next four years, 11,892 shares of common stock. All stock beneficially owned, as of Feb. 8, 1963.

The Ryan Aeronautical Co.—T. C. Ryan, chairman of the board, $77,500 salary, 117,379 shares of stock (in addition, Mr. Ryan is a director of Emtor, Inc., and owns 4,000 shares of stock in that company. Emtor, Inc., owns 364,400 shares of stock in Ryan Aeronautical); R. C. Jackson, president and director, $67,500 salary, 551 shares of stock (in addition, Mr. Jackson owns 40,000 shares of stock in Emtor, Inc., and is a director of that firm—see above); C. A. Stillwagen, vice president and treasurer, $49,600 salary; C. A. Smith, director, 3,969 shares of stock; A. J. Hair, director, 266 shares of stock (in addition, Mr. Hair owns 26,000 shares of stock in Emtor, Inc.—see above); G. Hoffman, director, 507 shares of stock. All salary amounts are for the fiscal year ending Oct. 1, 1962. All stock beneficially owned, as of Dec. 10, 1962.

Thiokol Chemical Corp.—J. W. Crosby, president and director, $90,000 salary (pursuant to an agreement dated June 20, 1957, as amended Feb. 21, 1963, between Mr. Crosby and the corporation, it is provided that if Mr. Crosby shall retire or be retired at any time after Feb. 21, 1963, the company shall pay to him deferred compensation for a period of ten years after his retirement in equal monthly installments of $2,000 under certain conditions as agreed upon between the two parties. If Mr. Crosby should die before retirement or before expiration of the ten-year period, his wife, if living, shall receive $1,000 per month during the unexpired portion of such ten-year period, or until her death if she should die before expiration of the ten-year period), 48,962 shares of stock; H. R. Ferguson, executive vice president and director, $63,750 salary, 28,718 shares of stock; J. S. Jorczak, vice president and director, $35,500 salary, 7,108 shares of stocks; S. M. Martin, Jr., vice president and director, $43,250 salary, 2,435 shares of stock; A. Raws, Jr., treasurer and director, $35,625 salary, 10,007 shares of stock; H. W. Ritchey, vice president and director, $57,500 salary, 5,488 shares of stock; A. A. Burke, director, 104 shares of stock; O. R. Cook, director, 100 shares of stock; J. E. Hughes, director, 113 shares of stock; C. S. Lutkins, director, 2,435 shares of stock; C. S. Proctor, director, 3,019 shares of stock; O. L. Schweng, director; D. N. Sosland, director, 139,439 shares of stock (including total number of shares owned by three partnerships in which Mr. Sosland is a partner. Partnership "A" owns 99,333 shares, partnership "B" owns 29,138 shares, partnership "C" owns 10,496 shares, and Mr. Sosland owns directly 472 shares); W. M. Spencer, director, 3,120 shares of stock; C. B. Vose, director, 44,686 shares of stock; T. F. Walkowicz, director, 42 shares of stock (held of record by Mr. Walkowicz, but beneficially owned by his children). All stock beneficially owned, as of Feb. 15, 1963.

Thompson Ramo Wooldridge, Inc.—J. D. Wright, chairman of the board and chief executive officer, $168,750 salary, 14,740 shares of common stock; S. Ramo, vice chairman of the board, $135,000 salary, 50,919 shares of common stock (1,155 of these shares are owned by Mr. Ramo jointly with his wife); H. A. Shepard, president and director, $135,000 salary, 9,680 shares of common stock; F. C. Crawford, consultant, director, $70,292 salary, 34,399 shares of common stock; R. F. Bacher, director, 110 shares of common stock; J. T. Brown, director, 110 shares of common stock; A. T. Colwell, director, 11,000 shares of common stock; J. H. Doolittle, director and consultant, 14,465 shares of common stock; W. S. Vaughn, director, 110 shares of common stock; D. E. Wooldridge, director, 36,379 shares of common stock. All stock beneficially owned, directly or indirectly, as of Feb. 11, 1963.

Rohr Corp.—F. H. Rohr, president and general manager, $85,000 salary, 34,988 shares of common stock, 48,929 shares of common stock owned by wife, 37,738 shares of common stock owned by F. H. Rohr, Jr., assistant vice president; B. F. Raynes, senior vice president, $65,000 salary, 14,112 shares of common stock; A. F. Kitchin, vice president-administration, $43,940 salary; F. E. McCreery, vice president-engineering, $43,940 salary; G. M. Harrington, director and treasurer, vice president and treasurer of subsidiary, 257 shares of common stock; I. M. Laddon, director, 3,358 shares of common stock (including a one-half interest in a trust owning 2,000 shares of common stock; also owning 20 debentures—see next item), 26 5¼ p.c. convertible subordinated debentures due 1977 (including a one-half interest in a trust owning 20 debentures—see preceding item); B. P. Lester, director, 7,238 shares of common stock held of record by Lester, Ryons & Co., an investment banking firm of which B. P. Lester is a general partner, as nominee for third persons. All salary amounts are for the fiscal year ending July 31, 1962. All stock beneficially owned, as of Oct. 1, 1962.

Raytheon Co.—C. F. Adams, president and director (effective as of Feb. 8, 1962), $116,500 salary, 36,253 shares of common stock; R. E. Krafve, president and director (resigned Feb. 8, 1962), $16,667 salary, $26,171 termination payments; T. L. Phillips, executive vice president and director, $87,700 salary, 916 shares of common stock; P. L. Spencer, senior vice president and director, $49,500 salary, 1,330 shares of common stock; G. Ingram, Jr., vice president—finance, $65,000 salary; C. L.

RAYTHEON AT WORK

"Apollo launched. Target moon. Raytheon guidance computer on course."

The roar of lift-off has died, and silence has settled on the launching site. Streaking toward that distant glowing orb in the sky is Apollo, NASA's manned spacecraft. Within the speeding vehicle on its 240,000-mile trip into a lunar orbit and return is a Raytheon digital guidance computer.

A glimpse of tomorrow? Yes, but today Raytheon engineers are working to make it a reality. They're providing technical support to M.I.T. in the design of a computer to be built by Raytheon. A compact "nerve center," it is part of the guidance system for which M.I.T. has overall design responsibility. It will produce information needed by the crew for navigation and their operation of the many flight functions.

Such vital participation in America's Apollo program typifies Raytheon electronics skills at work in behalf of science, business, industry, and defense. Raytheon Company, Lexington, Massachusetts.

RAYTHEON



Calosi, vice president—Europe, $65,000 salary; D. S. Edmonds, director, 42,762 shares of common stock; C. J. Gilbert, director, 1,602 shares of common stock; W. J. Hogan, director, 218 shares of common stock; S. P. Lovell, director, 206 shares of common stock; R. W. Stoddard, director, 253 shares of common stock; C. F. Avila, director, 103 shares of common stock; R. C. Damon, director, 116 shares of common stock. All salary figures include bonuses with respect to 1961. All stock beneficially owned, directly or indirectly, as of Apr. 3, 1963.

United Aircraft Corp.—W. P. Gwinn, director, president, $141,120.08 salary, 3,133 shares of common stock; H. M. Horner, director, chairman of the board, $177,099.92 salary, 8,080 shares of common stock; E. Martin, director, vice president for research and development, $104,720 salary, 1,000 shares of common stock; W. R. Robbins, director, vice president for finance, $105,420 salary, 5,000 shares of common stock; D. T. Bartholemew, director, 100 shares of common stock; H. S. Beers, director, 200 shares of common stock; H. J. Berry, director, 100 shares of common stock; J. D. DeWitt, director, 220 shares of common stock; O. Enders, director, 1,500 shares of common stock; L. S. Hobbs, director, 400 shares of common stock; E. C. Maxcy, director, 75 shares of common stock; G. S. Moore, director, 100 shares of common stock. All stock beneficially owned, as of Feb. 7, 1963.

PRODUCTION BRIEFING

Convair Div. of General Dynamics, San Diego, will build additional guidance housing assemblies for Minuteman ICBMs under a $768,000 follow-on contract from Air Force. Contract value for the program now stands at $1.3 million, and work will run through 1964.

Sanders Assoc., Inc., Nashua, N.H., will house its corporate advanced program development group and advanced systems laboratories in a new 50,000-sq. ft. facility at Bedford, Mass. Both units had previously been located in quarters that Sanders leased at Burlington, Mass.

Kearfott Div., of General Precision Aerospace, Little Falls, N. J., has been awarded a $2.1-million subcontract by Douglas Aircraft for 127 navigational computers for Douglas A-4E attack aircraft. The computer, Minac-5, continuously computes and displays aircraft position, wind direction and velocity, distance and course to three destinations, ground track and steering angle.

