Aviation Week & Space Technology

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September 24, 1962

SPECIAL REPORT:

- Infrared Sensors In Space

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AEROSPACE CALENDAR

Oct. 1-3—Seventh Annual Exposition & Symposium, Air Traffic Control Assn., Flamingo Hotel, Las Vegas, Nev.

Oct. 1-3—National Communications Symposium, Institute of Radio Engineers, Hotel Utica, Utica, N. Y.

Oct. 1-5—Northeast Commerce and Industry Exposition, Commonwealth Armory, Boston, Mass.

Oct. 2—15th Annual New York State Aviation Conference, Mark Twain Hotel, Elmira, N. Y.

Oct. 2-4—Symposium on Physics and Nondestructive Testing, Granada Hotel, San Antonio, Tex. Arranged by Southwest Research Institute.

Oct. 2-4—Third Symposium on Advanced Propulsion Concepts, Cincinnati, Ohio. Co-sponsors: AFOSR, General Electric.

Oct. 2-4—National Symposium on Space Electronics and Telemetry, Institute of Radio Engineers, Fontainebleau Hotel, Miami Beach, Fla.

Oct. 2-4—15th Annual Meeting and Convention, National Business Aircraft Assn., Penn-Sheraton Hotel, Pittsburgh, Pa.

Oct. 6—14th Annual Reunion, U. S. Naval Test Pilot School Alumni, U. S. Naval Air Station, Patuxent River, Md.

Oct. 7-9—International Northwest Aviation Council Meeting, Idaho Falls, Idaho.

Oct. 8-10—18th Annual National Electronics Conference & Exhibition, McCormick Place, Chicago, Ill.

Oct. 8-12—National Aeronautic & Space Engineering & Manufacturing Meeting &

(Continued on page 7)

AVIATION WEEK and Space Technology

September 24, 1962

Vol. 77, No. 13

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AEROSPACE CALENDAR

(*Continued from page 5*)

Display, Society of Automotive Engineers, The Ambassador, Los Angeles, Calif.

Oct. 9-11—National Airports Conference, American Assn. of Airport Executives, University of Oklahoma, Norman, Okla.

Oct. 10-12—Ions in Flames & Rocket Exhausts Conference, American Rocket Society, Palm Springs, Calif.

Oct. 10-12—20th Annual Aerospace Electronics Exposition/Report, Aerospace Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif.

Oct. 12-13—Symposium on Photography of Electronic Display, Shoreham Hotel, Washington, D.C. Sponsors: Society of Photographic Scientists & Engineers, National Bureau of Standards.

Oct. 15-17—Fall Meeting, International Scientific Radio Union & Institute of Radio Engineers, Ottawa, Canada.

Oct. 15-17—ASW Meeting, Somerset Hotel, Boston, Mass. Sponsors: IAS; U. S. Navy. (Classified Secret)

Oct. 15-18—International Symposium on Space Phenomena and Measurement, Statler-Hilton, Detroit, Mich. Ninth Annual Meeting: Institute of Radio Engineers, co-sponsored by NASA and AEC.

Oct. 15-18—17th Annual Instrument-Automation Conference & Exhibit, Instrument Society of America, Coliseum and Hotel New Yorker, New York, N. Y.

Oct. 16-17—Symposium on Inertial Guidance Test, Holloman AFB, N. M. Sponsor: Air Force Missile Development Center.

Oct. 18-19—Second National Conference on Planning & Designing Urban Helicopter Facilities. Institute of Aerospace Sciences Bldg., Los Angeles, Calif. Sponsor: Los Angeles Chamber of Commerce.

Oct. 18-19—Sixth Annual Display, Aerospace Electrical Society, San Diego, Calif.

Oct. 22-23—Joint Meeting, Canadian Aeronautical Institute—Institute of the Aerospace Sciences, King Edward Sheraton Hotel, Toronto, Canada.

Oct. 22-24—East Coast Conference on Aerospace and Navigational Electronics, Institute of Radio Engineers, Emerson Hotel, Baltimore, Md.

Oct. 24-26—Annual Meeting & Exposition, Society for Experimental Stress Analysis, Hotel Schroeder, Milwaukee, Wis.

Oct. 25-27—1962 Electron Devices Meeting, Institute of Radio Engineers, Sheraton Park Hotel, Washington, D.C.

Oct. 26-27—17th Midwest Quality Control Conference, American Society for Quality Control, Denver Hilton Hotel, Denver.

Oct. 29—Fourth Annual Western Technical Conference, American Institute of Electrical Engineers, Biltmore Hotel, Los Angeles, Calif.

Oct. 29-30—Aerospace Fluid Power Conference, Pick-Fort Shelby Hotel, Detroit, Mich. Sponsor: Aerospace Division, Vickers, Inc.

Oct. 29-30—Meeting on Large Rockets, Institute of the Aerospace Sciences, El Dorado Inn, Sacramento, Calif.

Oct. 29-31—Symposium on Dynamics of Manned Lifting Planetary Entry, Philadelphia, Pa. Attendance limited; for in-

(*Continued on page 9*)

AEROSPACE CALENDAR

(*Continued from page 7*)

formation: Sinclaire M. Scala, General Chairman, Room M7023A, General Electric Co., MSVD, Valley Forge Space Technology Center, Box 8555, Philadelphia 1, Pa. Co-sponsor: AFOSR.

Oct. 29-Nov. 2—World Metal Show & National Metal Congress, American Society for Metals, Coliseum and Hotel Biltmore, New York, N. Y.

Oct. 29-Nov. 2—International Symposium, "Basic Environmental Problems of Man in Space." UNESCO House, Paris, France. Sponsors: International Astronautical Federation; International Academy of Astronautics.

Oct. 30—Supersonic Commercial Transport Metals Symposium, Metallurgical Society, Statler-Hilton Hotel, New York, N. Y.

Oct. 30-31—National Conference on Spaceborne Computer Engineering, IRE, Disneyland Hotel, Anaheim, Calif.

Oct. 30-Nov. 1—Eighth Tri-Service Conference, Armour Research Foundation, Chicago, Ill. Sponsors: U. S. Army, Navy and Air Force.

Nov. 1-2—Sixth National Conference, Product Engineering and Production, Institute of Radio Engineers, Jack Tar Hotel, San Francisco, Calif.

Nov. 2-3—Advanced Technology Symposium, New Mexico Section/American Society of Mechanical Engineers, University of New Mexico, Albuquerque, N. M., in cooperation with AFSWC-Kirtland AFB.

Nov. 4-7—14th Annual Conference on Engineering in Biology and Medicine, Conrad Hilton Hotel, Chicago, Ill. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; Instrument Society of America.

Nov. 5-7—Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn. Co-sponsors: Oak Ridge National Laboratory; NASA Manned Spacecraft Center; American Nuclear Society.

Nov. 5-7—Northeast Electronics Research and Engineering Meeting, Institute of Radio Engineers, Commonwealth Armory & Somerset Hotel, Boston, Mass.

Nov. 5-16—16th Air Transport Management Institute, School of Business Administration, The American University, Washington, D. C.

Nov. 7-8—Symposium on Lasers and Applications, Antenna Laboratory, Department of Electrical Engineering, Ohio State University, Columbus, Ohio.

Nov. 7-9—International Air Cargo Forum, Dinkler-Plaza Hotel, Atlanta, Ga. Sponsors: Institute of the Aerospace Sciences; Society of Automotive Engineers.

Nov. 12—Wings Club Annual Dinner, Americana Hotel, New York, N. Y.

Nov. 13-14—Retardation and Recovery Symposium, Imperial Motel, Dayton, Ohio. Sponsor: Aeronautical Systems Division's Flight Accessories Laboratory.

Nov. 13-18—17th Annual Meeting and Space Flight Exposition, American Rocket Society, Pan Pacific Auditorium, Los Angeles, Calif.

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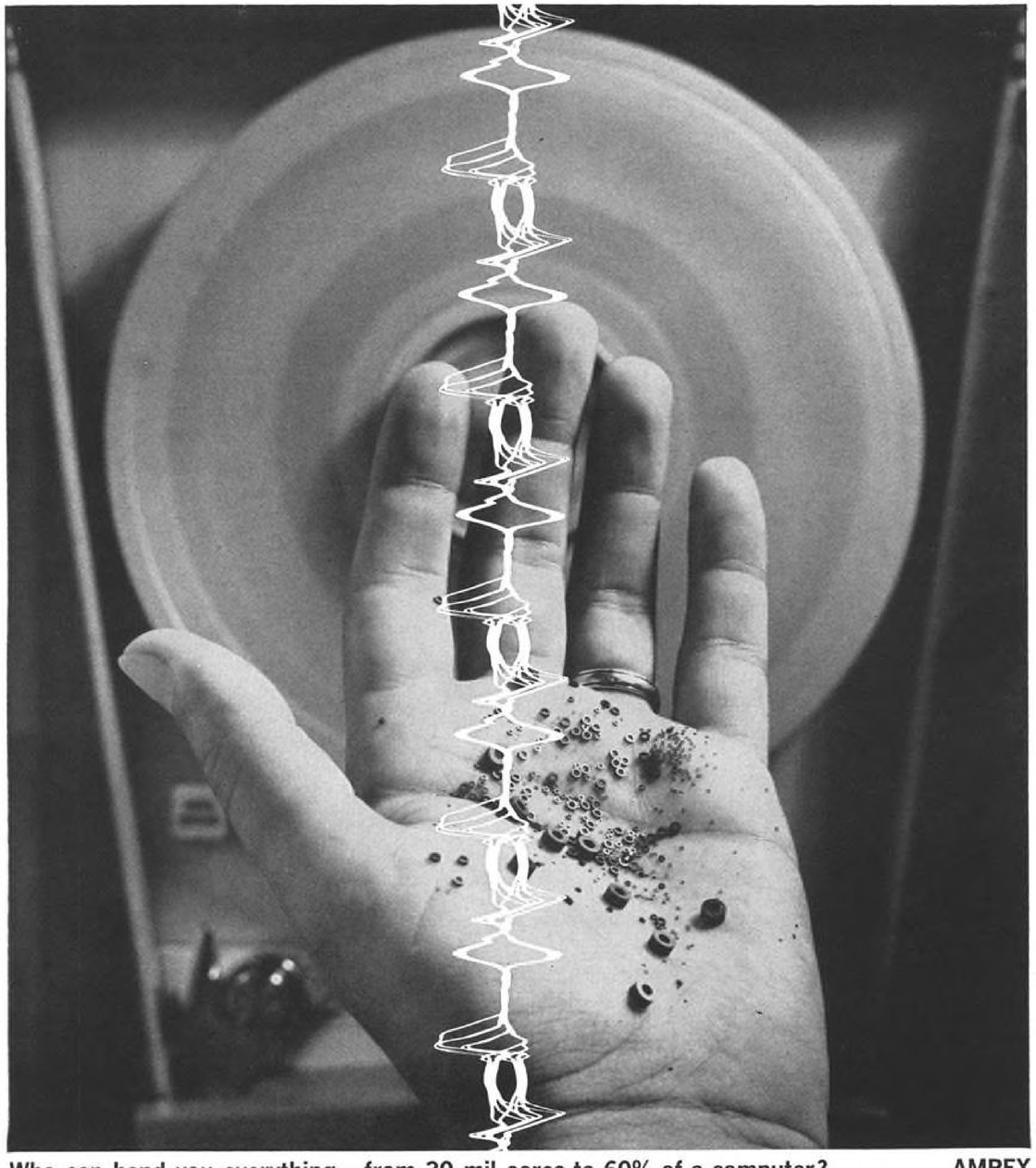

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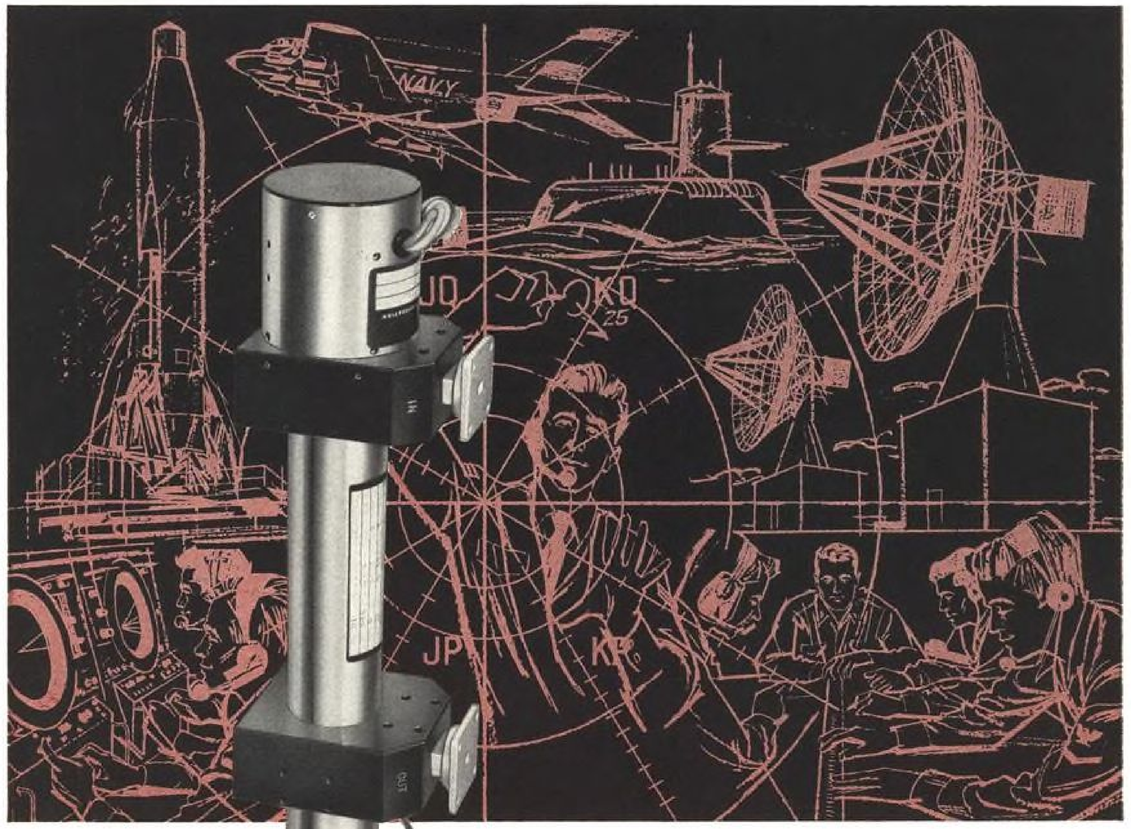

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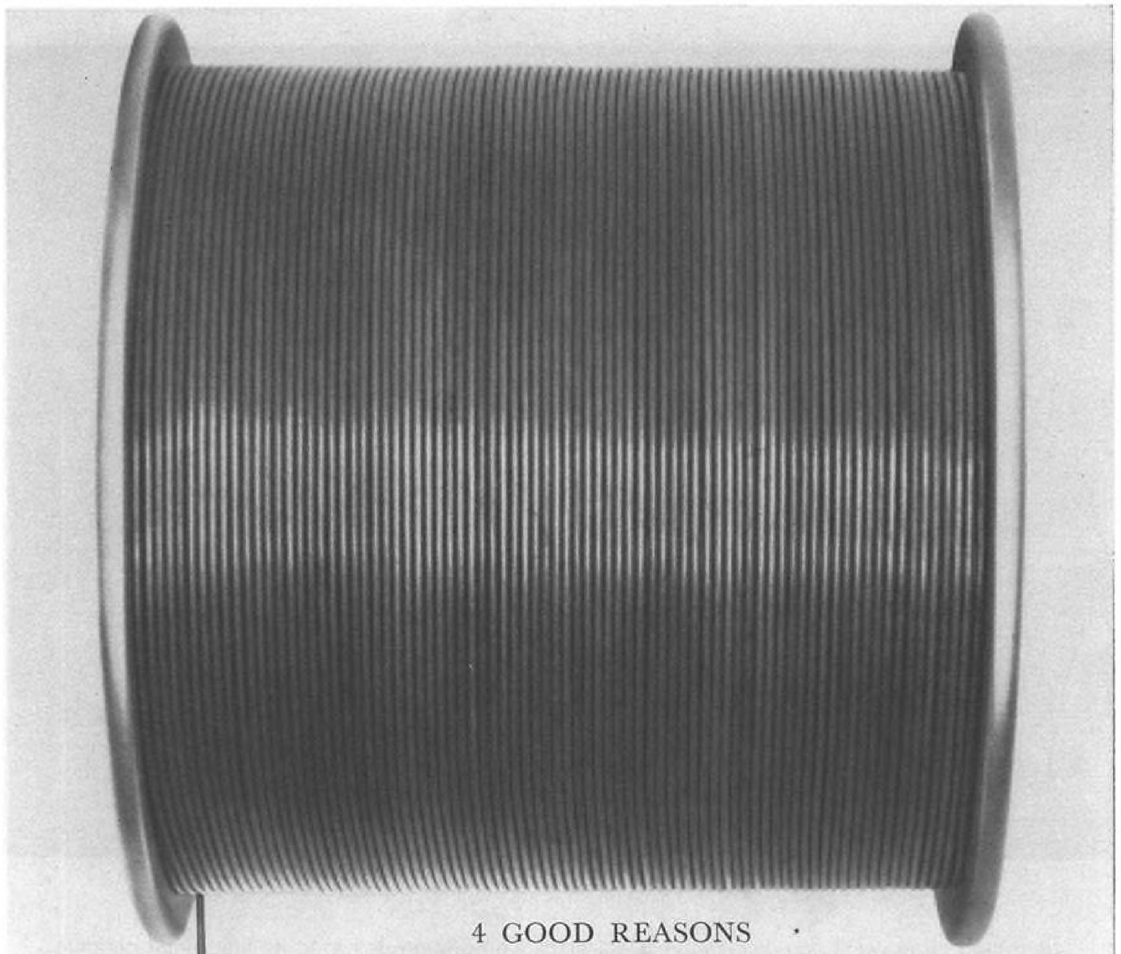

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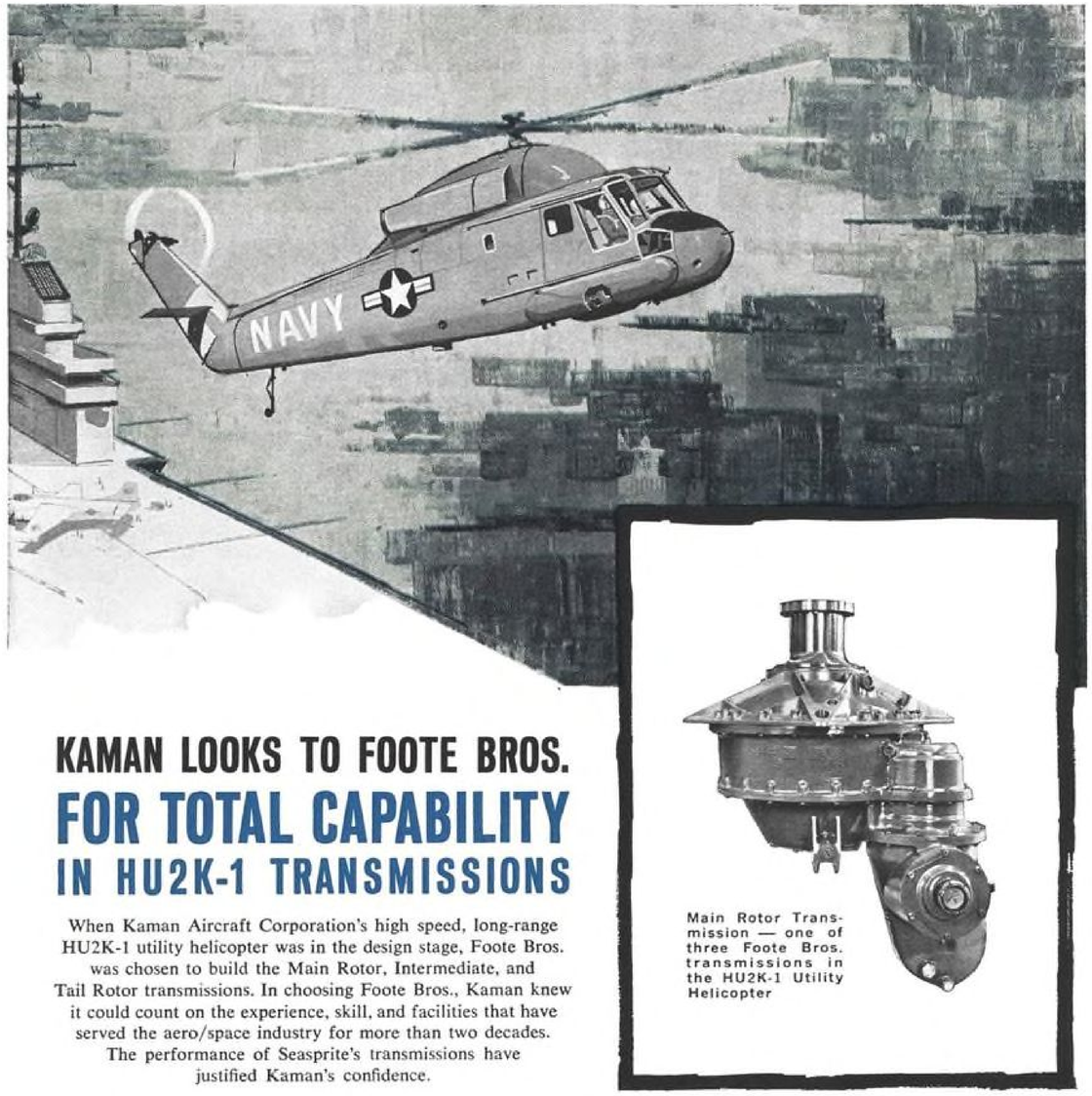

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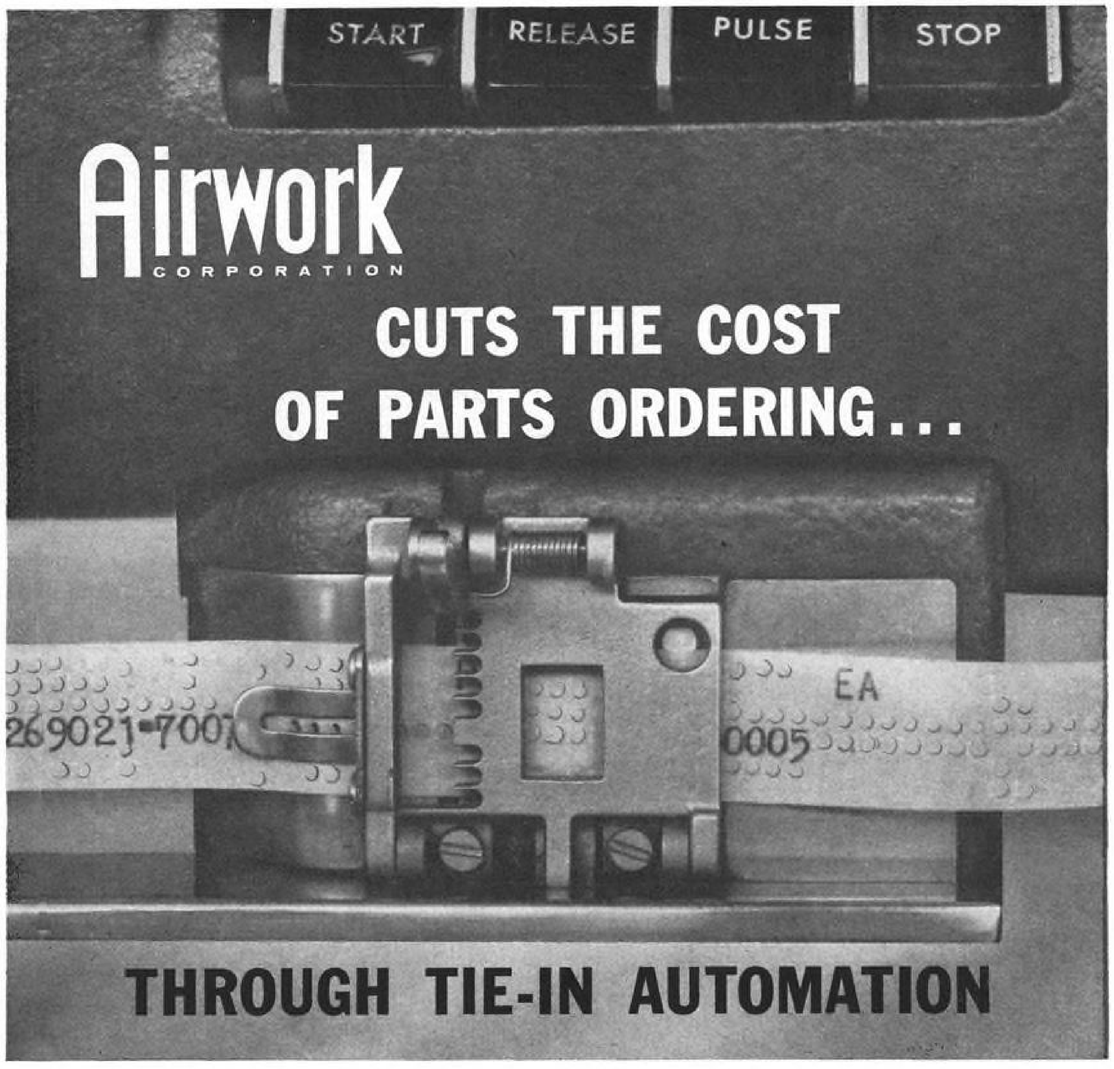

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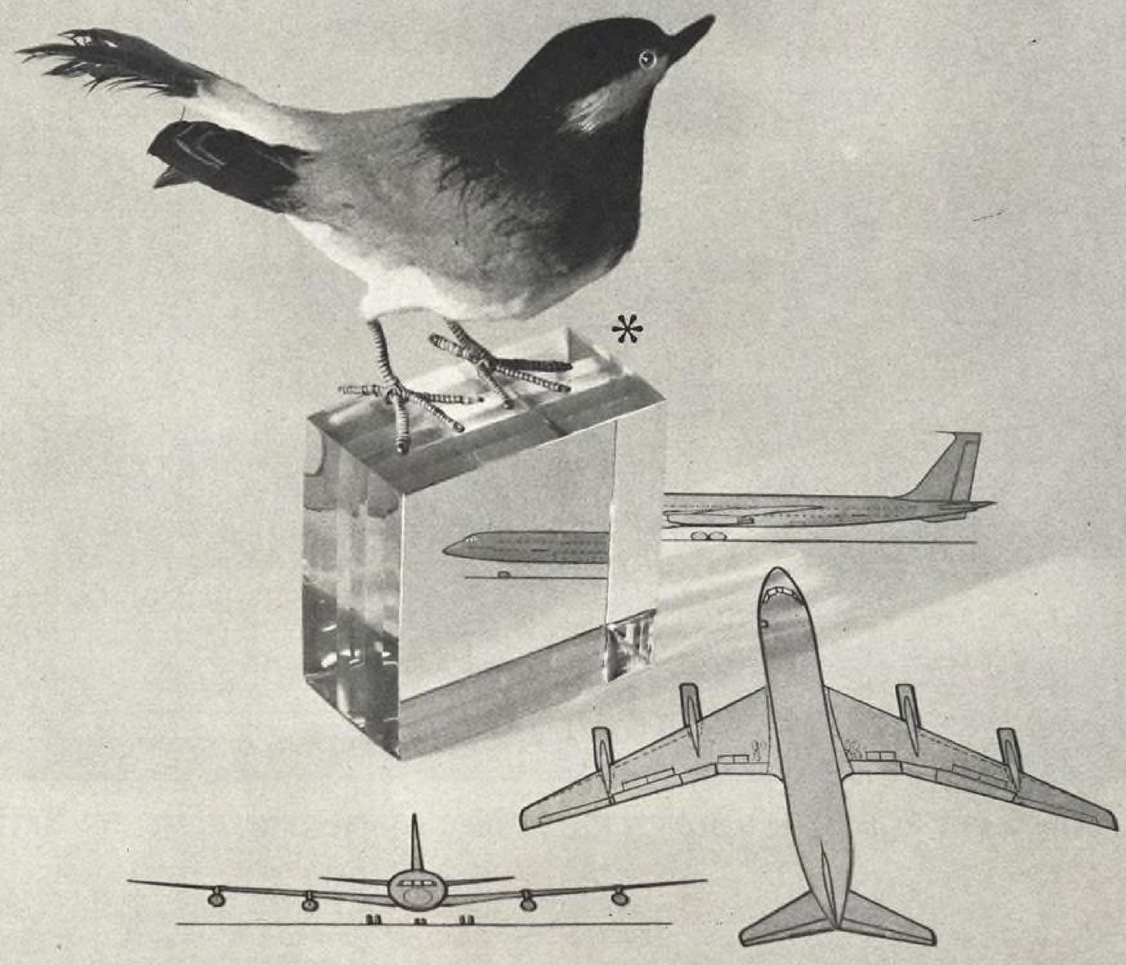

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COVER: First production model of the de Havilland DH-125 is currently flying in Britain. Aircraft has increased wingspan and larger tail surfaces than the prototype. Fuselage will be lengthened beginning with the No. 3 aircraft. Two aircraft have been sold to commercial buyers and the Royal Air Force has ordered 22. Company is considering increasing initial production batch of 30. More photos and details are on pp. 112-113.

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88,208 copies of this issue printed.

EDITORIAL

Space and National Security

(Dr. Edward C. Welsh, executive secretary of the National Aeronautics and Space Council, asked himself several tough questions concerning national space policy in a speech prepared for a panel meeting at the 16th annual Air Force Assn. convention in Las Vegas, Nev., last week (see p. 26). Aviation Week & Space Technology is publishing significant excerpts from his talk).

Question: Is there a space gap like the missile gap we heard so much about a short time ago?

Answer: First of all, I would point out that there was a missile gap, but it did not translate itself into the numbers previously predicted. Moreover, the threat of such a gap dissolved some of the lethargy in the U. S. and caused us to get busy and help upset the predictions. There is a space gap in the sense that the Soviets have larger rocket engines now operational and are able to place larger payloads into orbit. They have also made substantial strides in other aspects of space technology. Our leadership in satellite applications to weather, communications, and navigation is noteworthy, but it is not sufficient to fill in the gap in its most crucial aspects.

The numerical aspect of the gap is in size rather than in quantity of satellites as, in the latter, we have placed nearly four times as many into orbit as they have. A significant thing about the space gap is that it has military potential, as did the missile gap. Moreover, it is having some of the same effect on the U. S. as did the missile gap, namely, it is stimulating us to do more faster. When one is behind in any important aspect of a race, it is foolish and dangerous to pretend otherwise.

Space Defense Budget

Question: What are we spending on space for defense purposes and why are we not doing more?

Answer: The portion of the defense budget attributed to space for Fiscal 1963 is one and one-half billion dollars. That is less than 3% of our total defense budget, but if properly applied it can get a lot of space accomplishment. It is often cited that the defense space budget is relatively small when compared with NASA's budget of $3.8 billion, but the difference is primarily due to the one large mission, that is, the lunar project, which involves so much in facilities, development and performance.

In addition to giving consideration to more money for defense in space, serious attention needs to be given continuously to getting more space competence from each dollar in the budget.

There are several reasons why we are not devoting more to space spending by the Department of Defense: (1) Many in this country as well as abroad fail to understand that U. S. expenditures to keep the peace are as peaceful as any other expenditures; (2) Many civilians and military officials have wide divergences of views as to what the defense missions in space should be; (3) Defense advantages can and do come from space expenditures made by other agencies; and (4) Many still haven't learned the lesson that blueprints and studies alone cannot meet aggression.

I would add that we should not minimize what is being done by Defense in space, just as we should not be satisfied with the rate of accomplishment.

Question: Why is there confusion as to what the U. S. is doing in space?

Answer: First of all, there is a tendency on the part of those who think more should be done to play down what is being done in order to make their point. I would also add that there are those who hold the mistaken belief that classification and secrecy conceal our activities from potential enemies, while what really happens is the concealment of the facts from our own people. It is also worth noting that a U. S. failure in a space shot gets almost as much attention as a success, and would get even more attention if a fatality were involved. The Soviets have failures, but only their successes are advertised. I see no reason why, as general policy, we should not reveal the space failures of others as well as our own. I believe we could do a lot to clarify what we are doing, and I think we are competent to handle international issues should they arise from a frank and open policy on our part.

Anyone who is critical of our space projects is, of course, free to engage in similar endeavors if he so chooses and has the ability.

National Space Policy

Question: Do we have a national space policy, and if so, what is it?

Answer: Yes, we have such a policy. It has been expressed in legislation and in presidential messages and statements. The objective of our policy is to obtain and maintain leadership in space activities for the benefit of man's freedom, man's well-being, man's understanding, and man's scientific progress. The details of the policy are not quite so clear, as those who have studied our budgets and public documents have reason to know. It is clear, however, that our policy includes going to the moon during this decade. It includes developing an operational communications satellite system as well as navigation and meteorological systems on a world-wide basis. The specifics are less clear as to the roles of man in space and what can and should be done to maintain peace in outer space. This lack of clarity, however, is partly due to the difficulty of knowing what can be done and what cannot be done. Continuing efforts will be made to clarify policy, while keeping it necessarily flexible.

Question: Do the space accomplishments of the Soviets have military significance?