Northrop Nortronics Div. of Northrop Corp., Palos Verdes, Calif., has a $7-million contract from Boeing Co. for additional voice reporting systems for Minuteman ICBM launch silos. New contract increases the amount spent for Voice Reporting Signal Assembly (VRSA) equipment to more than $15 million. The system reports system malfunctions in a male voice.

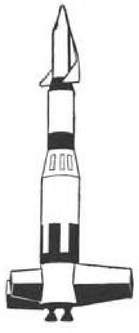
ENGINEERS / SCIENTISTS / PHYSICISTS / MATHEMATICIANS

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- Analysis of control systems, including stochastic processes.
- Simulation of real-time devices.
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We are actively engaged in the design and development of airborne and spaceborne navigation systems for such programs as X-20A, Centaur, Gemini and others of even greater complexity. Our continuing expansion means fresh opportunity in several engineering disciplines AT EVERY LEVEL OF EXPERIENCE. Honeywell offers the inquisitive, imaginative engineer the growth and responsibility possible only within an aggressive engineering-oriented firm.

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Cave paintings of Bushmen discovered near Oudtshoorn, South Africa

MOON SAFARI

10,000 MILES FOR A 37-SECOND MISSION

What is the exact shape of the moon? Interference of the earth's shadow has long prevented man from determining it. To solve this mystery, an "eclipse expedition" from Lockheed's Rye Canyon Research Center recently traveled 10,000 miles to Oudtshoorn, South Africa. They photographed the moon—under ideal scientific conditions—for the 37 seconds it was silhouetted against the sun's near-perfect circle.

The precise measurements secured by this "moon safari" provide added information on the effects of moon gravity: data of great importance in planning lunar landings and computing the lifetime of vehicles which will orbit the moon.

Lunar and planetary studies are but one of the basic projects under research by Lockheed scientists and engineers at



the Rye Canyon facility. Others include: Astrodynamics; Communications; Optics, Plasma, Solid State, Solar, Geo and Biophysics; Thermodynamics; Aerodynamics; Propulsion; Altitude and Space Environment. Research projects at other Lockheed-California facilities include work on America's supersonic transport; ASW and Ocean Systems; and Spacecraft.

SCIENTISTS AND ENGINEERS are invited to explore the exciting future these projects offer men of top-level talent and training. *Write:* Mr. E. W. Des Lauriers, Manager, Professional Placement Staff, Dept. 1109, 2401 N. Hollywood Way, Burbank, California. An equal opportunity employer.

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A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

CAB Accident Investigation Report:

Three-Engine Go-Around Cited in Crash

On July 22, 1962, at 2319 (HST), a Canadian Pacific Air Lines Bristol Britannia crashed while attempting a three-engine go-around following a landing approach to Runway 8 at Honolulu International Airport, Honolulu, Hawaii. Except for the rear portion of the fuselage, and attached tail section, the aircraft was destroyed by impact and fire.

Thirteen of the 40 persons aboard survived the crash.

Shortly after takeoff from Honolulu for Nandi, Fiji Islands, a fire warning indication caused the pilot to feather the propeller on the No. 1 engine. Fuel was jettisoned, and the flight returned to Honolulu for landing approximately 40 min. after departure. The three-engine landing approach appeared normal until the aircraft had proceeded beyond the runway threshold and had commenced its landing flare at an altitude of approximately 20 ft. above the runway centerline. A go-around was attempted from this position and the aircraft banked and veered sharply to the left. Initial ground contact was made by the left wing tip approximately 550 ft. to the left of the runway centerline. The aircraft progressively disintegrated as it moved across the ground, then struck heavy earth-moving equipment parked approximately 970 ft. from the runway centerline.

The Board determines that the probable cause of this accident was the attempted three-engine go-around, when the aircraft was in a full landing configuration, at insufficient airspeed and altitude to maintain control.

Investigation

CF-CZB, a Bristol Britannia 314, had arrived in Honolulu at 0507[1] on July 21, 1962, as Canadian Pacific Air Lines (CPA) Flight 323 from Vancouver, British Columbia. The aircraft and its crew remained in Honolulu overnight as scheduled, and departed the following evening as Empress Flight 301 for Nandi, Fiji Islands; Auckland, New Zealand; and Sydney, Australia. There were 29 passengers and a crew of 11 aboard Empress 301.

The only aircraft maintenance required while in Honolulu was the replacement of the No. 4 inverter.

There were no carry-over items, and no discrepancies were entered on the preflight inspection form.

An Instrument Flight Rules (IFR) flight plan was filed to Nandi via Victor 9 to South Honolulu, thence via the Great Circle route at 20,000 and 24,000 ft., with an estimated time en route of 9 hr. and 25 min.

The aircraft was serviced to a total of 64,000 lb. of fuel which was properly distributed within the four main and three transfer fuel tanks. The weight and balance manifest filed prior to the departure of the flight indicated the gross ramp weight of the aircraft was 170,074 lb. and the center of gravity (c.g.) was within approved limits. Examination of this document by Board investigators subsequent to the accident revealed that approximately 4,000 lb. of cargo had not been included in the gross weight and, consequently, was not reflected in the c.g. computations. The recomputed gross weight of the aircraft at the ramp was found to have been 174,005 lb. rather than the 170,074 lb. originally calculated. The maximum allowable gross takeoff weight for this flight was 185,000 lb. Computations based on the recomputed weight and loading configuration indicated the aircraft's actual c.g. at takeoff was 20.6% Mean Aerodynamic Chord (MAC) which was within the allowable British Civil Airworthiness c.g. limitations.[2]

Empress 301 was issued an IFR clearance in accordance with its flight plan and was cleared for takeoff on Runway 8. This runway is level, approximately 13 ft. m.s.l., 12,380 ft. long, and 200 ft. wide. There were no notices to airmen in effect that would have restricted the runway from being used for normal or emergency operation.

Takeoff Procedure

Takeoff was commenced at 2238. Approximately 2 min. after the aircraft became airborne, and during the climbout, a fire warning indication for the No. 1 engine was received in the cockpit. The No. 1 propeller was feathered and the fire warning indication ceased. The crew then advised the tower local controller that the No. 1 engine had been shut down, and they would return to Honolulu for landing. The tower advised Empress 301 that all runways were available, and the wind was from the northeast at 6 kt. The flight then requested Runway 8 for landing.

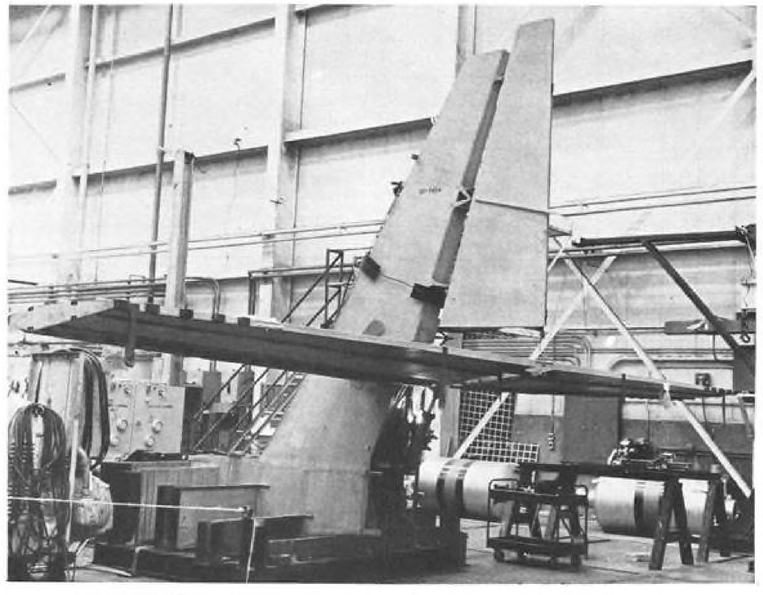
Emergency crash and rescue units were alerted and proceeded to standby positions adjacent to this runway.

Empress 301 then advised the tower that an over-gross landing weight[3] condition existed, and fuel jettisoning would be required in order to lighten the aircraft. The aircraft was vectored by radar approach con-

[1] All times herein are Hawaiian Standard based on the 24-hr. clock.