Answer: While I would not pretend to know what the Soviets will do with their growing space competence, I find several guidelines which are pertinent: (1) Never underestimate your opposition; (2) Never forget the Soviets' objective of world domination; (3) Do no minimize the military value of placing heavy objects in orbit and keeping men as well as devices in orbit for long periods; (4) Do not overlook the blackmail possibilities of weapons in space. The obvious conclusion is: a satellite does not have to contain a weapon to possess military significance. The Soviets' feats have indicated a space competence which has a direct bearing upon what is necessary to defend our country and to protect our own rights in space and on earth. . . .

We have better uses for our sand than to use it like the proverbial ostrich. The realities of the situation demand that we face the facts and meet fully the challenge that has been thrust upon us.

WHO'S WHERE

In the Front Office

H. Leslie Hoffman, board chairman, Hoffman Electronics Corp., Los Angeles, Calif. **Stanley W. Horrocks,** formerly executive vice president of North American Aviation's Autonetics Division, succeeds Mr. Hoffman as president and a director.

Dudley Swim, board chairman, National Airlines, Inc., succeeding **G. T. Baker,** who continues as a director.

C. C. Noah, acting president of Astropower, Inc., Costa Mesa, Calif., a subsidiary of Douglas Aircraft Co., succeeding **Y. C. Lee,** resigned.

John F. Aldridge, vice president-Model 122M aeroballistic missile concept, McDonnell Aircraft Corp., St. Louis, Mo., and **Robert E. Hage,** vice president-Advanced Product Planning. Also: **Charles M. Forsyth,** director of sales for North America; **John F. Sutherland,** director of Product Support, a new division; **C. Warren Drake,** vice president-Manufacturing and Support.

Dr. George E. Mueller, vice president for research and development, Space Technology Laboratories, Inc., Redondo Beach, Calif., a subsidiary of Thompson Ramo Wooldridge, Inc., and **Frederick W. Hesse, Jr.,** vice president for corporate operations.

Frank Sharpe, executive vice president in charge of the newly formed Sales and Services Department, Eastern Air Lines, Inc. Also: **H. Walton Cutshall,** vice president-sales and advertising; **Charles M. Moni,** vice president-customer services.

G. R. Jefferson, chief executive, Guided Weapons Division of English Electric Aviation, Ltd., a British Aircraft Corp. company, London, England.

Brig. Gen. Charles A. Heim (USAF, ret.), assistant to the president, Autonetics, a division of North American Aviation, Inc.

Dr. Lawrence Gould, executive vice president and general manager, Microwave Associates, Inc., Burlington, Mass.

Capt. Robert T. Tolleson, commanding officer, Navy Astronautics Group (NAG), Pt. Mugu, Calif., succeeding **Cdr. James C. Quillin, Jr.** Cdr. Quillin has been selected for promotion to rank of captain, and will remain with NAG until reassignment.

Honors and Elections

Dr. Charles F. Gell of Ling-Temco-Vought has been named the first president of the new Aerospace Industrial Life Sciences Assn., an affiliate of the Aerospace Medical Assn.

Changes

Dr. John R. Summerfield, corporate staff economist, Douglas Aircraft Co., Inc., Santa Monica, Calif. Also: **C. S. Glasgow,** chief engineer, Douglas Aircraft Division, Long Beach, Calif.

Dr. Seymour Lampert, manager, Advanced Systems Research, North American Aviation's Space and Information Systems Division, Downey, Calif.

Robert S. Erickson, director of engineering, Government Systems Division, Control Data Corp., Minneapolis, and **Arthur O. Hoistad,** director of manufacturing.

INDUSTRY OBSERVER

► Army Ordnance Missile Command is expected to select several contractors for three-month studies of its Hardsite program (AW Aug. 27, p. 32) and then choose a hardware contractor late next spring. Companies expected to bid for the studies include Boeing, Douglas, General Dynamics/Pomona, Hughes, Ling-Temco-Vought, Martin-Marietta and Republic.

► **New warhead concept—deployment of a uniform pattern of oriented and stabilized rod-shaped fragments—is planned, possibly for anti-satellite use, by Air Proving Ground Center, Eglin AFB, Fla. Qualified companies interested in submitting proposals must contact APGC by Sept. 25.**

► Office of Naval Research is seeking organizations and educational institutions with experience in unconventional warfare operations, technology and concepts, for studies of geophysical warfare.

► **Industry proposals for an Agena D strap-down guidance system (low-cost, no computer, no gimbal capability) will be submitted this week to Lockheed Missiles and Space Co., prime contractor for the Air Force Systems Command second-stage booster. Companies expected to submit proposals include Minneapolis-Honeywell, which supplied the strap-down system for Agena B (AW Jan. 16, 1961, p. 88), Kearfott Division of General Precision, Bell Aerosystems and Sperry Rand. The Agena D system is expected to extend the reliability and accuracy available from the present Agena vehicle system.**

► Cornell Aeronautical Laboratory will modify its variable-stability Douglas B-26 aircraft (AW Sept. 17, p. 66) for future tests simulating landing of a supersonic transport. NASA's Ames Research Center awarded the contract. On-Mark Engineering will start drawings for the modifications and rework the airplane.

► **National Aeronautics and Space Administration gave a day-long briefing in Washington Sept. 18 to a university-industry group from Kansas, covering methods of participating in the space program and commercial applications of space findings. Similar briefing will be held next month in Boston.**

► Individual and local-section opposition to the proposed consolidation of the American Rocket Society and the Institute of the Aerospace Sciences is building at an increasing rate. Many members who first agreed to the proposed merger have had second thoughts and now strongly oppose it. Major arguments center on still-unsettled questions of finance, membership categories, publications, executive staff organization and personnel, with opponents of the merger holding that there is still no agreement on these points between the two societies after months of negotiations.

► **Food storage for Astronaut Walter Schirra's scheduled flight in Mercury MA-8 is expected to be improved by isolation of the food containers to keep them from being mashed by equipment and creating a floating-crumb hazard in weightless environment. New recipe for chocolate which raises its melting point by several degrees is expected to answer earlier complaints of its softening during storage.**

► Mk. 25 jet-assist-takeoff rocket has been qualified for operation over a temperature range of −75F to 165F by Navy Bureau of Weapons evaluation program aimed at the unit's eventual use on manned aircraft and carrier-based operations. Rocket was developed by Rocketdyne Division of North American Aviation, is being produced by division's solid-propellant facility at McGregor, Tex.

► **Air Force Systems Command's program to challenge individual reports or reporting systems required by higher authority but of little benefit to the Command has resulted in cancellation of 71 such reports. The Command has hired the G. C. Dewey Corp. of New York to develop a mechanized inventory of data required in Systems Command reports in order to weed out duplications.**

Washington Roundup

Kennedy Space Policy

Gradual reshaping of the Administration's space policy seems to be taking place (see p. 26). Air Force Secretary Eugene Zuckert's speech at the AFA convention, which was coordinated with the White House, is a public pledge that Air Force will pursue its space program and other aspects of its mission within the ground rules laid down by the White House and the Pentagon. But it also reflected a full recognition that there are military roles in space, as exemplified by this statement: "We in America have no choice but to extend our defenses as far as they need to be extended to save freedom on earth."

Communist China is carefully avoiding giving any indication of how it brought down a Chinese Nationalist U-2 reconnaissance aircraft. In a series of rallies staged around the country, it has had military pilots and anti-aircraft officers speak, but it also has had artillerymen, infantrymen and even a submarine captain make public statements on the incident.

President Kennedy says that the U. S. has not granted U-2 export licenses to any country other than Nationalist China "and we have no plans to sell any further [aircraft] or grant any other export licenses."

Tracking Deficiencies

Deficiencies in the nation's military space tracking network continue to cause feuding between Navy and Air Force. Maj. Gen. C. H. Terhune, Jr., commander of the Electronic Systems Division of Air Force Systems Command, said at the Air Force Assn. convention last week that "we will need a surveillance system with a first-orbit capability for detecting, tracking, identifying and cataloging all objects. This function . . . will be particularly critical to military operations in space."

Air Force has been trying for some time to get money for an elaborate phased-array antenna system for world-wide coverage, with first-pass capability over the U. S. But Navy two years ago contended it could do the job cheaper by extending its Spasur net. Defense Department has modestly funded both approaches so they can be compared before a large investment is made in either.

Advanced Research Projects Agency will soon announce appointment of an assistant director to head its research in behavioral sciences as applied to command and control systems. The appointee is a well-known name in the behavioral sciences field.

F-4C, RS-70 Proposals

Air Force is showing enthusiasm for the fighter it was forced by Defense Department to buy—the McDonnell F4H-1, or F-4C in the Air Force version (see p. 101). It has proposed a program change calling for purchase of 1,700 F-4Cs in the next five years. This would permit faster phaseout of all older tactical and air defense fighters. If only a portion of this proposal is approved, a second production source would be required. Best guess on a second source—Republic Aviation Corp.

Another proposed change would provide an operational force of 60 North American RS-70A aircraft in 1969 at $50 million each, and another 150 in the following year. Air Force also has asked Defense Secretary Robert McNamara to release all the RS-70 development money that has been appropriated. Prospects of approval of the proposed change for inclusion in the Fiscal 1964 budget are poor. Defense officials want to see how well the first XB-70 aircraft, due to fly late this year, performs. They also will require more applied research on RS-70 subsystem components.

Present plans for the Dyna-Soar (X-20) development and training program (see p. 27) **do not include any attempts at rendezvous in space. X-20 pilots may fly** some training missions in X-15s. Unmanned flights of the glider are to begin at Cape Canaveral late in 1964.

Nerva Flight Slippage

Atomic Energy Commission Chairman Glenn T. Seaborg told Congress last year **it was "realistic" to figure on conducting the first flight test** of the AEC-NASA Nerva nuclear rocket engine in the 1966-1967 time period. Now AEC officials say the target date has slipped six months to the 1967-1968 time period. They blame technical difficulties.

Budget Bureau, as well as Dr. Harold Brown, Defense director of research and engineering, has drawn a bead on the Pluto nuclear ramjet engine program (see p. 38). On Aug. 10, the Bureau wrote Defense asking if Pluto was worth the $500 million it would cost to bring the program through flight test. Brown said his own reviews had begun before he received the letter.

"Double standard" that allows NASA to release news that the services must treat as secret is causing considerable bitterness. Air Force officers point to the flood of publicity surrounding the Mercury astronauts, in contrast to enforced secrecy on the training of Dyna-Soar pilots as an example. Both profit from government-furnished education and both use government equipment. But Dyna-Soar and X-15 pilots are barred from selling and often from telling their stories to the public. Some results: promising young engineers, given their first practical training by the Air Force, are leaving to work for NASA; public interest in the military space program remains at a relatively low level.

—Washington Staff

McNamara Reviews USAF's Space Plan

"Program package" requested after Vostok flights; public criticism of military space role continues.

Washington—Air Force's comprehensive plan for an expanded space program, requested by Defense Secretary Robert S. McNamara in the aftermath of the flights of Vostoks 3 and 4, has been reviewed by McNamara in his capacities as defense secretary and as a member of the National Aeronautics and Space Council.

How much of the proposed plan will be adopted and what effect it will have on the formulation of Fiscal 1964 defense budget requests has not been determined and may not be until after a special White House military space study group reports (AW Sept. 17, p. 25).

Meanwhile, public pleas for greater military participation in the national space program continued last week in spite of recent statements by President Kennedy indicating that he believes the military and civilian efforts are now divided in the proper ratio.

Air Force civilian and military leaders who favor a larger space role have had to tone down or eliminate such opinions from public statements in recent months. This censorship policy was applied heavily to speeches planned for delivery last week at the Air Force Assn.'s 16th annual convention in Las Vegas, Nev.

But Ivan A. Getting, president of the non-profit Aerospace Corp., which does almost all of its systems engineering work for the Air Force, last week criticized the "space dichotomy" under which "the idea is all too general that we are now engaging in two kinds of space activity—the first, peaceful and pure; the second, military and evil."

Getting said the Air Force cannot meet emergencies in space if it must depend only on work being done by the National Aeronautics and Space Administration. He told a National Rocket Club meeting here that the military services must be assigned missions and development responsibility and be given the chance to gain operational experience with space weapons systems if they are to help keep the peace in space.

In other developments:

- **Air Force Assn.** called for a strengthened military space role and a clarification of national policy on military space (see box).
- **Edward C. Welsh,** executive secretary of the space council, also cited a lack of clarity in national space policy. In a speech prepared for delivery late last week at the AFA meeting, Welsh said: "Continuing efforts will be made to clarify policy, while keeping it necessarily flexible."

While Welsh did not appear to differ directly with the President's position on space, his speech contained remarks that were interpreted as direct criticism of the Pentagon's policies on space secrecy (see p. 25) and on space research and engineering (see p. 21).

Welsh also said "increases are expected in both the defense space activities as well as the non-defense space activities," and said: "In addition to giving consideration to more money for defense in space, serious attention needs to be given continuously to getting more space competence from each dollar in the budget."

AFA Space Policy

Las Vegas—Air Force Assn. last week adopted a strong policy statement in favor of an expanded military space role. It said that the "national commitment" to a military space capability was "not clear" and that the "time for clarification is now."

Informally endorsing the statement, ranking USAF officers attending the 16th annual AFA convention here are promising that the service will not relax its efforts to reverse or modify the stated policy of the Kennedy Administration that U. S. exploitation of space should be primarily a civilian effort.

According to the AFA statement, which reflects the thinking of many top Air Force officers, it would be next to disastrous to "concentrate on space exploration if this means the abdication or loss of the military posture necessary to make our national policy of deterrence effective." Current U. S. space policy, the statement said, is a defensive reaction to Soviet achievements. Instead, it said the U. S. should work to narrow competition with the Communists to the fields of politics, technology and economics.

Lack of an adequate U. S. military space capability, the statement said, may enable Soviet Russia "to deny access to space for our exploratory vehicles. More important is the possible hostile use of space by the Soviets—against which we may not be able to apply military strength either to deter or retaliate."

Neither the Getting and Welsh speeches nor the AFA policy statement were subject to the same censorship that has kept down criticism of national space policy by military leaders recently. The speeches were variously interpreted as differing with the President; falling within the broad scope of the President's statement that "we hope that space will be used for peaceful purposes . . . but we shall be prepared if it does not;" and as trial balloons preparatory to a shift in the Administration's position toward greater military participation—either through a larger military program, a forced increase in cooperation between NASA and the military (AW Sept. 17, p. 26)—or both.

McNamara asked Air Force for its proposed space program on Aug. 20 (AW Aug. 27, p. 34). At that time, Air Force did not have a comprehensive, agreed-upon plan that included the five-year cost projections required by current Pentagon planning and accounting procedures. The plan as it now exists is a "program package," including projected cost figures.

McNamara reviewed the plan less than 10 days ago. Air Force was still working on the details of the plan late last week. Development of a one-stage-to-orbit Aerospace Plane and a multi-man space station have been major Air Force hopes if its space role should be increased. There is strong speculation now, however, that USAF may be allowed to accelerate spaceplane development but will have to rely on NASA for early work on a multi-man space station such as the proposed Olympus (AW Sept 17, p. 27).

Getting said the "real problem is in the state of thinking" about military space. "Many progressive ideas are killed," he said, because no specific military requirement can be stated. Yet the best way to get something developed is to establish the requirement first, he said.

President Kennedy and others have emphasized that the military program will benefit from work being done by NASA. Getting pointed out that development of a weapon system requires about seven years, and said the services cannot "depend on NASA's experience for useful weapon systems without operational experience, including development."

Asked for specifics, Getting said there should be more military participation in NASA's two-man Gemini capsule program, which will develop rendezvous techniques; that the Titan 3 space booster should be "expeditiously and adequately funded so that we have launching pads on both coasts," and said there are "some very good re-entry configurations which would add to the military capability" that should be explored for use on Titan 2 missiles.

Getting also said the services have a greater motivation to work on communications satellites than does NASA, plus specialized requirements for development of navigation, weather and reconnaissance satellites.

In spite of U. S. hopes for peace in space, "the Russians are demonstrating to the world that their space exploits are straightforward demonstrations of raw military power, capable of being employed with terrible effect at any time the Kremlin whim may decree."

He said the U. S. should reaffirm "with pride instead of seeming shame" the position that its military strength is the most potent in the world and is working for peace; gain "the military tools that are best suited to help keep the peace"; "give our military people a pat on the back now and then instead of constantly putting them on the defensive"; "restate the historic peacetime military role of sharing in exploring the frontiers [of space]," and evaluate space missions—many of which have both military and civilian uses—on the basis of how they can be realized most effectively from the standpoint of over-all national benefit.

Welsh also used the theme that military space funds are funds spent to help keep the peace. He said one reason "why we are not devoting more to space spending by the Department of Defense" is that "many in this country as well as abroad fail to understand that U. S. expenditures to keep the peace are as peaceful as any other expenditures."

F-104A Retrofit

Las Vegas—Air Force plans to retrofit three Lockheed F-104A Starfighters with rocket engines and reaction controls to train students at its Aerospace Research Pilots School at Edwards AFB, Calif.