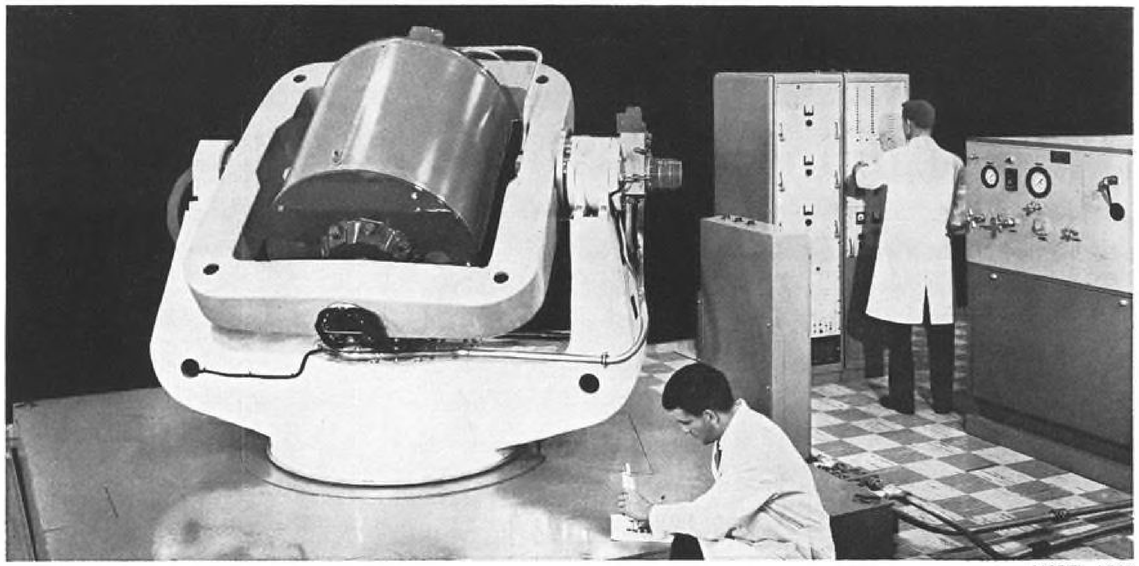
[2] The British Civil Airworthiness forward c.g. limit for this weight and configuration is 19.3% MAC.

[3] The maximum three-engine gross landing weight is 135,000 lb.



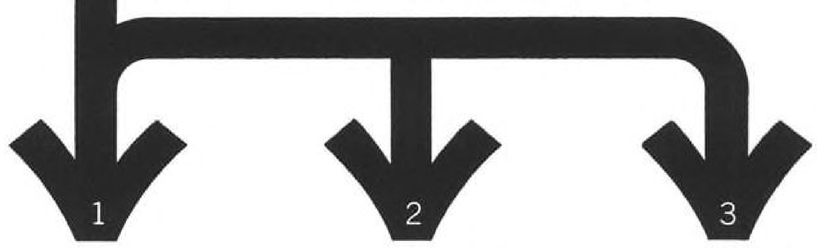
XC-142A Simulator Tail Section Shown

Tail portion of Vought-Hiller-Ryan XC-142A transport simulator, being constructed at Chance Vought's Dallas facility, will have movable control surfaces. Tail section is fabricated by Ryan. Simulator is designed to provide Vought's test pilots with a representation of the real aircraft's handling and flight characteristics.



MODEL J-267

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trol to an isolated area over the water approximately 20 mi. south of Honolulu at an altitude of 4,000 ft. Fuel jettisoning was initiated at 2253 and completed at 2306.

Radio Silence

One of the surviving stewardesses as well as several of the surviving passengers stated that during the fuel jettisoning Check Captain Giguere and First Officer Eldred came back to the rear passenger cabin on several occasions to visually check on the operation. It was stated that they used a flashlight to observe the jettisoning of fuel from both wings. During one of these trips Captain Giguere mentioned to Mr. William O'Connell (a Canadian Department of Transport air carrier inspector who was seated in the rear passenger cabin) that 35,000 lb. of fuel was being jettisoned. Empress 301 maintained radio silence during this operation; however, radar monitoring and vectoring were continued by approach control. After completing the jettisoning operation, two-way radio communication was resumed, and the flight was vectored west of the outer marker to intercept the ILS final approach course for Runway 8. The flight later reported departing the outer marker, and, after receiving clearance to land, reported the landing gear down. After the flight reported passing the low frequency radio range station it was again cleared by the tower to land.

The acknowledgment of this landing clearance was the final transmission received from Empress 301 and occurred approximately 50 sec. prior to impact.

Fire and rescue personnel first observed Empress 301 when its landing lights were turned on. The aircraft was then on final approach over Pearl Harbor Channel. Witnesses stated that the aircraft passed over the approach end of Runway 8 in what appeared to be a normal approach attitude at an estimated altitude of between 50 and 100 ft. The No. 1 propeller was observed to be feathered and the landing gear extended. After continuing above the runway for a short distance, the aircraft was described to bank and turn sharply to the left, contact the ground, and burn.

Twenty passengers and the seven flight crew members sustained fatal injuries. The 13 survivors received varying degrees of crash injuries and burns.

Landing Account

Nine of the survivors were interviewed and their recollections generally corroborate the statements of the witnesses on the ground. A detailed account of the landing approach was given by passenger O'Connell. He said the three-engine approach was normal, . . . "rather flat," and that he felt the landing gear . . . "come down and lock," approximately 2 min. before the aircraft crossed over the runway threshold at an altitude of approximately 100 ft. The aircraft continued its descent to an altitude of between 20 and 40 ft. and approximately over the runway centerline. It then leveled off momentarily, the nose was raised, and engine power applied as if a go-around were being initiated. The aircraft then banked and veered to the left, passed over the runway's left boundary and seconds later contacted the ground on its left wing. He also stated that approximately 8 sec. elapsed from the momentary level-off to the first impact.

It was determined that the aircraft first contacted the ground on its left wing tip approximately 550 ft. left of the centerline of Runway 8 and approximately 1,700 ft. beyond the threshold of the runway. Evidence indicated that the aircraft was, at the point of initial contact, in a left bank of between 10 and 20 deg., slightly nose-down, and on a heading of approximately 40 deg. magnetic. Examination of the wreckage distribution path indicated that the dragging of the left wing across the ground caused its disintegration and at the same time decreased the radius of curvature of the path of the aircraft. This was accompanied by rotation of the aircraft about its vertical axis and was immediately followed by the destruction of the forward fuselage when it contacted the ground. The aircraft proceeded across the ground for approximately 680 ft. in a tightening arc until it was nearly perpendicular to Runway 8 with the tail pointing away from the runway. It continued rearward, tail-high, into three construction vehicles[4] that were parked approximately 970 ft. from the runway centerline. The rear portion of the fuselage and attached tail section separated from the main wreckage and continued tail-first approximately 50 ft. to the north, right side up, and canted 45 deg. to the right.

Impact, Fire Damage

The flight deck and main fuselage section were essentially destroyed by impact and the fire that ensued. The rear fuselage section, from a position just forward of the galley, remained intact with the tail section still attached. It passed over and partially demolished a construction field office building before coming to rest beyond the parked earth-moving equipment. Because of the tail-first movement of this section, most of the damage was inflicted to the tail cone and empennage.

Light fire damage and heavy sooting were concentrated on the right side of the vertical fin and rudder, and on the right side and top of the fuselage over the entire length of this segment. This sooting continued down to the window level on the left side. Light sooting was present on the upper surface of the right horizontal stabilizer. The soot pattern on the fuselage continued across the exposed inner structure of the right wing root, indicating the wing had already become separated from the aircraft at the time of the fire. Popped rivet heads in the areas of heaviest sooting revealed bright unsooted countersunk surfaces. Items of the aircraft's cargo, upon which this section had come to rest, were themselves unmarked by heat or fire but had wiped clean the sooted areas of the fuselage with which they were in contact. There was no evidence of fire prior to initial impact.

The assistant fire chief was standing by

[4] Four earth-moving vehicles in the 10 to 22 ton weight class were parked approximately 850 ft. to the north of, and parallel to Runway 8. This equipment was being utilized in the construction of a jet taxiway which is parallel to and 750 ft. from the runway. Three of these vehicles formed a partial barricade to the progress of the disintegrating aircraft and confined the main portion of the wreckage in this area.

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in an emergency truck just off the edge, and near the approach end of the runway prior to the accident. He stated that all conditions observed during the approach appeared to be normal and that the landing gear was in the extended position. He observed no vehicular or pedestrian traffic on or adjacent to the runway. The tower local controller verified his statement that no vehicular traffic was observed on or in proximity to Runway 8. The fire and rescue crews proceeded to the crash scene immediately and succeeded in keeping the fire from the rear portion of the fuselage but were unable to extinguish the fire which had completely engulfed the main section of the aircraft.

Landing Gear Assemblies

All three landing gear assemblies were recovered and, although the impact and fire damage was severe, it was determined that they were in the up or nearly up position at impact. The left main gear up-lock mechanism was engaged, the truck was rotated and the retract cylinder actuator rod was fully retracted. The right main gear and the nose gear retract cylinders were also found in the retract position. The nose gear door panel was recovered and had no significant edge deformation but was extensively abraded on its outer surface, indicating it was in the closed or nearly closed position at impact.

Portions of the drive units for the landing lights were recovered and were determined to be in the fully extended position on both units.

All eight flap screwjacks were found in the fully extended position corresponding to a 45-deg. flap setting.

A flight recorder was not installed nor was it required on the aircraft.

The control pedestal was recovered but was so severely damaged from impact and fire that the only significant evidence present was the longitudinal trim indication which was in the takeoff position on both the pilot and copilot indicators. Other trim settings, control positions, or cockpit instrument readings could not be determined.

Control surface positions at impact could not be determined because of the extensive damage to the flight control system from impact and fire. However, there was no evidence to indicate a flight control or structural failure prior to impact.

Only one of the two left side fuel jettison valves was found. Due to impact and fire damage the valve position could not be determined. Neither of the two right wing jettison valves was recovered from the wreckage area.

All four engines and propeller assemblies separated from the aircraft during its disintegration and were recovered in the wreckage area. It was determined that the No. 1 propeller was in the fully feathered position and that the engine was not operating at the time of impact. Inspection of powerplants Nos. 2, 3, and 4 indicated that they were operating at impact and their propellers were at approximate blade angles of 27, 25, and 27 deg., respectively. The flight low pitch (flight fine) stop is 22 deg.

None of the engine control items recovered yielded definitive information except for the No. 2 engine high pressure fuel cock, which was found in the open position.

The propeller turbine shafts of engines Nos. 2 and 4 had been failed in torsion by impact forces as had the propeller-coupling shaft of the No. 3 engine. There was only minor impact rotational damage to the rotor assembly indicated in each of the engines.

Control Unit Actuator

The control unit actuator for the No. 2 propeller was found in the maximum r.p.m. position and the maximum switch was in the "ON" position.

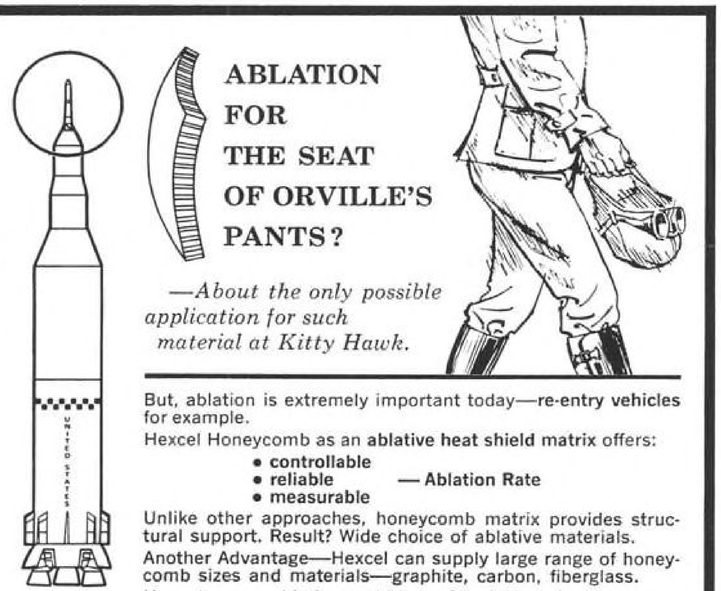
There were no significant propeller control indications for the No. 3 or 4 powerplants.

No evidence was found in any of the powerplants, including No. 1, that would indicate a failure or malfunction prior to impact.

Eleven of the 13 survivors had been seated in the rear fuselage section which had separated from the aircraft. The other two survivors had been seated in the main fuselage section just forward of where the aircraft broke apart. Although they were seated in an area of severe disintegration, they were thrown clear of the wreckage still strapped in their seats.

Extensive pathological investigation of the fatally injured crew members disclosed no evidence of any in-flight incapacitation.

Stewardess Huebner stated that she had gone to the flight deck shortly after takeoff



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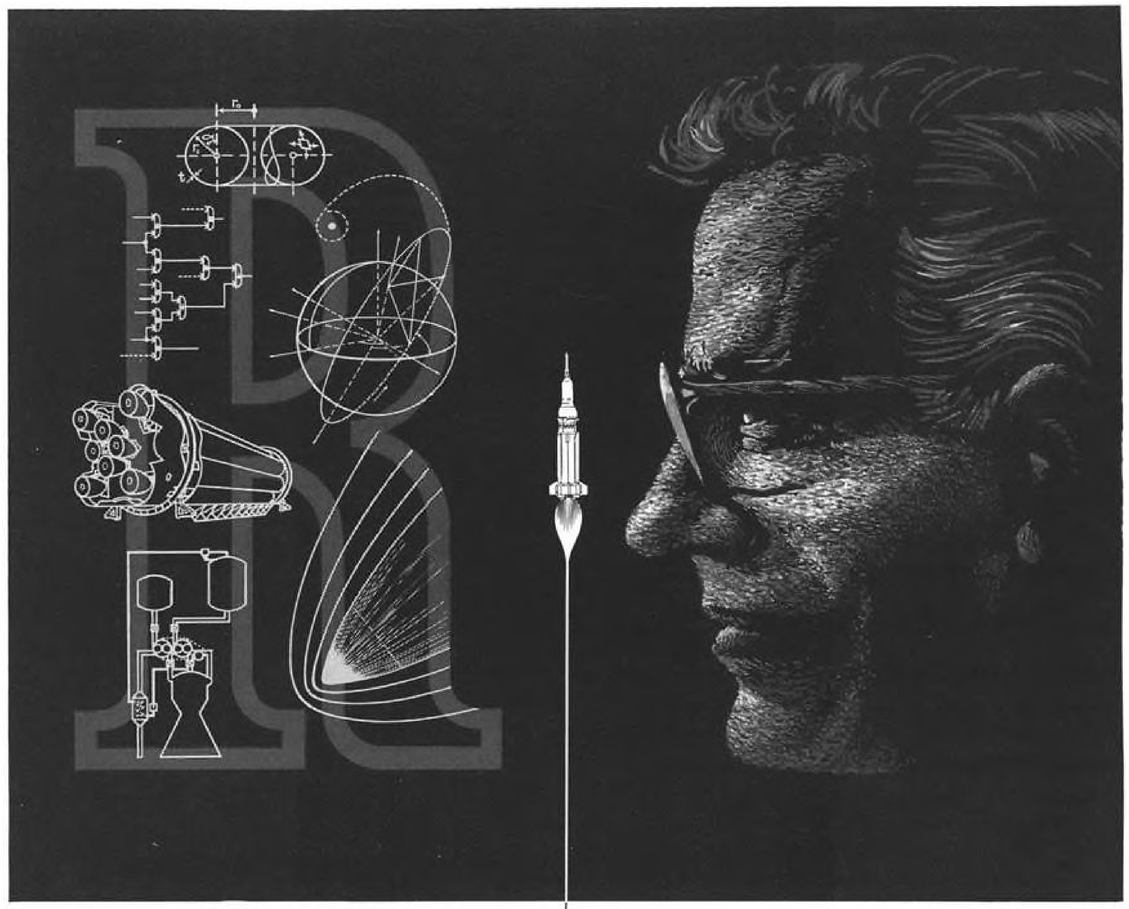
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and again just prior to the aircraft's descent. On both occasions she observed Captain Jennings in the left seat, First Officer Norton in the right seat, Second Officer Farr in the middle seat, and Navigator Hill in the navigator's seat. Check Captain Giguere, First Officer Eldred, and Navigator McLennan were seated in the club compartment located behind the flight deck.

The weather observation made by the U. S. Weather Bureau at Honolulu International Airport immediately after the accident was as follows: local 2320, 2,600 ft. scattered, measured 4,800 ft. broken, 10,000 ft. broken, high overcast, visibility more than 15 mi., temperature 76F, dewpoint 67F, wind east-northeast 7 kt., altimeter setting 30.01 in., rain showers of unknown intensity west to north.

Runway 8 has a U. S. standard configuration "A" approach lighting system with sequenced flashing (strobe) lights. This system includes a row of green threshold lights and white, high-intensity runway lights. All lights, with the exception of the strobes, were on and operating throughout the approach of CF-CZB.

Warning System

The landing gear unsafe warning system installed in the Britannia was examined to determine its possible involvement in the attempted go-around of Empress 301. Two separate systems, visual and audio, operate through independent electrical circuits so as to provide warning to the crew in the event of an unsafe gear condition. The visual system utilizes strut and bogie-position switches, depending on the selector and gear position, to activate red or green indicator lights located in the cockpit. The audio system receives its information from strut, bogie, and throttle-position switches and responds with a horn warning when any one of the throttles is retarded and the gear is not in the extended and locked position. Since these are separate systems with independent position switches it is possible for contradictory indications to be received in the cockpit in the event of failure of certain position switches.