Air Force said the change will enable the aircraft to attain altitudes between 120,000 and 130,000 ft.

The rocket engines to be installed in the aircraft will be Rocketdyne throttleable AR-2 types fueled with hydrogen peroxide and JP-4 jet engine fuel. The engine will be mounted at the base of the F-104 fin and will protrude beyond the tailpipe.

In addition, four nozzles for reaction control—two for pitch and two for yaw—will be installed in the aircraft's nose. Two more nozzles, one in each wing tip, will substitute for ailerons. Nozzles will be fed from a hydrogen peroxide storage tank located aft of the cockpit.

Dyna-Soar to Use Low-G Re-entry; Air Force Selects First Six Pilots

Las Vegas—Air Force-Boeing X-20 (Dyna-Soar), now scheduled for its first manned orbital flight in 1965, will follow a single, shallow trajectory in its re-entry maneuver—not the skip-glide profile originally proposed.

By employing this technique, in which anticipated temperatures of up to 4,000F can be dissipated over a timespan of about 30 min., X-20 pilots will escape the high g-loads imposed on astronauts during the deep, ballistic re-entry of their capsules. According to Air Force and Boeing officials here, only about 2 or 3g will be sustained by X-20 pilots during re-entry, as opposed to the 10 to 11g borne by Mercury astronauts.

Full-scale engineering mockup of the X-20 was first displayed to the public here last week during the 16th national convention of Air Force Assn. The Delta-winged glider, which is being manufactured for Air Force by Boeing's Aero-Space Division, is constructed of high-nickel alloy steel, molybdenum or columbium and heat resistant ceramics. Its skin will radiate heat back into the atmosphere and ablative material will not be incorporated in the X-20.

Despite the shallow character of the X-20's re-entry maneuver, its skin will be scorched by atmospheric friction and must be thoroughly treated before a second launch can take place.

First class of six X-20 pilots began training at Edwards AFB, in June, 1961, but they were not then identified as X-20 pilots. They are:

- **Maj. Henry C. Gordon.** An aeronautical engineer, Gordon, 36, graduated in 1958 from the AF Experimental Flight Test Pilot School at Edwards. He flew 100 missions with 4th Fighter Group during the Korean War and holds the Distinguished Flying Cross and the Air Medal with oak leaf clusters. Gordon is either current or checked out in the F-100, F-102, F-104, F-106 and U-2.
- **Capt. William J. Knight.** Knight, 32, stayed on as a test pilot at the AF Experimental Test Pilot School after graduation in 1959. In 1958, he was graduated from the AF Institute of Technology with a bachelor's degree in mathematics. He is qualified in all Century-series fighters.
- **Maj. Russell L. Rogers.** Rogers, 34, flew 142 fighter missions during the Korean War, earning the Distinguished Flying Cross, the Air Medal with 10 oak leaf clusters and the Purple Heart. He was graduated from the University of Colorado in 1958 with an aeronautical engineering degree, then from the test pilot school, where he has remained as a test pilot.
- **Milton O. Thompson.** Thompson, 36, has been with NASA's Dyna-Soar pilot consultant group since 1960. With a B.S. degree in civil engineering, Thompson has flown the F5D to evaluate X-20 abort maneuvers, the F-104 to investigate skin friction effects and boundary layer transition and the B-58 during capsule stabilization parachute test. He completed naval aviation training in 1946 and has 3,100 hr.
- **Maj. James W. Wood.** Wood, 38, is assistant chief of fighter operations at the AF Flight Test Center and holds a bachelor's degree in aeronautical engineering from the AF Institute of Technology. Qualified in all Century-series fighters, Wood earned the Distinguished Flying Cross and the Air Medal with nine clusters while flying in the European theater in 1944-45.
- **Capt. Albert H. Crews, Jr.** Crews, 33, is one of eight test pilots attending the second class of the aerospace research pilot course at Edwards, which began June 18. He was graduated from the experimental test pilot course in 1960 and holds a chemical engineering degree from Southwestern Louisiana Institute and master's degree in aeronautical engineering from the AF Institute of Technology.

The X-20 flight test program is to begin in 1963 at Edwards AFB. First flights will involve air-drops of unpowered gliders carried aloft by B-52 bombers, during which data on the X-20's stability and control at subsonic speeds will be gathered.

Prior to the first scheduled orbital flight in 1965, airdropped X-20s equipped with rocket boosters will be flown at supersonic speeds.

Data on hypersonic flight characteristics in speed regimes beyond Mach 6 will be furnished by the orbital flight test phase. First orbital X-20 flight, at better than 17,000 mph., will last more than one hour.

Transtage Capability

Las Vegas—Titan 3 workhorse space booster fourth stage, or transtage, will be able to change a payload orbit from inclined to equatorial or send it on an escape trajectory, it was revealed here at the Air Force Assn. convention. It will also be able to change an orbit from elliptical to circular (AW May 28, p. 29).

Aerojet-General Corp. was chosen to make the two-motor, pressure fed storable propellant powerplant producing 16,000 lb. of thrust.

New Astronauts to Pilot Gemini, Apollo

By Erwin J. Bulban

Houston—First civilians to enter training as astronauts in National Aeronautics and Space Administration's manned space flight program are among nine new astronauts announced here last week by NASA.

New trainees will join the Mercury pilots to provide a pilot pool for Gemini and Apollo space missions. Civilians are Elliot M. See, Jr., and Neil Armstrong (see biographical profiles).

In addition, NASA announced a new policy concerning disclosures to the press and appearances on radio and television by the astronauts.

New criteria, providing a broader base of applicants, was followed in selection of the newest candidates. Pilots representing NASA and industry were eligible, unlike the previous program. Although See, who comes from the flight test section of General Electric Co. and Armstrong, former NASA flight test pilot at Edwards AFB, both were Navy-trained, the former has been working for GE since 1956 and Armstrong's duty tour ended in 1952. Numbers were not available as to how many of the more than 200 applicants in the latest selection group were civilian and military, but MSC indicated that the former category was a sizable group.

Qualifications Required

Qualifications necessary for selection included experience as a jet test pilot, preferably engaged in flying high-performance aircraft; experimental flight-test status attained through military service, the aircraft industries or NASA, or possession of a certificate of graduation from a military test pilot school; U. S. citizenship; age less than 35 at time of selection; possession of a degree in physical or biological sciences or engineering and recommendation from the individual's organization.

The variances from the previous Mercury astronaut-candidate criteria opened the way for civilian volunteers, allowed candidates to be somewhat taller and reduced the age limit. Average age of the new group of pilots, all of whom are married, is 32.5 compared with 34.5 for the seven Mercury astronauts. As Robert Gilruth, manned spaceflight director, explained, Mercury astronaut-candidate age was not considered as critical at time of their selection, because at that time Mercury was the only program NASA could foresee and it was expected that the candidates would easily meet the foreseen requirements of Mercury. New Gemini and Apollo programs are of a longer-range nature.

NEIL ARMSTRONG, naval aviator 1949-52, 78 Korean war combat missions, joined NACA after 1955 graduation from Purdue, worked for NACA's Lewis Flight Propulsion Lab, then transferred to Edwards AFB as aeronautical research engineer for NACA and NASA. Recipient of the Institute of Aerospace Sciences' 1962 Octave Chanute Award. Flight time—2,400 hr., 900 in jets.

FRANK BORMAN, entered USAF after graduation from West Point in 1950, instructor in thermodynamics and fluid dynamics at the Military Academy 1957-60. From 1960 until his present assignment, instructor at USAF Aerospace Pilot School, Edwards AFB. Flight time 3,600 hr., including 3,000 in jets.

CHARLES CONRAD, JR., naval aviator following graduation from Princeton in 1953, attended Navy Test Pilot School, Patuxent River, flight instructor and performance engineer at Naval Air Station, Patuxent River, 1959-61. Last assignment was safety officer of Fighter Squadron 142, and F4H flight instructor of Fighter Squadron 142. He has 2,800 flying hr. and 1,500 in jets.

JAMES A. LOVELL, JR., attended University of Wisconsin 1946-1948, U. S. Naval Academy 1948-1952, test pilot at Patuxent River Naval Air Test Center 1958-1961, including work as program manager for F4H weapon system evaluation, last assignment being flight instructor and safety officer at Naval Air Station, Oceana, Va. Has logged over 2,300 hr., including 1,600 hr. jet time.

JAMES A. McDIVITT, graduated University of Michigan 1959, joined USAF 1951, flying 145 combat missions in Korea in F-80s and F-86s, attended USAF Experimental Test Pilot School, Edwards AFB 1959-1960 and USAF Aerospace Research Pilot course 1961, last assignment being experimental flight test officer at Edwards. He has logged more than 2,500 hr. flight time, including 2,000 hr. in jets.

ELLIOT M. SEE, JR., graduate U. S. Merchant Marine Academy, Navy service 1953-1956, worked for General Electric Co. following graduation in 1949 until he entered Navy and since that service, as flight test engineer and experimental test pilot, last job with GE being project pilot on the J79-8 engine evaluation program on a bailed F4H. Has logged more than 3,200 hr., including 2,300 hr. jet time.

THOMAS P. STAFFORD, graduated U. S. Naval Academy 1952, then entered USAF, last assignment being chief of performance branch, Experimental Test Pilot Division, USAF Aerospace Research School, Edwards AFB. Coauthor of Pilot's Handbook for Performance Flight Testing and Aerodynamics Handbook for Performance Flight Testing. Has logged 3,500 hr. flight time, with 2,500 hr. in jets.

EDWARD H. WHITE II, graduated U. S. Military Academy 1952, joined USAF and attended Air Force Test Pilot School in 1959, last assignment being as experimental test pilot with Aeronautical Systems Division, Wright-Patterson AFB. White has logged 2,900 hr. flight time, including 1,700 hr. in jet aircraft.

JOHN W. YOUNG, graduated Georgia Institute of Technology 1952, joined the Navy in 1952, last assignment being maintenance officer Fighter Squadron 53, Miramar (Calif.) Naval Air Station. Earlier this year he set world time-to-climb records for 3,000-meter and 25,000-meter event in Project High Jump with F4H. From 1959-1962 he was program manager and test pilot for Navy's F4H project.

New candidates are slightly taller than some of the earlier astronauts—averaging a two-tenths-inch increase.

The trainees average somewhat less flying time than the original team—more than 2,800 hr. as against over 3,500 hr. But they average higher jet experience—1,900 hr. as against 1,700 hr. for the initial group.

Gilruth emphasized that all of the new group may not necessarily participate in actual space missions, assignment depending upon their continuing physical and technical status and upon future flight requirements. He indicated that their training will fit them for roles in other aspects of the manned space flight program, in addition to flight aspects.

To speed the training and integration in the engineering development programs of this new group of trainees, Astronaut Donald K. (Deke) Slayton, will become coordinator of astronaut activities, responsible for assignments of flight test personnel to training activities and engineering assignments. He also will act as personal adviser to Gilruth and MSC Associate Director Walter C. Williams on flight crew affairs. Slayton's duties include scheduling of jet aircraft for the astronauts and trainees to maintain their flight proficiency.

Observe MA-8

New trainees are to be integrated immediately with the Mercury flight team and training will include briefing on the Mercury program and operations. They will observe the MA-8 six-orbit flight by Walter Schirra planned for Sept. 28. They definitely will not be used in Mercury flight missions, but will be trained for Gemini and Apollo flights.

Training will include university-level lectures in basic sciences two days a week, with contract arrangements to be made at schools to handle some of these studies. Refresher-type courses will emphasize space navigation, computer theory, flight mechanics, astronomy, upper atmosphere and space physics, bioastronautics, advanced propulsion systems, aerodynamics, guidance and control, space communications, global meteorology and selenology.

New policy by NASA concerning disclosures by astronauts or astronaut candidates concerning their experiences is aimed at improving press contact with the space flight test group and necessitates NASA administrator approval of sales of personal experiences of themselves and their families.

NASA will increase the number of post-flight press conferences from one to two.

New policy requires:

• **All information** reported by the astronauts in the course of their official duties which is not classified to protect the national security will be promptly made available to the public by NASA.

• **Public information media** will be granted frequent accessibility to the astronauts for the purpose of obtaining information from them concerning their activities in connection with actual space flight. Timing and conditions of interviews with the astronauts for this purpose will be controlled by NASA director of public information so as not to interfere with their performance of official duty. During such interviews the astronauts will be directed to disclose all information acquired in the course of their activities in connection with actual space flight except information classified to protect the national security.

With reference to post-flight news conferences, two will be held. The first will be the large affair that has been held after the past flights. A second conference will follow, in which the astronaut will meet a pool of about a dozen representatives of the press for an hour and answer their questions in a more relaxed atmosphere. Members of the pool will be selected by the press in cooperation with public information office of NASA.

• **While detailed to NASA** or in the employ of NASA for duties in connection with actual space flight, the astronauts may not without the prior approval of the NASA director of public information appear on television or radio programs or in motion pictures; may not without the prior approval of the NASA director of public information publish or collaborate in the publication of writings of any kind; may not receive compensation in any form for radio, television or motion picture appearances or for the publication of writings of any kind which involved reporting to the public their performance of duties in any phase of duty in connection with actual space flight and may not endorse commercial products either directly or indirectly.

• **Astronauts are free** to make agreements for the sale of stories of their personal experiences and those of their family including rights in literary work, motion pictures, radio and television production provided such agreements do not violate the foregoing restrictions and are approved by the administrator of NASA. Such stories shall not contain or purport to contain official information concerning the astronaut's training and flight activities which has not previously been available to the public. Nor shall such stories purport to be exclusive when in fact they are not or are exclusive only in part. The contracting publication must provide an acceptable format for avoiding this inference.

In connection with contracts for the publication of personal and family experiences, they may make themselves available for interviews so long as this does not interfere with their official duties, and so long as they do not withhold for this purpose any information which is directly pertinent to their experiences while on duty as astronauts.

Minor Changes Made in MA-8 Capsule

Washington—Several minor changes have been made in Cdr. Walter M. Schirra's Mercury Atlas-8 capsule, which he has named Sigma 7, and the system is being prepared for launch from the Atlantic Missile Range Friday, Sept. 28.

Because Cdr. Schirra's six-orbit mission includes three orbits of drifting flight, his capsule will require no more reaction control fuel than that carried by Marine Lt. Col. John H. Glenn, Jr., in MA-6 and Lt. Cdr. Scott Carpenter in MA-7.

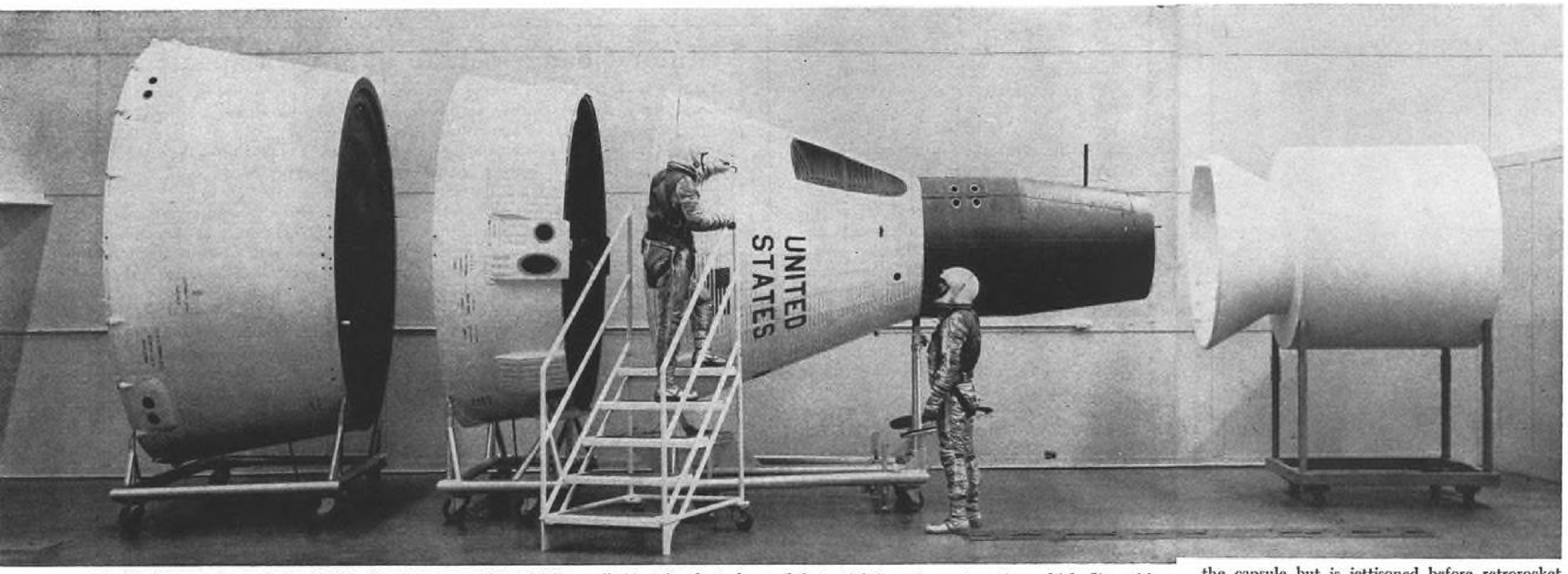
Changes include addition of 15 lb. of water coolant in the environment system, increasing the capacity of the on-board tape recorder to 11 hr. from 6 hr., removal of two cabin floodlights and replacement of the leg restraint with a foot restraint. Suit temperature indicator dial has been eliminated because Cdr. Carpenter had trouble with it in adjusting his suit temperature (AW Aug. 27, p. 30).