A review of Mechanical Irregularity Reports revealed that on Jan. 5, 1962, a discrepancy of this nature was noted for this aircraft. The report stated that when the throttles were pulled back with the gear down and locked the horn sounded. In addition, both the red warning light and the green safe light were on for the port gear. The discrepancy was explained on the work report as having been caused by a short in the bogie-rotation position switches for the audio and the visual warning systems. Records indicate that these switches were replaced on Jan. 14, 1962.

The CPA Britannia Flight Manual does not contain specific instructions regarding three-engine go-around procedures when the aircraft is at low altitude and in a full landing configuration (landing gear extended and flaps full down at 45 deg.). However, Board investigators were advised by the CPA chief pilot that flight crews are verbally instructed that after full flap extension on a three-engine approach they are committed to land. Any attempt to go around on three engines with flaps fully extended must be initiated at a safe altitude and speed to insure that flaps can be retracted to 30 deg. and control of the aircraft maintained.

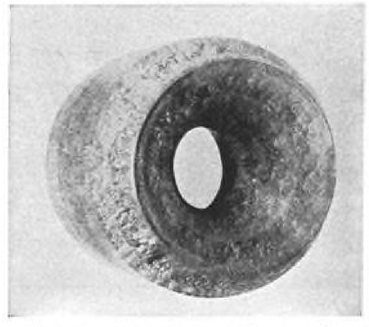
Analysis

As far as could be determined, approximately 35,000 lb. of fuel was jettisoned in the prescribed manner. Following the completion of this operation the aircraft was in flight for approximately 13 min. before the accident occurred. It can be assumed that during this time the crew had sufficient opportunity to insure that the remaining fuel load was symmetrically distributed and that the aircraft trim was set accordingly.

The gross landing weight of the aircraft at the time of the attempted landing has been estimated at 134,005 lb. This was computed by subtracting both the 35,000 lb. of jettisoned fuel and the 5,000 lb. of fuel estimated to have been consumed in flight from the recomputed ramp gross weight of 174,005 lb. At the estimated landing weight the c.g. during approach would have been 18.2% MAC which is within the approved aircraft landing limits.

All available evidence indicates that the three-engine approach was conducted under visual flight conditions and in a satisfactory manner up to the time the aircraft crossed the threshold of Runway 8.

From the probable approach flightpath, based on observations of survivors and witnesses, in conjunction with the wreckage distribution pattern, it was determined the go-around was initiated at a point approximately 600 ft. beyond the runway threshold and at an altitude of between 20 and 40 ft. above the runway centerline. This was further substantiated by the fact that the landing gear was observed in the extended position as the aircraft crossed over the runway threshold but was found in the retract position in the wreckage area. The average landing gear retraction time for the Britannia is 8½ sec. Thus, using a target threshold speed of 115 kt. it would require



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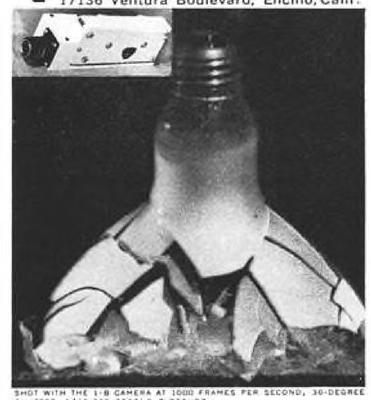
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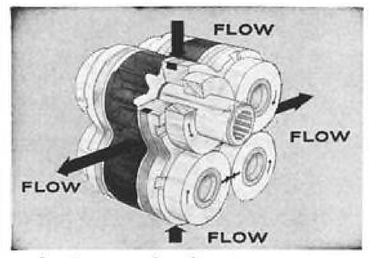
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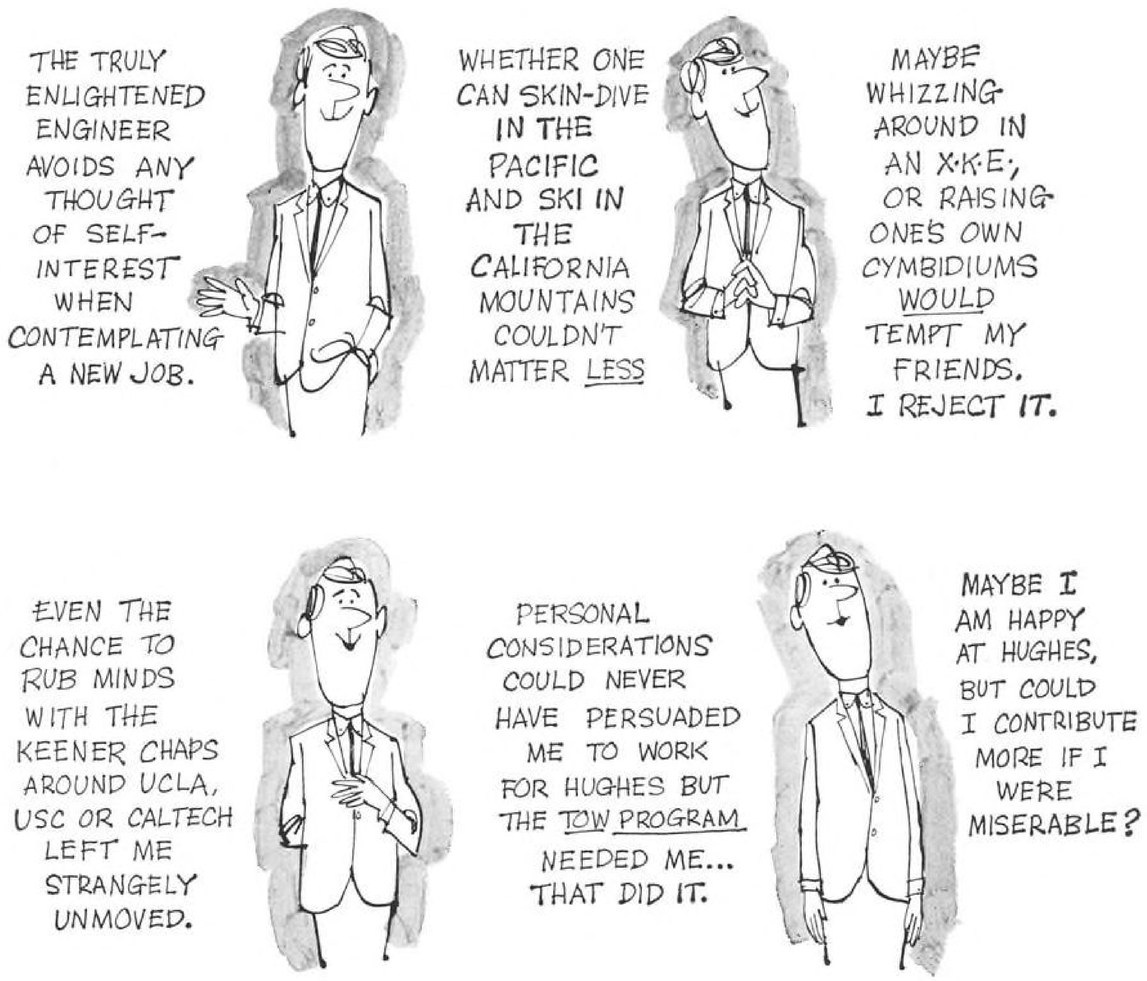
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8 sec. to cover the distance of 1,600 ft. from the go-around initiation point to the general wreckage area. The minimum threshold speed of 115 kt. used in this computation is undoubtedly high considering that the pilot had most likely reduced power below that necessary for approach and was in the process of flaring the aircraft prior to initiating the go-around. However, it does sustain the conclusion that the landing gear retract position had been selected at the initiation of the go-around and that sufficient time was available to attain retraction prior to impact.

Go-Around Attempt

The Board is unable to determine the reason why a go-around would have been attempted at so late a stage in the approach and with the aircraft still in the full landing configuration. There was no evidence to indicate a go-around was required in order to avoid any obstacles, vehicles or pedestrians that may have been on the runway.

The possibility of a fuel imbalance condition resulting from a fuel jettison system malfunction was presented by one of the parties to the investigation for consideration by the Board. It was theorized that a fuel jettison valve on the right wing did not close following the fuel jettisoning operation resulting in an asymmetrical fuel loading condition. It was stated that this condition presented a control problem at flareout which necessitated a go-around. The Board thoroughly reviewed this report and has concluded that the effects of fuel imbalance resulting from the described system failure would not have resulted in the sequence of events that were evidenced in the investigation of this accident.

Statements of surviving passengers recalled the application of engine power prior to the bank to the left. This implies that power was not applied because of an uncontrollable left-wing down condition, but rather that power application caused this condition.

Ground Evidence

Additionally, ground evidence indicated that the abrupt deviation of CF-CZB from the runway was accompanied by a shallow bank angle, indicating a predominance of yaw without the influence of an asymmetrical wing loading condition.

The slight bank angle which was present at impact would be that which was induced by the yaw.

These facts, along with other evidence detailed in this report, offer no substantiation to a fuel imbalance problem relative to this accident.

The remaining most obvious and compelling reason for a go-around under the pre-described circumstances would be the receipt of an unsafe landing gear warning horn and/or light in the cockpit when the throttles were retarded. However, there was no physical evidence found to substantiate this possibility.

The investigation revealed no evidence of an actual fire in the No. 1 engine, nor was there any indication of power failure, or operational distress.

Furthermore, there was no evidence to indicate that any fire extinguishing agent had been discharged.

It was determined that engines Nos. 2, 3, and 4 were developing takeoff power at



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INTERNATIONAL AIR TRANSPORT ISSUE October 7, 1963

To meet the information challenge created by the international character of aviation, AVIATION WEEK & SPACE TECHNOLOGY publishes each year an issue devoted to international air transport progress. This issue is received with such enthusiastic response that it will again be greatly expanded to provide the most comprehensive analysis and forecast of the air transport industry and its technical developments.

Publishing date is October 7, 1963, timed to coincide with the annual general meeting of the International Air Transport Association (IATA) in Rome. Copies of the issue will be flown to Rome for distribution at the opening plenary session to airline presidents, IATA delegates and other world aviation leaders.

Issue theme will be the current problems in international air transport including bilateral agreements; rates and tariffs; flight equipment; passenger, mail and cargo traffic; air traffic control; the capacity issue; exchange of international routes. Other subjects essential to a full analysis of the airline industry world will be stressed including trends in supersonic transport development; military transport operation; survey of Russian and Communist Bloc airline activity; impact of U.S. international transport policy on world political and industrial relations.

Feature treatment will be given to trends and projected future prospects for traffic growth and development of flight equipment in all major world markets. North and South America, Atlantic, Pacific, Europe, Africa, Middle and Far East. Amply illustrated, it will also contain specially prepared charts and graphs to show growth and forecast trends.

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impact. Additionally, it was ascertained that a takeoff propeller speed of 1,000 r.p.m. had been selected and attained on all operating propellers prior to impact.

The most reliable blade-angle evidence, from an accuracy tolerance standpoint, was obtained from the No. 3 propeller which was at an angle of 25 deg. Subsequent analysis indicated that the Nos. 2 and 4 propellers actually were in consonance with No. 3 at blade angles of 25 deg.

From the appropriate propeller performance curve it was determined that a 1,000 r.p.m. and 25-deg. blade angle combination would have absorbed the engine takeoff power at a true airspeed of 90 kt. This aircraft speed is considered valid in view of the operational conditions at impact.

Information was obtained from the Bristol Aeroplane Co. through the British Air Registration Board concerning the minimum control speed at landing (V_{mcl}) for Britannia aircraft. This information was based on an aircraft gross weight of 130,000 lb., a temperature of 50F, flaps at 45 deg., landing gear extended, and a threshold speed of 115 kt. indicated airspeed. It was found that, under the above conditions, and with an outboard engine shut down and its propeller feathered, a climb gradient of only 0.51% or approximately ½ of 1 deg., could be attained after maximum takeoff power has been applied to the operating engines. The report stated that at airspeeds below 100 kt. (V_{mcl}), and under the same conditions, it is highly improbable that directional control could be maintained. According to the factory data, Britannia aircraft operating under similar conditions should be capable of maintaining directional control and positive acceleration on three engines if a go-around is attempted at an airspeed in excess of 100 kt.

Subsequent to the accident a flight test was performed by CPA regarding the go-around performance and characteristics of the Britannia in the full landing configuration with the No. 1 engine inoperative and its propeller feathered. The test was carried out at 5,000 ft. m.s.l. with the aircraft's weight at approximately 130,000 lb. A simulated final approach was performed using a threshold speed of 112 kt. Under these conditions, a go-around was attempted without raising the flaps from the 45-deg. position. Maximum power and gear up were selected while holding the airspeed at 112 kt. Corrective action for the loss of directional control was attempted by the use of rudder and aileron, but a slow left turn developed and a loss of 120 ft. was noted. Any attempt to increase aileron and reduce rudder to cut down the rudder drag effect resulted in a loss of airspeed. When the flaps were reduced to 30 deg. the aircraft climbed out under full control. However, a loss of about 40 ft. of altitude was noted during flap retraction.

The test flight did not exactly duplicate the conditions under which CF-CZB was operating, in that it was conducted at 5,000 ft. m.s.l., rather than sea level, without the added help of ground effect and visual reference.

From all the evidence available, the Board concludes that a go-around was attempted shortly after the aircraft had crossed the runway threshold and while it was still in a full landing configuration. The abruptness of the aircraft's veering from the

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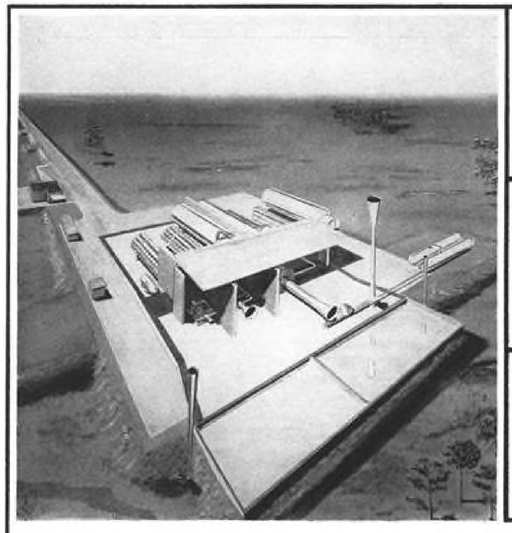
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runway, in conjunction with the evidence of a shallow angle of bank at impact, confines the responsible factors necessary for this maneuver to those which would produce a condition of asymmetry about its vertical axis. It can be assumed that an airspeed of 115 kt. (target threshold speed) or above was maintained until the aircraft crossed over the threshold. From this point and until the go-around was initiated, engine power was reduced and the aircraft was flared in preparation for landing, thus decreasing the airspeed to or below V_{mc1}. Because the aircraft was operating at a speed below V_{mc1}, it could not have responded to the application of primary flight control so as to accomplish the described maneuver. The existence of a split-flap condition was ruled out by the position of the flap jackscrews which evidenced a symmetrical full-down flap configuration. However, an asymmetric thrust condition could have produced the necessary yawing moment the maneuver required. The Board believes that this condition was developed by the sudden application of takeoff power on the three operating engines.

Probable Cause

The Board determines that the probable cause of this accident was the attempted three-engine go-around, when the aircraft was in a full landing configuration, at insufficient airspeed and altitude to maintain control.

By The Civil Aeronautics Board:
ALAN S. BOYD, Chairman
ROBERT T. MURPHY, Vice Chairman
CHAN GURNEY, Member
G. JOSEPH MINETTI, Member
WHITNEY GILLILLAND, Member

SUPPLEMENTAL DATA

Investigation

The Civil Aeronautics Board was notified of this accident at 0102 on July 23, 1962. Board investigators were immediately dispatched to the scene and an investigation was initiated and conducted in accordance with the provisions of the Convention on International Civil Aviation dated Dec. 7, 1944, and the provisions of Title VII of the Federal Aviation Act of 1958, as amended.

Air Carrier

Canadian Pacific Air Lines Ltd. holds an Air Transport Board license and a valid operating certificate issued by the Canadian Department of Transport. The carrier also holds a permit issued by the Civil Aeronautics Board to engage in foreign air transportation between a terminal point or points in Canada, the intermediate points Honolulu, Hawaii, Canton Island and Fiji, and co-terminal points in Australia and New Zealand.

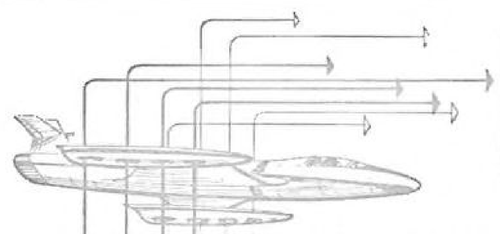
Flight Personnel

Captain Welland T. Jennings, age 45, held a valid Canadian airline transport certificate, No. 428, with a Britannia aircraft endorsement which was dated May 25, 1962. His medical certificate was renewed on Feb. 9, 1962, with no waivers and his last proficiency check was conducted on Feb. 9, 1962. Captain Jennings had a total of 13,250 flying hr. of which 920 hr. were in Britannia aircraft. In addition to his training flights, he had, as captain, performed two prior three-engine landings in the Britannia under actual conditions.