Changes in the General Dynamics/Astronautics MA-8 Atlas include use of baffled instead of flat injectors, replacement of the explosive igniter with a hypergolic igniter and a slightly modified boost program designed to ease the pitchover maneuver.

One change in scientific experiments (AW Aug. 6, p. 35) is retention of the periscope, rather than replacement of this system with an ultraviolet experiment. Other scientific experiments in MA-8 include several ablative materials samples, flare visibility and photography.

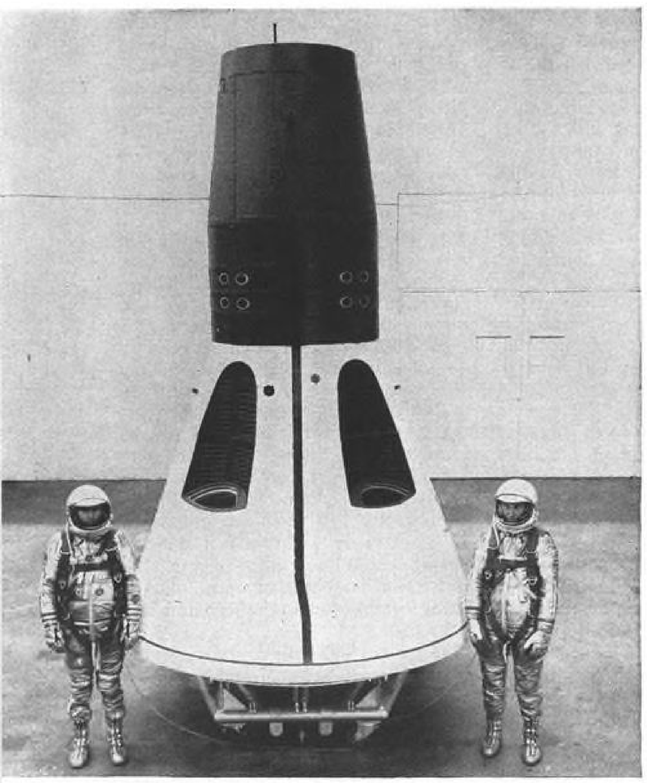
Meanwhile, Cdr. Schirra has frankly criticized some aspects of the Mercury program in a Columbia Broadcasting System television interview with Walter Cronkite. Although it was later denied officially by National Aeronautics and Space Administration, and by Col. Glenn and Cdr. Alan B. Shepard, Jr., the first astronaut to fly a Mercury mission, Schirra said in the interview:

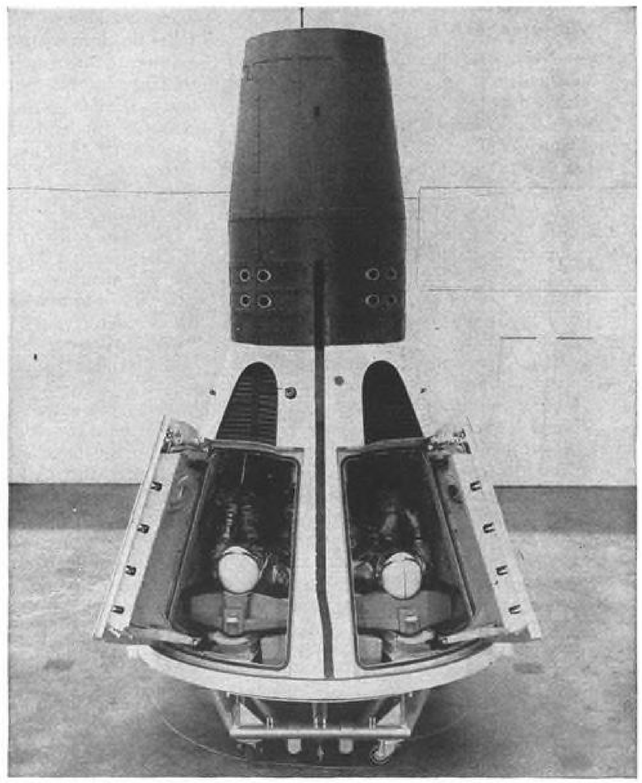
Public commitments "have just about wiped him [Glenn] out of the space program. He hasn't been able to maintain the currency that he should have with the rest of us and we have frantic meetings trying to keep each other up to date on what he has been doing technically and what we've been doing technically. John's falling behind, in other words."



Boilerplate mockup of the NASA Gemini spacecraft at McDonnell Aircraft plant shows (left to right) equipment section which flies with firing; the retrograde rocket section which is jettisoned after retrofiring prior to re-entry; the capsule, and also the Agena B rendezvous nose

NASA Accepts Engineering Mockup of Gemini Space Capsule





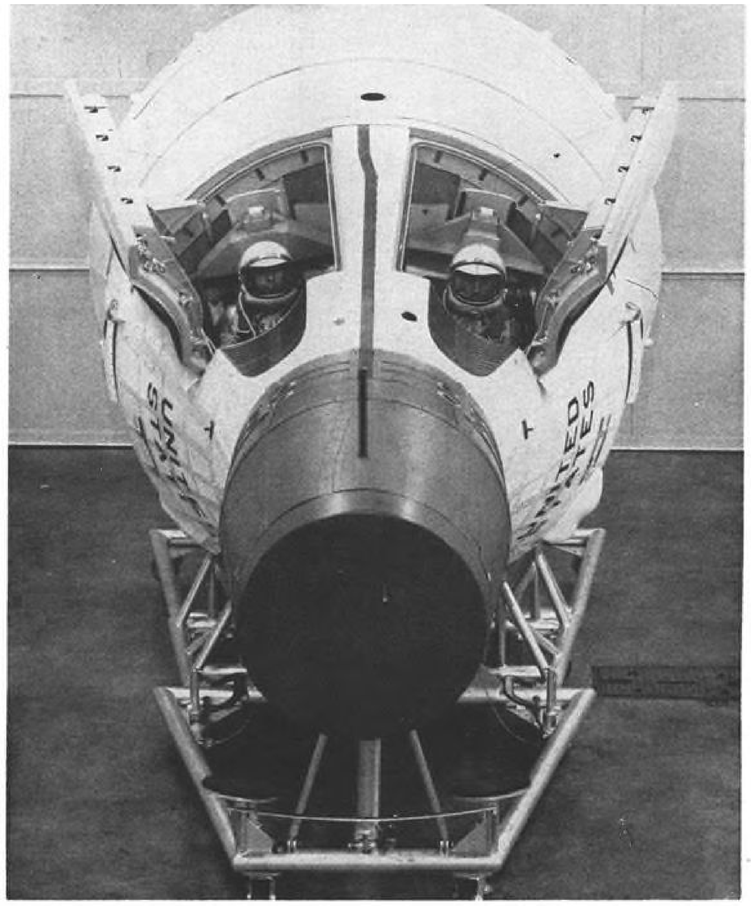
Ungula shape nose cap, designed to turn capsule around aerodynamically in case of reaction control failure, has been replaced by flat configuration. Reaction control ports are visible ahead of cockpit ports. Capsule has shingled structural panels used in Mercury capsules.

Engineering mockup of the two-man Gemini spacecraft has been accepted by National Aeronautics and Space Administration from McDonnell Aircraft Corp. and was exhibited for the first time during President Kennedy's visit to McDonnell Sept. 12 (AW Sept. 17, p. 26). The company is producing 12 Gemini flight capsules for two missions: rendezvous and long-duration flights. Rendezvous configuration will weigh about 7,700 lb., about 1,000 lb. more than the long duration vehicle because of the need for maneuvering fuel.

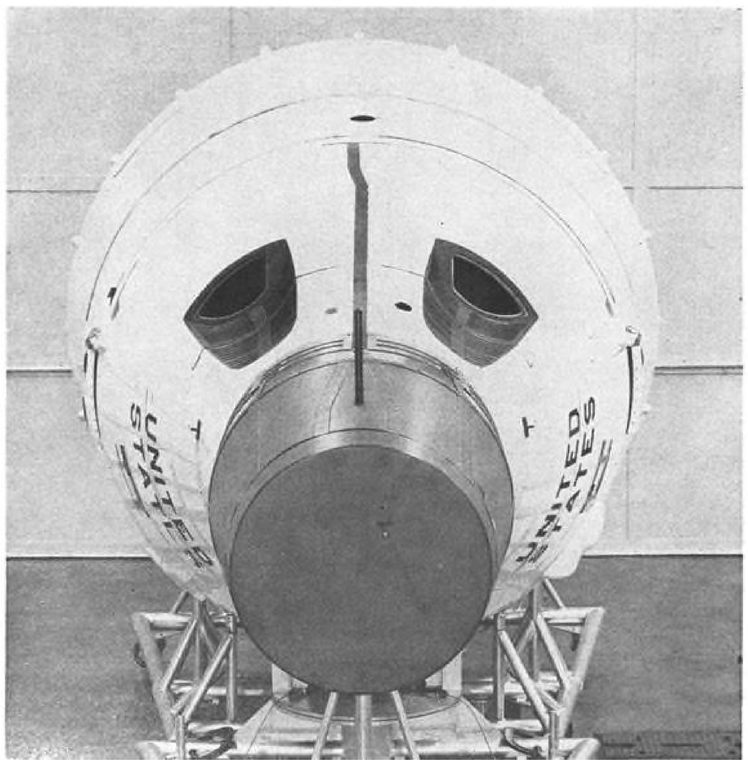
Gemini rendezvous mission entails launch of a fully-fueled Lockheed Agena B stage by a General Dynamics/Astronautics Atlas booster into a 150-mi. circular orbit. Gemini then will be launched into a slightly elliptical (87-150 mi.) orbit. Rendezvous maneuver begins with radar lock at 250 mi., and at a 50-mi. range pilots will shift to a visual technique, homing into the Agena stage by means of a high intensity flashing light on the stage.

The Gemini spacecraft will have 24 attitude control jets, each with a thrust rating of 25 lb., and eight 100-lb. thrust maneuvering jets. The 90-in.-high adapter section, which houses reaction control fuel and environmental oxygen, will be jettisoned prior to re-entry. Upper section, which houses the paraglider, also will be jettisoned when the paraglider is deployed.

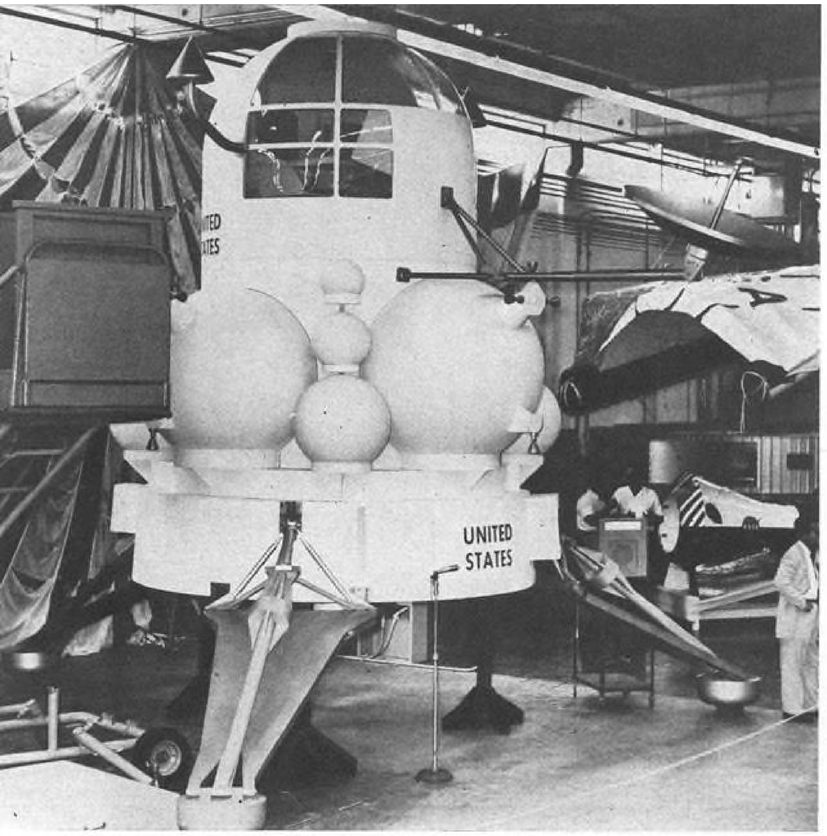
Pilot will have four manual and two automatic attitude control systems (AW July 2, p. 94).

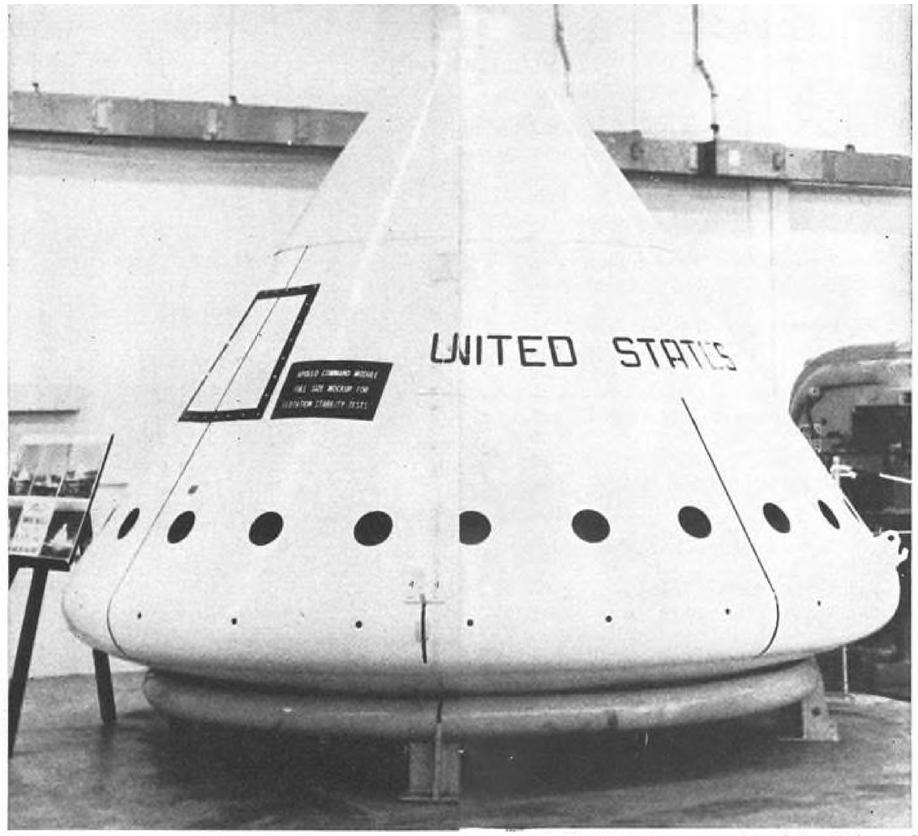


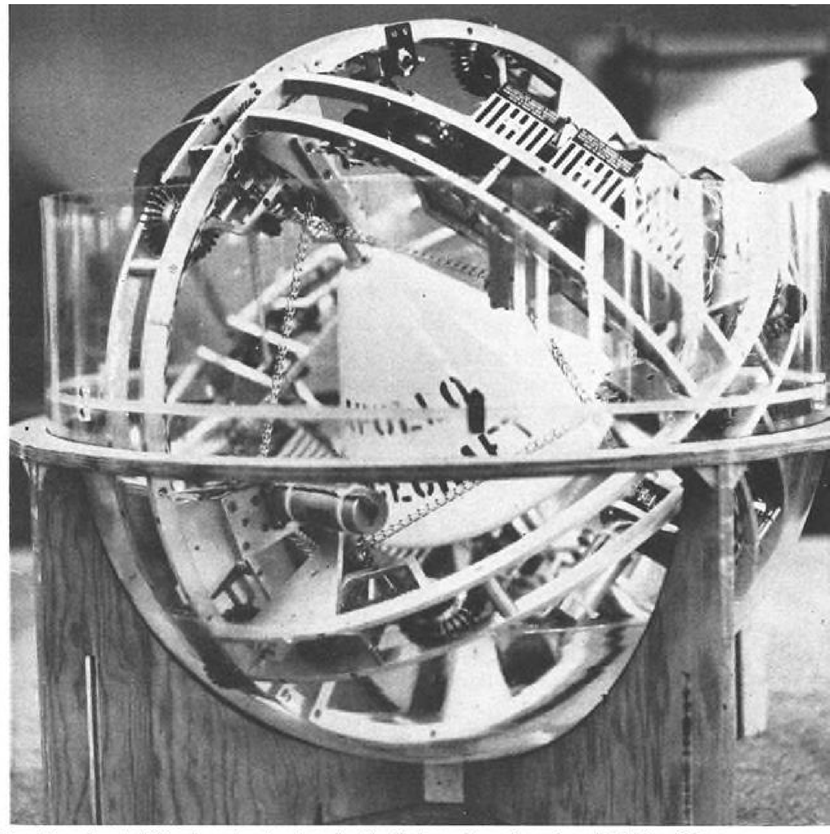
Front view of capsule shows hatch and astronaut seating layout. Black line behind docking index bar extending between hatches marks location of paraglider attachment cable.



the capsule but is jettisoned before retrorocket adapter mockup (above).



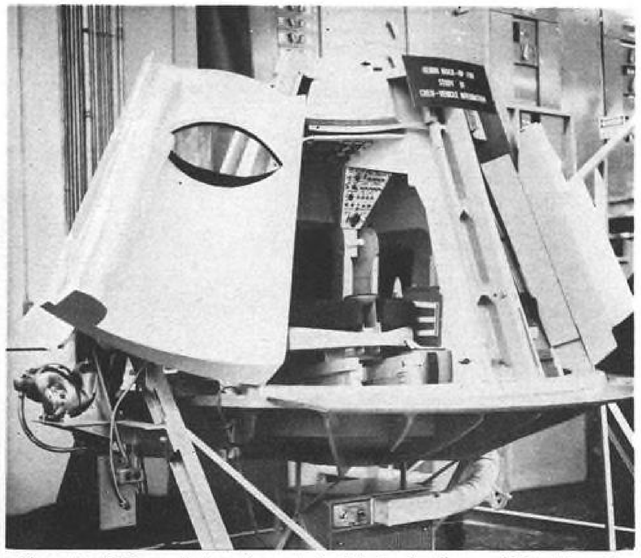




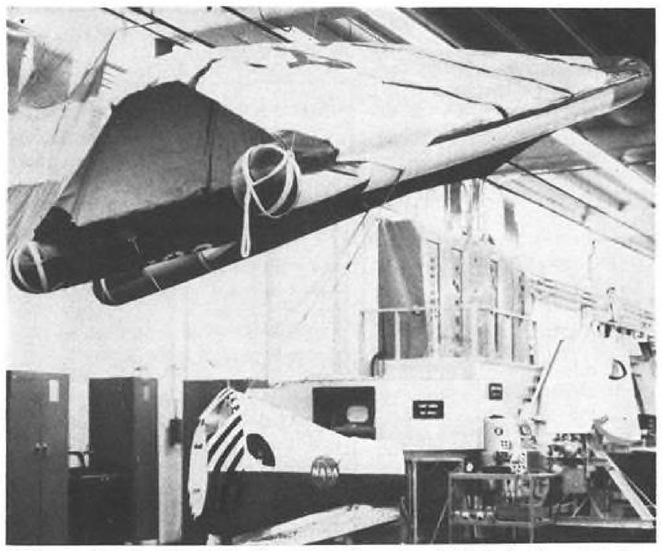
Full-scale 17-ft. mockup of North American's two-man lunar excursion module (left) was shown to President Kennedy during his recent visit to the Manned Spacecraft Center, Houston, Tex. (AW Sept. 17, p. 26). Spheres around the vehicle contain fuel for attitude control, deceleration and launch rockets. Note extensive use of glass in crew compartment. Communications and radar antennas are in their deployed position. Base section will remain on the lunar surface when the bug is launched to rendezvous with the Apollo command module.

Apollo full-scale command module will be used to determine stability in water (center photo). It has a base diameter of 154 in. Three-axis simulator trainer (right) 1/12th scale, would be used to train Project Apollo pilots. This is one of a number of devices under study by MSC in the Apollo project. Actual equipment would provide three-man crews with three-axis freedom of motion simulator that would provide training in various flight modes including recovery from disorientation caused by tumbling.

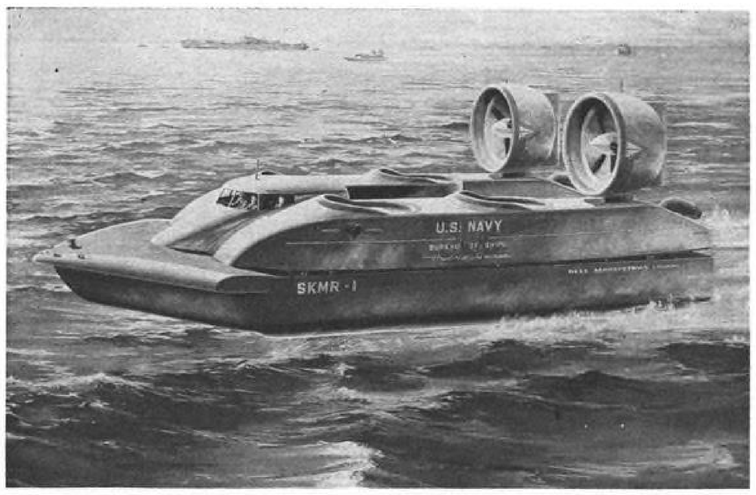
Manned Spacecraft Center Shows Advanced Mockups to President Kennedy's Party During Space Tour



John Glenn explains Mercury survival kit. He is holding a knife, part of his survival equipment, in his hand. Crew vehicle integration studies are being carried out in the full-scale Gemini mockup (right) in which shape, size, instrumentation layout are studied.



Half-scale model of Paraglider-Gemini configuration (left), in landing attitude was displayed. Adapter section of Gemini section is shown as it would be after jettisoning. Right, Astronaut Shepard demonstrates flexibility of Mercury pressure suit glove in vacuum chamber.



BUREAU OF SHIPS SKMR-1, designed and being built by Bell Aerosystems Co. under a $2,040,000 contract, is scheduled for test runs on Lake Erie next May. This artist's concept shows some changes in detail design from an earlier model (AW Jan. 29, p. 91), particularly in the addition of bow spray strips and the placement and shape of the four engine-air intakes. Design speed of the SKMR-1 is 70 kt., over-all length is 65 ft., and weight (not displacement in this case) is 27 tons. Vehicle will be used to study rough-weather control problems, the feasibility of using large air-cushion vessel, and mission capabilities. Primary missions will be over water but the vehicle also will operate over land.

New Hypotheses May Allow Better GEM Performance Predictions

Washington—New hypotheses for the flow around ground effect machines may lead to more accurate prediction of performance parameters and may show that current estimates of performance are pessimistic.

The new flow theories were presented by Norman K. Walker to an Institute of the Aerospace Sciences-Navy meeting on Hydrofoils and Air Cushion Vehicles here last week. Walker, who is head of his own systems engineering consulting firm, Norman K. Walker Associates, Inc., said his analysis has been successful in predicting and describing phenomena of the GEMs and in simplifying the collation of test results.

Part of his hypotheses are the descriptions of the first and second critical velocities, speeds where the flow regime is changing from one type to another, and where large changes of trim and stability might be expected. Full-scale tests have shown there is a steady increase in nose-up pitching moment as speed increases towards a critical value. Speed is limited by the drag buildup caused by rearward tilt of the lift force.

Most of the tunnel tests made so far have not reached second critical velocity, Walker said, but there has been general agreement that at high speeds a GEM could run off its cushion. Tunnel tests made at the University of Wichita show this doesn't happen, but that there is a possibility of violent transient trim changes. Some tow-tank tests at the David Taylor Model Basin showed a sudden nose-down pitching during the fastest tow, and during a high-speed test run of the Princeton GEM, its nose wheel hit the ground, bumped the nose up, and the pilot could not control the nose-up pitch that followed. The Princeton GEM nosed up at an estimated 30-deg. angle with the nose about 12 ft. off the ground before drag decelerated the machine and it settled back to a normal attitude.

The GEM vehicles now being built, such as the Bureau of Ships' SKMR-1 being developed and built by Bell Aerosystems Co., are really the first generation of practical types, Vice Adm. William F. Raborn told the meeting. They will be ". . . the means whereby we attain a capability to design and build seagoing platforms of optimum performance. . ." The next generation will be working vehicles that will make the transition from optimum designs into economical systems and will define the operational role for these vehicles.

But a warning that the United States is "woefully behind the parade" in both hydrofoil and ground-effect machine technology was sounded by Rear Adm. Ralph K. James, chief of the Navy's Bureau of Ships.

Only by a competitive effort which includes commercial goals as well as military applications will the U.S. be able to match the rest of the world, he said. European nations have tied their developments to passenger- and cargo-carrying commercial operations, he pointed out, with weapons concepts following technology improvements.

Adm. James suggested that the upper limit for hydrofoil vessels is on the order of 1,000 tons; above that size, displacement tonnage, foil size and power transmission problems become too complex. Biggest current design is the AG (EH) hydrofoil ship, being developed for BuShips by Grumman Aircraft Engineering Corp., an experimental anti-submarine ship 212 ft. long and displacing 320 tons.

Speed limit for hydrofoil craft with sub-cavitating foils (laminar water flow over the entire surface) is about 50 kt., Adm. James said; with super-cavitating foils, the upper limit appears to be about 100 kt.

Idlewild to Get GEM

New York—Bell Aerosystems Co. will lease a ground effect machine to the Port of New York Authority for testing around New York's International Airport starting in about one year.

Vehicle is now being built, and will be 27 ft. long, 14 ft. wide, and weigh 5,600 lb. It will have a five-place cabin. The foot-thick air cushion will be developed by a 6½-ft.-dia. horizontal fan driven by a 350-hp. engine, and forward propulsion will be provided by a 6-ft.-dia. propeller driven by a 180-hp. engine.

Bell and the Port Authority will work jointly on a program to evaluate the vehicle for operations near airports.

Nova Launch Facility Bids

Washington—Fifteen companies have submitted proposals for a two-part study of Nova launch facilities. National Aeronautics and Space Administration expects to award a contract by Oct. 1.

Winner will make a general study of major launch facilities requirements for several Nova configurations until Dec. 14, and will concentrate on facilities for the configuration which NASA selects after that time (AW Sept. 10, p. 32).

Companies invited to bid which submitted proposals were Aerojet; American Machine and Foundry; Bechtel; Chrysler; Brown Engineering; Daniels, Mann, Johnson & Mendenhall; Douglas; Martin, Rust Engineering; and Westinghouse. Not on the bidders list but submitting proposals were Vitro; Lummus Co.; Holmes & Narver; Lockheed; and Catalytic Construction Co.

THE HI-JACKING HERO

LEACH HERITAGE OF THE AIR — 21

All around him were Italian pilots and crewmen, the sound of revved-up and ready planes, the smell of burnt castor oil. In the pre-dawn of August 18, 1918, on an airfield near Padua, Italy, there was one man who didn't belong.

He was Lieutenant Willis Fitch, one of 20 American pilots stationed with the Royal Italian Air Force. Leader of this American group was Major Fiorello La Guardia. The same.

Fitch had persuaded an Italian pilot to give up his part in one of the most dangerous bombing missions of the war: the attack, in broad daylight, on Pola—the largest naval base in Austria. And the one most strongly defended from both land and air.

A near equal hazard of the raid was the plane Fitch would fly—the Caproni Ca. 36 Night Bomber. The three-engine plane, forerunner of the strategic bombers of World War II, was not built for daylight raids. It was too slow and flew too low when bomb-laden for daylight attacks over water except with superior fighter escort.

The Caproni Bomber was powered by three 200 h.p. Isotta Fraschini 6 cylinder in-line engines—one mounted on each wing and a pusher behind the centrally mounted, bathtub-like fuselage. Two huge gas tanks on the lower wing fed the engine. But there were no gas gauges.

There were four crewmen on a Caproni. The pilot commander-bombardier, his co-pilot, an observer-machine gunner squeezed in the very front, and a machine gunner at the turret gun behind the pilot.

Instrumentation on the Caproni left some things to be desired. There were only three readings on the instrument panel: compass, altimeter and oil gauge. A pilot depended on the horizon to tell him whether he was flying level or not. Airspeed was determined by the degree to which a piece of thin, flat metal, mounted on a strut, was deflected by the wind.

Getting off the ground was an exciting experience. Each of the three engines was controlled by individual fuel and ignition levers. They had to be perfectly synced at take-off. If either side engine was fed too much gas, the Caproni would angle off and ground loop.

So even as he squeezed into the pilot's seat, wearing a life jacket and a steel helmet, Fitch wondered whether he'd ever leave Padua. His Caproni was carrying one ton of bombs and enough fuel to make the 240-mile round trip to Pola. It was a wobbly take-off, but Fitch made it. And once in the air, the Caproni, with its 76-foot wing spread and three heavy engines, held its course without a flutter.

Fitch was flying second in formation. As he headed into the glaring sun, plane after plane from field after field flew up to join the raiders. There were 60 planes in all—S.I.A.'s, S.V.A.'s, Nieuports and four squadrons of Capronis—workhorses of the attack.

While still over land, the lead plane dropped smoke bombs for the trailing planes to follow. When they left the Eastern coast of Italy, the planes were guided by torpedo boats pointing their wakes to Pola.

The air armada slowly rose to 9,000 feet. The glare of the sun was almost unbearable. Someone forgot to issue sun goggles. Then, suddenly, a ring of land appeared. Pola.

There were no enemy planes to meet the raiders. The Austrians were completely surprised. But approaching the docks and warehouses, Fitch saw puffs of smoke from ack ack batteries on land and the anti-aircraft guns of the battleships maneuvering in the harbor.

Fitch dropped his bombs, and turned for home. By now, the sky above Pola was black with smoke. By now, the Austrian planes had climbed to Pola's defense. But two squadrons of Allied escort planes kept them busy while 60 tons of bombs were dropped on the very surprised port city of Pola.

New AFSC Council To Bolster Reviews

Washington—Air Force Systems Command has formed the AFSC Council to review critical problems with the idea of reducing the amount of mandatory review ordered by higher echelons in the Defense Department.

The council will also consider major policies and recommend action aimed at ensuring the ability of the command to carry out its assigned mission. The AFSC vice commander will be council chairman.

In the past two years, the Systems Command has found that many high priority programs, whose redline vertical organizations can cut across regular management lines, were not being sufficiently reviewed within the command itself and at USAF headquarters. This resulted in closer and often embarrassing scrutiny in the Office of the Secretary of Defense.

Program definition was often faulty and cost estimates were unrealistic, resulting in cost overruns. In the case of the Skybolt air launched ballistic missile, reviews were conducted at various command and civilian levels for over two years before program aims were made acceptable. The council will try to avoid such situations by imposing severe review procedures at the command level.

Membership will include the deputy chiefs of staff for foreign technology; plans; systems; personnel; comptroller; procurement and materiel; and research and engineering, plus the deputy to the commander for manned space flight. Advisers will be the command executive; assistant for bioastronautics; assistant for management; chief scientist; chief of staff, director for procurement; staff judge advocate and the inspector general.

The relationship of the council to the Systems Command and its structure and aims resemble those of the Air Council at USAF headquarters.

The council will also:

- **Review and recommend** appropriate action concerning major command programs and objectives.
- **Provide program** and policy guidance.
- **Review and evaluate** proceedings of source selection boards (SSB) which require approval of the commander.
- **Determine those system** programs requiring SSB action and designate the approving authority.
- **Appoint standing and Ad Hoc** Systems Command headquarters boards, committees and panels and review their proceedings and recommendations.

Agenda items for the consideration of the council will be originated by council members, chairmen of boards, committees and panels and the staff.

Pluto, Snap De-emphasized by Defense

By George C. Wilson

Washington—Defense Department is moving to de-emphasize such nuclear programs as Pluto and Spur/Snap 50 in a major policy fight which pits civilian research chiefs against military leaders and the Joint Congressional Atomic Energy Committee.

The outlines of the battle were sketched during a series of hearings by the joint committee's research subcommittee, headed by Rep. Melvin Price (D.-Ill.). As the hearings ended last week, Rep. Price said he feared the Pluto project would suffer the fate of the Aircraft Nuclear Propulsion program, which was canceled by the Kennedy Administration shortly after it took office.

On one side is Dr. Harold Brown, defense director of research and engineering, who feels military participation in the nuclear programs should be decreased until more specific missions emerge. On the other side are Air Force and Navy leaders who feel such nuclear-powered developments as the supersonic, low altitude missile (Slam)—the product of the Pluto project—would give the U. S. a significant edge over the Russians in weaponry. Vice Adm. W. F. Raborn, Jr., deputy chief of naval operations for development, said that "the combination of the nuclear ramjet and the nuclear submarine is the most powerful weapon we have yet thought of."