Captain Alfred A. Giguere, age 44, the check captain on this flight, held a valid Canadian airline transport certificate, No. 550, with a Britannia aircraft endorsement which was dated Apr. 7, 1960. His medical certificate was renewed on May 17, 1962, with no waivers and his last proficiency check was conducted on June 21, 1962. Captain Giguere had a total of 16,073 flying hr. of which 1,628 hr. were in Britannia aircraft. He had signed the flight clearance for this flight inasmuch as this was Captain Jennings first check over this route on Britannia aircraft. This was in accordance with company procedures.

First Officer Charles J. Norton, age 33, held a valid commercial pilot certificate, No. 6140, with Britannia aircraft endorsement which was dated Apr. 18, 1960. His medical certificate was renewed on June 25, 1962, with no waivers and his last proficiency check was satisfactorily conducted on Apr. 5, 1962. First Officer Norton had a total of 5,688 flying hr., of which 1,527 hr. were in Britannia aircraft. In addition to his training flights, he had, as first officer, made five prior three-engine landings under actual conditions.

First Officer Donald A. Aldred, age 30, on a familiarization training flight, held a valid Canadian airline transport certificate, No. XDA 785, with a Britannia aircraft endorsement which was dated May 7, 1962. His medical certificate was renewed on Apr.



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2, 1962, with no waivers and has last proficiency check was conducted on Apr. 11, 1962.

First Officer Eldred had a total of 5,724 flying hr., of which 1,506 hr. were in Britannia aircraft.

Second Officer Gerald E. Farr, age 28, held a valid airline transport rating, No. VFA 830, with a Britannia aircraft endorsement which was dated Apr. 25, 1960. His medical certificate was renewed on May 28, 1962, with no waivers. Second Officer Farr had a total of 4,234 hr., of which 956 hr. were in Britannia aircraft.

Navigator Roy D. McLennan, age 34, held a valid Canadian flight navigator certificate, No. 83, dated Dec. 5, 1956. His medical certificate was renewed on Mar. 14, 1962, with no waivers and his annual flight check was satisfactorily conducted on Apr. 1, 1962.

Navigator Ronald G. Hill, age 35, held a valid Canadian flight navigator certificate, No. 64. His medical certificate was renewed on June 14, 1962, with no waivers and his annual flight check was satisfactorily conducted on Nov. 14, 1961.

Purser Harry Soukop[6], age 36, was qualified as a purser on May 8, 1956, and his last Britannia emergency examination was passed on Oct. 17, 1961. His medical certificate was renewed on Apr. 24, 1962, with no waivers.

Stewardess Andrea L. Johnston[6], age 28, was qualified as a stewardess on Nov. 17, 1958, and her last Britannia emergency examination was passed on Mar. 30, 1962. Her medical certificate was renewed on June 28, 1961, with no waivers.

Stewardess Ursula C. Huebner[6], age 25, was qualified as a stewardess on Jan. 16, 1958, and her last Britannia emergency examination was passed on Oct. 31, 1961. Her medical certificate was renewed on Apr. 19, 1961, with no waivers.

Stewardess Nancy Chalmers[6], age 29, was qualified as a stewardess on Apr. 1, 1958, and her last Britannia emergency examination was passed on Oct. 24, 1961. Her medical certificate was renewed on May 3, 1961, with no waivers.

The entire crew received 34:30 hr. rest prior to this flight.

The Aircraft

The aircraft was a Bristol Britannia, model 314, Canadian Registry CF-CZB, owned and operated by Canadian Pacific Air Lines as aircraft No. 522. It was manufactured on May 1, 1958, serial No. 13394. The total time on the airframe was 9289:52 hr.

The aircraft was equipped with Bristol Proteus 765 engines and DeHavilland propellers. No. 1 engine had a total time of approximately 6,685 hr., 1,105 hr. since overhaul; No. 2—approximately 6,515 hr., 1,560 hr. since overhaul; No. 3—approximately 5,866 hr., 912 hr. since overhaul; No. 4—approximately 6,930 hr., 1,130 hr. since overhaul.

The flight times on the propellers were as follows: No. 1 had a total time of approximately 7,894 hr., 1,498 hr. since overhaul; No. 2—7,759 hr., 2,856 hr. since overhaul; No. 3—approximately 1,498 hr. since installation; and No. 4—a total of approximately 6,843 hr., 1,497 hr. since overhaul.

[6]Denotes surviving crew members.

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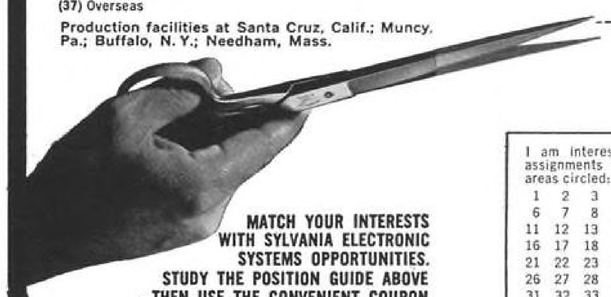
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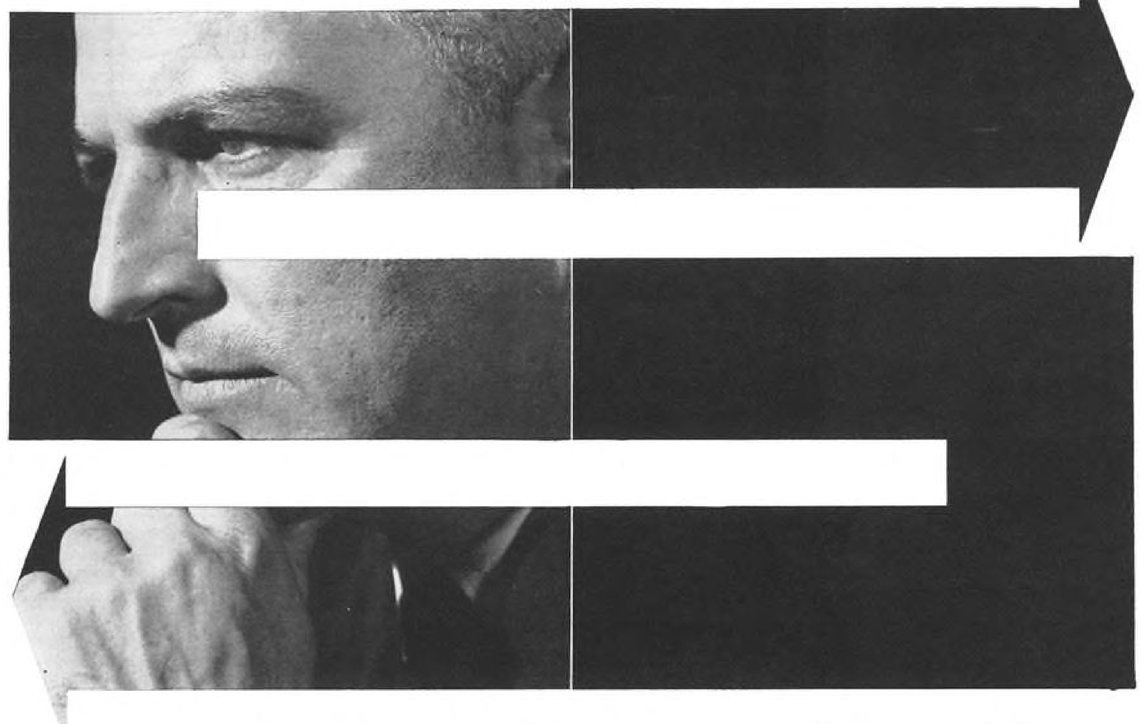
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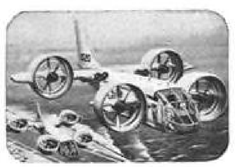
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LETTERS

Cooper Corner

In relation to the heated and sometimes improbable arguments presented in Letters to the Editor of Aviation Week about Major Cooper's sightings, I'd like to cite a few facts which might help to clarify the issue.

For any optical instrument, the eye included, the ability to resolve small objects has a limit set by the wavelength of light. Objects smaller than this limit (which for a telescope depends on the diameter of the objective lens) will not be invisible; however, the size and shape in which they appear bear little relation to those of the object itself and are instead characteristic of the optical system. As an example, stars are visible to the naked eye even when they are well beyond the resolving power of the best telescopes. Through a good telescope, such a star will appear as a circular patch surrounded by faint concentric circles; this is its diffraction image and bears no relation to what the star actually looks like (e.g. it may be an unresolved double star).

An astronaut in orbit may thus see objects below his eyes' resolving power if they have sufficient contrast with their surroundings (otherwise the diffraction image, which as a rule is larger than the object itself, will tend to merge with its background). He will not be able to make out details, such as whether the object seen is a lone building or a cluster of houses forming a monastery or village (as suggested by Dr. O'Keefe of NASA). However, using other clues (e.g. color) he may very well guess correctly that it is a human dwelling.

Incidentally, the accuracy of the best astronomical observations made before the invention of the telescope is 4 min. of arc, which is about twice the theoretical resolving power of the human eye (see article on Tycho Brahe in the February, 1961, issue of the Scientific American).

I hope this settles that.

(Name withheld by request.)

MARYLAND SCIENTIST

This is an effort to clear up the misunderstandings reflected in the arguments, some objective—others emotional, over the sightings reported by Maj. Cooper from MA-9. Unquestionably, the greatest misunderstanding is over the distinction between that which is "detected" and that which is truly "resolved" by the unaided human eye. Conventionally, we might speak in terms of seconds of arc, but it will be useful to include the linear dimensions at a distance of 100 mi.

The resolution limit of the human eye is approximately 90 sec. (230 ft.). Essentially this means that the eye cannot see individually two objects separated by less than this limit, nor ascertain the shape or identity of an object whose distinguishing features are smaller than the resolution limit. To merely detect the existence of an object is another matter. The contrast threshold of the eye, under ideal conditions, is approximately 2%. Therefore, a black line seen against an illuminated background could be detected with a width as small as 2 sec. (5 ft.), as is noted in the "telephone wire effect." A circular black spot can be as small as 13 sec. (33 ft.) and still be detected by a critical eye. In detecting a bright object against a dark background there is no limit, providing the object is bright enough. The largest stars visible to the unaided eye are 0.05 sec. in diameter (or the equivalent of 1½ in. at 100 mi.) and most stars are considerably smaller. In viewing bright objects on the earth from space, there is, of course, an upper limit in the brightness differences that might be expected. If, however, we assume that the wake of a boat might be as much as 15 times brighter than the surrounding water, then the wake could be detected by a well-trained eye if the bright trails making up the wedge were as wide as 15 ft.

It would seem quite probable that Maj. Cooper did see some or perhaps all of the small objects which he has reported. However, his identification of objects having characteristic dimensions of less than 200 ft. must be considered to be a product of experience, deduction, and logic. Thus a pattern of dark spots associated with a smoke-haze would most logically be assumed to be a village with individual houses, a moving dark line with a bright streak running out from one end would probably be interpreted to be a train with smoke, etc. It is most important to realize that Maj. Cooper's identification of such small objects is possible because of his considerable experience in observing familiar objects at lower altitudes, and his intelligent interpretation from orbital altitudes. It would be a mistake to assume that a future astronaut, circling a strange planet, would be equally successful. In general, I believe that the lens effect of the atmosphere has negligible advantage, and that it is unnecessary to invent this or other special "space effects" to explain Maj. Cooper's sightings.

BRADFORD A. SMITH
Associate Astronomer
New Mexico State University
Research Center
Las Cruces, N. M.

Several recent letters have questioned the ability of the astronauts to see small structures such as a truck or boat from orbit because of the limited resolving power of the human eye.

While not claiming to know all pertinent facts, I would like to point out that isolated objects smaller than the resolving power of the human eye may be observed if the contrast is sufficiently great. For example, the luminous disk of a visible star is far smaller than the resolving power of the eye but is visible at night because of its light intensity. In such cases, the eye does not resolve the object but observes that the total light received from one small area is greater or less than that from surrounding small areas.

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

More on 'V'

Re: "V for Vexatious" (AW July 8, p. 21) and Dan Berke's Letter to the Editor (AW July 29, p. 64).

The "V" in VAX stands for **heavier than air** as contrasted with "Z" in **ZAX** for **lighter than air.**

If "V" stood for fixed wing, as Mr. Berke's letter suggests, then Chance-Vought Crusader squadrons with their movable wings would be known as HF ("H" for helicopter, "F" for fighter) rather than VF squadrons.

However, if Crusader squadrons were redesignated thus, I am quite sure that helicopter pilots would be delighted at their discomfiture (they are a stuffy lot). Mr. Berke has my vote.

(Name withheld by request.)

NAVY HELICOPTER PILOT No. 5359

Re: "V for Vexatious" (AW July 8, p. 21).

Now that the new aircraft designations are in everyday use and the study period of learning and making the transition is over (I think), we have diligently researched the V, X, Y and Zs of an old tried and true system. I am almost sure that anyone involved in the trade first learns the V, X, Y and Zs of aviation by building model kits. (Incidentally, the kits I speak of were scale construction all the way and not preformed plastic without body, blood, sweat and tears, which did much to teach airframe structural methods, etc.)

Back to prefix letters and the meaning:

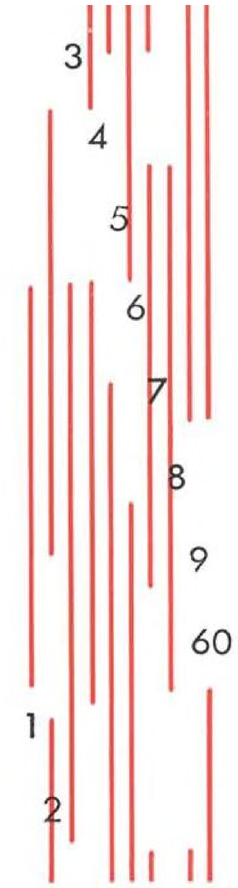
V—Heavier-Than-Air (Fixed Wing)
X—Experimental
Y—Prototype or Evaluation
Z—Lighter-Than-Air
H—Heavier-Than-Air (Rotary Wing)

One answer to how come the letters may be:

H—Helicopter
Z—Zeppelin
Y—Unknown math quantity
X—Unknown math quantity
V—Volant

A check in most any dictionary will give a definition of "volant"; maybe this is the basic word we are looking for?

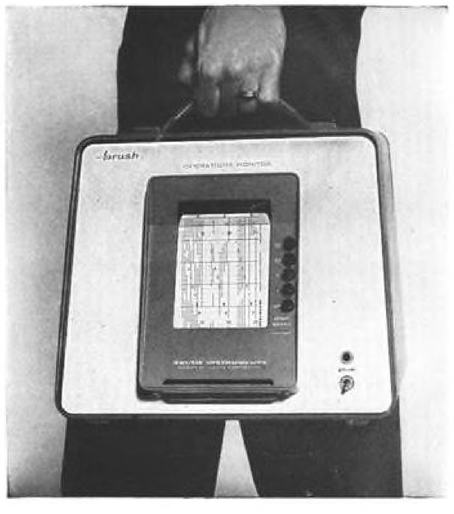
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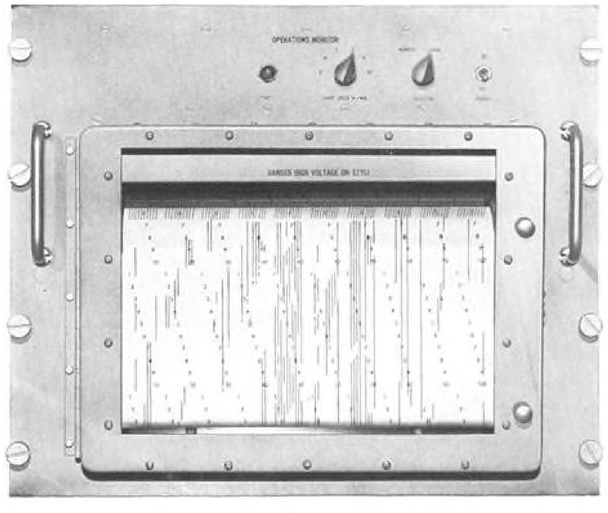


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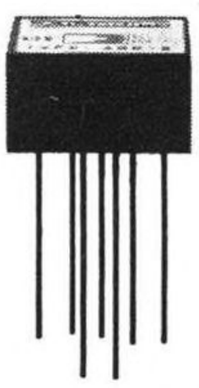




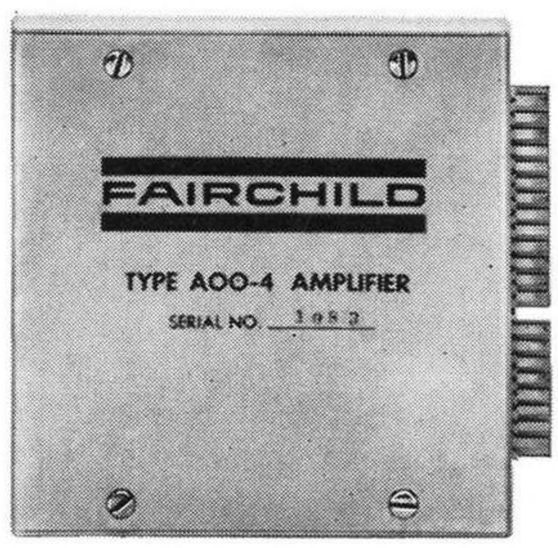
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