Just how the policy fight will be resolved is largely up to Defense Secretary Robert S. McNamara, who will rule on Brown's recommendations. Subcommittee members at the hearings clearly felt McNamara would continue to support his civilian research chief, who has won out in previous battles on the nuclear aircraft and the RS-70 bomber.

At hearings before the same committee last year, the Air Force recommended spending $41 million in Fiscal 1963 and $30 million in Fiscal 1964 on Pluto (AW Sept. 4, 1961, p. 26). These amounts were formally requested. Defense cut the Fiscal 1963 request to $24 million, and still has not released that money to the Air Force, even though the money has been appropriated by Congress.

Dr. Brown said he started reviewing the whole Pluto program several months ago on his own initiative. He told AVIATION WEEK he would make recommendations about the future scope of the program by the end of October.

Dr. Brown stated that Pluto's value is being compared with other weapons under study.

Fred A. Payne, deputy director of defense research and engineering for strategic and defensive systems, described some alternatives to Slam—none of which impressed such nuclear enthusiasts on the committee as Reps. Price, Chet Holifield (D.-Calif.) and Craig Hosmer (D.-Calif.).

"The interest in and possible importance of a low-altitude supersonic weapons system such as might develop out of Pluto lies in the possibility that at some time in the future enemy anti-ICBM systems might degrade the effectiveness of our ballistic missile forces," Payne said. "In such a situation, such a concept—if it proves feasible and if means are found to make it invulnerable to a first-strike attack—offers an alternative strategic system probably not vulnerable to the same defenses and offering other valuable characteristics."

Payne said alternatives to Slam for achieving low altitude penetration are: (1) ballistic missiles which maneuver when they re-enter the earth's atmosphere; (2) short-range, low-altitude cruise missiles which could be launched from either land or ships; (3) an advanced manned aircraft system which would have low-altitude penetration capability.

Brown said he would continue to support development of a reactor which could power a ramjet engine, but argued there was no necessity now to commit Defense to a specific weapon application such as Slam, since the requirements were not clear.

But Rep. Price said he could not understand why Slam should be downgraded when both the Air Force and the Navy wanted it and it appeared technically feasible. Rep. Price and Brown appeared to be using the alternatives "to beat down" Slam. The research chief said he knew of no Russian progress with Slam type weapons, despite published reports to the contrary.

Air Force Secretary Eugene M. Zuckert last week endorsed Brown's stand by declaring: "We do not at the moment have plans for a nuclear, supersonic low-altitude vehicle, although this concept is one of the major approaches currently being assessed in our operational evaluation studies. Such evaluations, however, are extremely sensitive to the initial assumptions that are made, and, unfortunately, we cannot always verify the soundness of these assumptions based upon current knowledge."

Similarly, Gen. Bernard A. Schriever, Air Force Systems Command chief, said last week "we are not advocating Pluto for weapons systems application at this time" but are "strongly recommending that the potential of nuclear ramjet propulsion technology not be pre-judged before all the facts are assembled."

From Fiscal 1956 through Fiscal 1962, the Atomic Energy Commission has spent $98.2 million and the Air Force $30.6 million on Pluto for a total of $128.8 million. Reactors of the type that would supply heat for the ramjet engine have been ground-tested successfully. The first such tests were with the Tory 2 A-1 last year. Those tests, which ended last October, were so successful that AEC skipped planned tests with the second reactor, Tory 2 A-2, and proceeded with the larger Tory 2-C reactor.

AEC officials said Tory 2 A-1 tests proved the technical feasibility of a nuclear ramjet reactor. The Tory 2-C tests, slated to begin next summer at AEC's Nevada Test Site, will determine the feasibility of a reactor capable of low-altitude, supersonic flight. Facilities under construction will enable the Tory 2-C to be tested for five minutes at full power.

A. R. Luedecke, general manager of AEC's reactor development division, told the subcommittee that the Lawrence Radiation Laboratory will complete the Tory 2-C tests, but said an industrial contractor will be brought into the program soon afterward if it is continued. The contractor would be responsible for the fabrication and test of the propulsion system reactors, Luedecke said.

Besides his doubts about Pluto, Brown also is showing decreasing interest in participating in the Spur/Snap 50 auxiliary nuclear power project. Although the project is being placed under an Air Force colonel responsible to the AEC, Brown told the subcommittee the AEC should provide "the bulk of the funding at least until such time as NASA or the DOD has a specific requirement for a particular space power unit" (AW Sept. 17, p. 31).

This view, if it prevails, will implement further Brown's basic philosophy that military money should be spent mainly to meet specific requirements—a philosophy which is being severely challenged in Congress and elsewhere by persons who feel specific requirements often do not become evident until it is too late technologically.

AEC Spending on Nuclear Space Projects

(Atomic Energy Commission spending to date for construction and operation, expressed in millions of dollars.)

Snap	Cumulative Through FY1960	FY1961	FY1962	FY1963	Total
Radioisotopes	9.0	2.7	4.6	3.2	19.5
Reactor units	19.3	16.1	39.5	44.8	119.7
Advanced space ..	0.0	3.9	17.5	34.8	56.2
Total	28.3	22.7	61.6	82.8	195.4
Pluto	46.1	24.8	31.6	29.0	131.5
Rover	83.4	33.8	66.7	84.8	268.7
Aerospace safety....	0.0	0.2	2.0	5.3	7.5
Total	157.8	81.5	161.9	201.9	603.1

Labor Dispute Settled

North American Aviation and General Dynamics Corp. agreed last week to accept a presidential board recommendation for an employe vote on the union shop issue, thus averting a strike, but Lockheed Aircraft Corp. indicated it would reject this approach.

President Kennedy had warned the companies that they would bear the responsibility for a strike if they rejected the board's formula. North American, whose agreement was announced by the White House, said that while it repeatedly had stated its opposition to the union shop, it would in the national interest agree to an employe vote on the issue.

North American and General Dynamics reached agreement on other contract terms with the International Assn. of Machinists and the United Auto Workers.

Lockheed wrote a letter to employes following the President's statement saying that it was not anti-union but anti-compulsion and that if a strike occurred the responsibility would be borne by the union. An election would not represent a vote by an employe to join a union, the letter said, but a vote to decide whether he and other employes, present and future, would be compelled to join a union.

ITT to Advise Defense on Advent Communication Satellite Successor

Washington — International Telephone & Telegraph Corp. has been selected to serve as technical adviser to the Defense Communications Agency in coordinating the development of a military communication satellite system and integrating it into existing military communication networks.

This is the system which will replace the now defunct Project Advent communication satellite program (AW June 18, p. 32).

The company will provide these engineering services over a four-year period under a $12.2-million Defense Department fixed-price contract.

Under the contract terms, ITT is excluded from bidding "on any of the hardware directly associated with the satellite or with ground equipment directly related to the satellite" for a five-year period. The provision is intended to prevent possible conflict of interest, because ITT is a supplier of military communications equipment, primarily of the ground-based type.

The contract is expected to contain waiver provisions which will allow ITT to supply hardware in cases where it is the only available source or where it is otherwise to the government's advantage, if approved by the Defense Communications Agency.

The selection of ITT was made without a formal competition after discussions with qualified companies, a Defense Department official said. He added that ITT was the only one of the qualified companies that was willing to take the job with the hardware exclusion clause.

Many companies with competence in the space communications field are known to be planning to bid on the low-altitude random-orbit or synchronous-orbit communication satellites, or already are involved in the ground terminal programs for the original Advent communication satellite which may be used with the new system.

Bendix, Philco, Radio Corp. of America and Space Technology Laboratories are expected to be among the contenders for the low-altitude satellite. Hughes Aircraft, STL and perhaps Lockheed are expected to bid for the synchronous satellite. Sylvania developed the antennas for the original Advent which are likely to be used in the new system.

American Telephone & Telegraph Co., which is not expected to bid on the new military communication satellites, probably shunned the opportunity because of previous criticism that it may try to dominate the commercial communication satellite corporation.

Observers suggest that ITT felt that the opportunity to gain experience in the operational problems of a communication satellite system and to establish a working relationship with DCA far outweighed its chances of winning one of the satellite contracts.

The company will set up operations for the new assignment in Arlington, Va., near the Defense Communications Agency headquarters. Some ITT personnel will be integrated with military personnel in the agency, a spokesman says. The company's ITT Federal Laboratories, Nutley, N. J., is expected to head the program.

Defense Secretary Robert S. McNamara has approved a plan submitted by DCA to appoint two deputy directors, with two-star rank, to head the agency's military communication satellite office and its national military command system office, but the officers have not yet been announced.

Record Claims

U. S. Air Force, U. S. Navy and Soviet Russia last week claimed four new world aircraft records.

Air Force said a Convair B-58 Hustler bomber flying from Edwards AFB, Calif. piloted by Maj. Fitzhugh L. Fulton, attained an altitude of 85,360.84 ft. carrying a 5,000 kg. (11,023 lb.) payload. Two records, for carrying 2,000 kg. and 5,000 kg. to higher altitudes than before, will be claimed.

The existing 2,000 kg. record of 66,170.72 ft. was set by a Russian RV monoplane powered by two 37V turbojet engines July 29, 1959. The existing 5,000 kg. record of 50,252.52 ft. was set Sept. 16, 1959 by a 201M midwing monoplane powered by four Type D turbojet engines.

Russia claimed an E-166 aircraft piloted by Pyotr M. Osrapenko attained an altitude of 22,680 meters (72,411.08 ft.) Sept. 11. Russia claimed this breaks the record for sustained altitude in horizontal flight—66,433.8 ft.—set by the McDonnell F4H-1 fighter Dec. 5, 1961. Russia said the aircraft held a constant speed of 2,500 kph. (1,553.5 mph.) during the flight.

A U. S. Navy Grumman UF-2 Albatross amphibian aircraft, piloted by Lt. Cdr. Richard A. Hoffman, flew a 5,000 km. (3,107 mi.) closed course at 151.4 mph. Sept. 17. The Navy claimed this as a record for a new category. The flight was made from the Floyd Bennett Naval Air Station, N. Y.

Apollo Solar Cell Studies

Solar cell energy conversion systems are attracting growing attention at National Aeronautics and Space Administration's Manned Spacecraft Center in Houston as possible alternative electrical power systems for the Apollo spacecraft.

The solar cell systems might be backups or substitutes for Apollo's Pratt & Whitney fuel cell system (AW Apr. 9, p. 54), which at this stage of its development appears above weight and volume specifications.

A detailed design study of a furlable 2.5 to 3 kw. solar cell system, conducted by Ling-Temco-Vought for the Manned Spacecraft Center under NASA contract, is being evaluated in Houston. Furlable system scale model also has been delivered.

The LTV system consists of 16 solar cell panels, to be arranged like petals around the after body of the Apollo service module. Each panel is about 200 in. long and 30 in. wide.

To unfurl from the folded position, the petals, hinged at their roots, swing back from the side of service module and unfold about hinges at center of panels.

Besides the funded LTV studies, Hoffman Electronics in Los Angeles is continuing its unfunded studies of Apollo solar cell backup systems for NASA. Hoffman is understood to have completed two phases of its studies, one of these related to Apollo's lunar orbit rendezvous mission and the other concerned with the de-emphasized direct ascent mission.

NASA Sees Telstar-Type Satellite As Best for World-Wide System

Washington—Space agency last week said it probably will be five years before a world-wide satellite communication system becomes operational and predicted it will employ the Telstar type rather than synchronous orbit satellites.

Leonard Jaffe, communications systems director for the National Aeronautics and Space Administration, made this prediction during House Science and Astronautics Subcommittee hearings during which Hughes Aircraft Co. officials claimed their Syncom system could become operational in mid-1964. Syncom would be better and cheaper than low- and medium-altitude communication satellites under development, they said.

The Hughes testimony raised anew the question of whether the U. S. should expand the Telstar program into a world-wide system or remain uncommitted until Syncom demonstrates its capability. Subcommittee Chairman Ken Hechler (D.-W. Va.) told AVIATION WEEK after the hearings that he was satisfied with the way NASA was proceeding and did not feel Congress should urge changes.

NASA's position, as expressed by Jaffe, is that Syncom still must prove itself before the space agency can justify changing its emphasis in communication satellite development. Although Syncom holds much promise, Jaffe said its reliability cannot be decided until it is flight-tested. Syncom 1 is scheduled to be launched early next year.

Dr. Fred P. Adler, Hughes space systems division manager, and C. Gordon Murphy, Hughes Syncom project manager, said, "the use of a synchronous, spin-stabilized satellite will provide the optimum operational communications system for both commercial utilization and for military requirements." Adler said the U. S. should not commit itself to any other type of communication satellite system "unless it is shown that there are some flaws in the basic concepts" of the Syncom approach. He said Syncom Mark 1 will "demonstrate essentially all the basic concepts and features that are in question."

Adler went so far as to imply that Telstar was more a stunt than a sophisticated communications system. Although he endorsed hailing Telstar as a scientific triumph of the West, he added: "There is a little distinction here between what you do as a stunt—as a prestige item—on the one hand and what you really put in as a commercial system requiring large investments of money on the other hand. It is with the latter that we are concerned when we say let's not make the major investments required to put in a Telstar-type world-wide operational system."

Hughes officials are hoping that Syncom Mark 1 will be so successful that NASA, early next year, will give the company about $15 million to accelerate the program. Adler said the $15 million would cover Hughes' cost in building a Syncom Mark 2 prototype, conducting environmental tests and constructing three flight models. This amount, however, would not cover Lockheed Aircraft Corp. work on the spin stabilization table and orbit analysis.

If NASA does accelerate the program this way, Adler said three Syncom 2s could be in orbit by the end of 1964, giving the U.S. an operational satellite system except for the ground stations.

Murphy said Syncom 2 will weigh 1,250 lb. He said Lockheed feels the planned Atlas-Agena combination will be able to inject as much as 1,470 lb. into synchronous orbit. Syncom radius from the center of the earth will be 22,700 naut. mi. Syncom 2 will be designed to stay in orbit at least five years. Adler said it will be simpler and cheaper to obtain world-wide coverage with a Syncom system than a Telstar system because fewer satellites would have to be launched and fewer, smaller ground stations would be needed.

Jaffe said that if Syncom 1 is successful and Syncom 2 is started early in 1963, it would be late 1964 or early 1965 before the first Syncom 2 was launched. "Our major questions are the reliability and survivability" of Syncom, Jaffe said. Dr. Hugh Dryden, NASA deputy administrator, estimated in an earlier hearing that it will be 10 years before a synchronous communication satellite system is fully developed. Jaffe agreed this was a realistic estimate.

Syncom 1 will be launched from Cape Canaveral by a Douglas Delta launch vehicle into a highly elliptical orbit. Once at the planned apogee of 22,300 mi., Syncom 1 will be given an extra kick by a gas propellant to make it rotate in phase with the earth. Another gas jet will be fired by ground command to spin the satellite so it will remain in the proper attitude. Still another gas rocket will be used to speed or slow Syncom to keep it moving the same speed as the earth's rotation. This launch sequence, as well as the gas propellant systems, are some of the unknowns which NASA must test before placing more emphasis on the Syncom program, Jaffe said.

Soviet Comsat Plans

Soviet Union's vice minister of communications, Alexsander Kakunin, says the USSR plans to put communication satellites into synchronous orbit. In an article appearing in Gazeta Pomorska, a Soviet commentator says the future "cosmovision center" will beam television programs to the satellites from 11 a.m. to 3 p.m. and from 11 p.m. to 3 a.m., and it will receive other satellite programs between those periods. No further details are provided.

The launching date for the communication satellites is not given, but it "should happen in the very near future, according to Prof. K. Sergeyev, an excellent forecaster of space events," the Russian publication says.

Gemini, Apollo Control Center

Los Angeles—Process of selecting a systems integration contractor to be responsible for an entire ground-based complex for controlling the Gemini rendezvous mission and the various Apollo spacecraft missions will get under way soon with the distribution to industry of proposal requests for an integrated mission control center. The proposal requests and subsequent procurement will be handled by National Aeronautics and Space Administration's Manned Spacecraft Center in Houston where the mission control center will be located.

Work statement was being prepared in Houston last week and the likelihood is that contractor selection process will begin shortly if the complex is to be completed, as intended, in time for the Gemini rendezvous mission.

In addition, the Manned Spacecraft Center currently is evaluating industry proposals for a large ground computer complex scheduled for inclusion in the integrated mission control center. Proposals are believed to have been submitted by International Business Machines Corp., Control Data Corp., International Telephone & Telegraph Corp., Radio Corp. of America, Bendix Corp., Philco Computer Division and Raytheon Co. with CEIR as a subcontractor. The company selected to supply the computer complex will serve as an associate contractor.

Tiros 6 Sends Excellent Photos; Surveys MA-8 Path, Storm Area

Washington—Sixth Tiros satellite, launched two months earlier than scheduled, was returning excellent cloud cover photographs late last week as part of the U. S. attempt to obtain maximum weather information on the area which spawns tropical storms and the path over which Cdr. Walter M. Schirra, Jr., will fly in his Mercury Atlas-8 spacecraft (see p. 29).

Early launch of Tiros 6 was made to monitor weather activity with three cameras—one in Tiros 5 and two in Tiros 6. Weather Bureau's National Weather Satellite Center was scheduled to correlate the programs of cameras of both satellites on Sept. 22.

In the most successful U. S. satellite program to date, the Tiros 6 was launched into orbit at 4:45 a.m. Sept. 18 as the payload of a Douglas Thor Delta vehicle. The launch was the tenth consecutive Delta success; the single Delta failure was on its first launch attempt May 16, 1960. Tiros 6 orbit ranges from 442-425 mi., and its orbital inclination is 58.3 deg. Period is 98.7 min.

Payload of the latest Tiros satellite is essentially the same as that of its predecessors, with the exception that it carries no infrared sensors. The 281-lb. spacecraft contains 104-deg. wide angle lens camera, able to photograph an area 750 mi. on a side, and a 76-deg. medium angle camera, covering 450 mi. on each side. Each camera can take 32 photographs during an orbit, separately or simultaneously, and the photographs are stored on a 400-ft. tape for readout over Wallops Island, Va., and Pt. Mugu, Calif.

During its first six days of orbit, Tiros 6 took photographs over the Middle East, Eastern Europe, Indian Ocean, Eastern Pacific, Southern Atlantic, and portions of the Southern Hemisphere over Africa and South America.

Tiros satellites are designed and built by Radio Corp. of America's Astro-Electronics Division, with National Aeronautics and Space Administration's Goddard Space Flight Center having project direction.

Weather Bureau will recommend extension of the Tiros program to include at least five more satellites (AW Sept. 3, p. 17) because of a delay in the Nimbus weather satellite program (see p. 73). Although an electrical failure in the medium angle camera lens on Tiros 5 makes this camera inoperative, Tiros 5 wide angle camera continues to function, and the Weather Bureau now has its first opportunity to correlate photographs from two satellites.

News Digest

Ground engine run-up operational tests have been resumed on the eight Rolls-Royce RB.162 lift engines aboard France's Dassault Balzac testbed for the proposed Mirage 3V Mach 2 VTOL interceptor. Ground and hovering test was delayed by a fire in the fuel cell for the lift engines during the initial stages of the program (AW Sept. 10, p. 30).

Air Force last week named the two civilians and two Air Force officers who will pilot the North American XB-70 Mach 3 bomber beginning late this year when it is expected to make its first flight. They are Al White and Van W. Shepard of North American, and Lt. Col. Joseph F. Cotton and Maj. Fitzhugh Fulton.

Thomas G. Lamphier, former General Dynamics and Fairbanks Morse executive, has been elected vice president for corporate planning for the Raytheon Co.

Mariner 2 spacecraft began experiencing a slight anticipated increase in speed Sept. 18 from attraction of the sun as the vehicle continued its long cruise toward the planet Venus. By 4 p.m. EDT today it was expected to be 4,587,721 mi. from the earth and traveling at 6,495 mph., an increase of about 47 mph. over its lowest speed occurring on Sept. 18.

Snap-8 experimental nuclear reactor was tested for the first time Sept. 17 at what the Atomic Energy Commission termed "very low power and without its electrical generating system." Atomics International conducted the test at Santa Susana, Calif. Snap-8 is designed to produce 30 kw. with one generating unit and 60 kw. with two units coupled to the same reactor. Full power tests are scheduled for next year.

Strategic Air Command last week suspended supersonic flights of its General Dynamics B-58 Hustler jet bombers following the crash Sept. 14 of a B-58 assigned to Bunker Hill AFB, Ind. A SAC spokesman said the suspension was ordered pending results of an investigation into the crash, which occurred in southern Indiana.

Air Force has leased two air-transportable communication satellite ground terminals from International Telephone & Telegraph Corp. which will be used to gain operating experience in use of satellites. One of the two USAF terminals will be located at Nutley, N. J., while the other will be located initially at an undisclosed site in the Caribbean area.

RL10-A3 Tests

Washington—Pratt & Whitney RL10-A3 hydrogen engine, which will power the Saturn S-4 second stage and advanced second stages of the Atlas Centaur vehicle, successfully completed its preliminary flight rating test (PFRT) last week at the company's West Palm Beach, Fla. facility.

The 15,000-lb.-thrust engine was static fired 20 times for an accumulated firing time of 2,820 sec. in the PFRT, according to NASA.

Magnetic Theory Cited in Doppler Dispute

Navigators show scientific backing for claim that underwater fields can disrupt navigation device.

By Robert H. Cook

Washington—Last ditch attempt to block Trans World Airlines' use of Doppler radar as a primary navigation system over the North Atlantic is being made by the Airline Navigators Assn. on the basis of a new theory that underwater magnetic fields in the mid-Atlantic Ridge affect accuracy of the equipment enough to create a hazard.

The union, claiming support for the theory from geomagnetic authorities of the Air Force, Navy and Columbia University, has appealed to Congress, the Civil Aeronautics Board and the Federal Aviation Agency to suspend TWA's planned use of Doppler on Oct. 1 pending a more exhaustive scientific investigation.

ANA has bitterly opposed the use of Doppler in the past on grounds that it is not accurate enough for a primary navigation system and that TWA, the only international carrier planning to utilize it in this manner, wants Doppler as a permanent replacement for 55 ANA navigators. TWA pilots will operate the Dopplers on international flights (AW Sept. 11, 1961, p. 42).

The company recently notified ANA that 37 navigators will be furloughed Sept. 30 and the remaining 18 will be assigned to piston aircraft. The furlough notice came after FAA did away with a requirement for specialized navigation on TWA's Boeing 707 aircraft, as a result of a joint evaluation of the equipment by the airline and the agency, TWA said. TWA and the navigators are now disputing the timing of the furloughing.

ANA and TWA have been in conflict since the start of the Doppler evaluation program, with the union contending that TWA aircraft log and maintenance books prove that the equipment has encountered a high percentage of operational malfunctions and is not sufficiently dependable or accurate to replace the navigator. A high percentage of these inflight failures were not reported by pilots, the union explains, because navigators were on board to correct course deviations which frequently exceeded 50 mi. on transatlantic crossings.

TWA denies the navigators' charges, replying that in 340 Doppler-controlled flights the average course deviation was only 10 mi. and the greatest error was 50 mi. Aircraft are equipped with two Doppler systems, and in no instance have both failed on the same flight, the company contends. No evidence of a magnetic interference from the mid-Atlantic Ridge has been reported, TWA said.

Rep. Henry B. Gonzalez (D.-Tex.) has in the past taken sharp issue with FAA Administrator Najeeb Halaby over approval of the Doppler system and last week renewed his attack on the basis of the magnetic field theory.

"I doubt very much if any of the data I have on [TWA] flight logs is not already known to Mr. Najeeb Halaby," Gonzalez said. "I think Mr. Halaby is wrong in his indifference to this situation, and I appeal to him to reconsider his stance. I do not doubt that he feels he can rely on certain tests that FAA performed prior to his approval. But a man should not be blind to new evidence and he should not turn a deaf ear to reasonable proposals to investigate the possible causes of the breakdown in this Doppler system."

Rep. Gonzalez cited a proposal from the Lamont Observatory of Columbia University that FAA provide $10,000 to collate data gained from a thorough investigation of the mid-Atlantic Ridge theory. He appealed for FAA's aid, saying the request is a "reasonable proposal when weighed against the many thousands of lives that depend on the performance of this device."

Much of the mid-Atlantic Ridge theory, formulated by an ANA member, was first presented at a recent meeting between CAB Bureau of Safety officials and union navigators at TWA, Scandinavian Airlines System, Swissair and Trans Canada. The consensus of the navigators was that Doppler use over the North Atlantic was subject to significant course deviation and should be employed only as another aid to the navigator. SAS, Swissair, TCA and several foreign carriers use the equipment as a secondary navigation system.

Possible cause of the Doppler deviations on transatlantic flights, according to TWA navigator Andrew Yelaney, is the presence of magnetic ore deposits in the mid-Atlantic Ridge below the ocean.

Yelaney, chairman of ANA's special projects branch and a TWA navigator for 20 years, said that in a six-month period of using Doppler across the Atlantic he recorded consistent course deviations of from 2 to 6 deg. whenever his aircraft was near the underwater ridge. Course corrections necessary in the direction of Ireland were from 45 to 56 mi., he said. Altitudes of these flights were generally from 33,000 to 39,000 ft.

In an attempt to support his theory, Yelaney said he contacted the Air Force Cambridge Research Laboratories, which expressed interest and advised him that the U.S. Navy Hydrographic Office had a program called Project Magnet to check out magnetic phenomena. Navy geomagnetics experts later told Yelaney that surface ships had reported unusual compass deviations in the area of the mid-Atlantic Ridge.

The Navy requested further information from Yelaney and said that under Project Magnet, a 250-sq.-mi. area south of Iceland would be flown for several months on a 3 to 5 mi. grid pattern, to determine the magnetic effects of the underwater mass on aircraft navigation. A Lockheed Constellation will be flown in the project at an altitude of 18,000 ft., the Navy said.

On the basis of this and other correspondence, plus an aircraft position chart with celestial observations pointing out the course deviations over the mid-Atlantic Ridge area for a period of six months, Yelaney came to these conclusions:

- **Mid-Atlantic Ridge** from Iceland to South Africa is generating a separate magnetic field because of geological changes in the ocean floor.
- **Degree of magnetic** attraction is not consistent and may vary from week to week.
- **Low radio frequency** range in the 200 to 400 kc. band can be affected by this magnetic field.
- **Turbojet aircraft**, equipped with a vector airborne magnetometer, should be flown over the ridge from Iceland to Ascension Island for at least one year to measure varying magnetic attraction.

Yelaney and the foreign carrier navigators later told CAB that another problem encountered with Doppler operation is that LORAN signals necessary to attain a position fix and correction of the navigation system have generally been weak in much of the area near the ridge.

Strong interest and support for Yelaney's theory has come from the Lamont Observatory, which has contacted CAB and the heads of both TWA and Pan American World Airways, in addition to FAA, with the proposal to conduct a more detailed study.

In a letter to the FAA, J. H. Heirtzler, head of Columbia's geomagnetism department, said that it was "only by talking directly with an alert jet aircraft navigator" that Columbia learned that present errors in magnetic charts covering the mid-Atlantic Ridge area are so large and that they can seriously affect commercial aircraft navigation.

Using Yelaney's figures comparing true with magnetic headings in the area, Heirtzler said that in aircraft that use magnetic headings, through Doppler systems, errors of 50 mi. off course can frequently occur. At a jet speed of 600 mph., an error of only 5 deg. in the existing magnetic chart would put the aircraft off course 25 mi. within one half hour, he said. An additional 5 deg. error in the calibration of the magnetic sensor would place the aircraft a total of 50 mi. off course in the same period.

"For present Atlantic air corridors of 60 naut. mi. to either side of the aircraft the margin for safety is small," Heirtzler stated. "If it becomes necessary to reduce the size of the space allotted to each aircraft in the future, the problem will be much worse."

Aid for Eastern

New York—Eastern Air Lines last week disclosed that it has received $15.8 million from member airlines of the Mutual Aid Pact since the beginning of the Flight Engineer's International Assn. strike on June 23.

Eastern, whose flight operations were completely shut down until Aug. 9, said it lost $23.4 million between June 23 and Sept. 12. Losses were reduced by Mutual Aid Pact assistance to $7.6 million.

Of the $15.8 million received from the eight Mutual Aid Pact airlines, $5.9 million was "windfall"—revenues that pact carriers received over and above normal revenues as a result of the strike and that were rebated to Eastern.

The remainder, $9.9 million, was labeled "supplemental" revenues which result from a newer amendment to the aid pact which has not yet received CAB approval. These revenues stem from an agreement among pact carriers to cover up to 25% of the operating costs of the struck carrier.

Dispute Over Fares, Cargo Rates Looms at IATA Traffic Meeting

Drawn-out fight over the lowering of passenger fares and cargo rates, especially in the North Atlantic area, is certain to develop at the International Air Transport Assn. traffic conference which begins today at Chandler, Ariz.

The wide-spread differences over rates, which were buried temporarily with the compromise group-fare plan introduced earlier this year to appease low-fare advocates (AW Feb. 12, p. 38), arose again after arguments over cut-rate ticket selling during the IATA annual meeting (AW Sept. 17, p. 38). At least two major carriers contended that discount fares stemmed directly from dissatisfaction with the current high level of North Atlantic fares.

Lufthansa, West German airline, has become the leader in the drive for lower fares. In a statement issued during the annual meeting, Lufthansa's delegates said, "a fundamental reorganization of the North Atlantic passenger tariff is essential. Lufthansa would like to see all special tariffs abolished and the introduction instead of lower regular fares on the North Atlantic route."

By special fares, Lufthansa referred to the 17-day excursion rates and special fares for tour groups of 25 persons or more now in effect. Group fares have never been popular within the industry and won approval only after a series of mail votes pressed on the industry by Sir William Hildred, director general of IATA.

A number of carriers want a simplified tariff structure as a means of easing passenger handling and ticketing procedures. In addition, some airlines, particularly U.S. companies, hope to eliminate low circuitous fares, permitting multi-stopovers, on European legs of round-trip North Atlantic flights.

Lower-fare advocates will meet opposition from other airlines, principally TWA, Air France and British Overseas Airways Corp., which will be backed by some smaller foreign flag carriers. Latter group views fare increases as the best solution of the industry's financial problems. TWA feels that excursion rates provide the necessary fares to lure traffic.

The small carriers believe that lower fares will merely deplete revenues rather than boost passenger volumes. Indications are that this group seeks a fare increase of about 5%.

Lufthansa says it "does not believe that these fare changes would result in any loss of revenue. Just the reverse—lower fares would be offset by an increase in demand and load factors."

Lufthansa can expect support from at least one U.S. carrier in its request for lower fares, as well as lower cargo rates. Several airlines will advocate expansion of excursion and group fares, rather than an across-the-board fares slash, but these will be in the minority.

There is still strong doubt that the stringent enforcement measures on cut-rate ticket selling adopted at the IATA general meeting will have any direct effect in arresting the practice. At least two major carriers were charged with violating IATA fare regulations in a special statement issued to the executive committee but during the session on enforcement, carriers pointedly claimed their companies were guiltless.

IATA plans to hire within one year a professional sleuth to run the expanded staff of enforcement officers approved during the annual general meeting, but many delegates feel this is not enough to prevent violations. Such drastic measures as expulsion from IATA of violators or public exposure of their misdemeanors were proposed.

One step that will be taken will be to notify the government of any carrier involved in a violation calling for a fine of $10,000 or more.

A simplified tariff structure, machine ticketing and new procedures for collecting excess baggage charges have long been considered major needs by international carriers. But disputes over fare levels, excursion rates and jet surcharges have forced IATA to side-track these more basic issues.

As a result of the new struggle over fare levels, these issues are again likely to be shelved at the Chandler traffic conferences.

IATA Elections

Dublin—Count Nicolo Carandini, president of Alitalia Airlines, has been elected president of the International Air Transport Assn. for 1963. He will replace J. F. Dempsey, general manager of Aer Lingus, who was named to IATA's executive committee.

Re-elected to the executive committee for three-year terms were Charles E. Beard, president of Braniff Airways; John C. Leslie, vice president and assistant to the president of Pan American World Airways; Sheikh Najib Alamuddin, chairman and managing director of Middle East Airlines; Louis Lesieux, president of Air France; and Gregorio A. Obregon, director, Avianca.

Richard M. Jackson, president and board chairman of Seaboard World Airlines, failed for the second time in his bid for election to the executive committee.

Maytag Seeks to Avoid Public Sale Of Pan Am-Owned National Stock

By James R. Ashlock

New York—Lewis B. Maytag, Jr., said last week that he wants to avoid a public sale of the 466,000 shares of National Airlines stock held by Pan American World Airways, a sale that could threaten Maytag's position as head of National.

Maytag said he had been talking with Pan Am about an exchange of the stock for the 400,000 shares of Pan Am stock held by National. The two airlines have been told by Civil Aeronautics Board to dispose of their holdings in each other by October, 1963.

A factor against the stock jeopardizing Maytag's seat as National's president is the CAB stipulation that no more than 10% of each carrier's shares can be sold to a single individual. Maytag and his associates already control 12% of National's total outstanding stock.

"In any event, I would prefer to exchange the stock with Pan American rather than release it through a public sale," Maytag said.

National and Pan Am obtained equal interest in one another in 1958, when National leased Boeing 707 equipment from Pan Am for East Coast service (AW Aug. 20, p. 40). Pan Am's original 400,000 shares in National grew to 466,000 through stock dividends, while National received $1,200,000 in cash dividends and retained its 400,000 shares of Pan Am stock.

As far as his own maintenance of control is concerned, Maytag said that it depended primarily on his ability to show a profit. "I ask no quarter otherwise," Maytag said. "The stockholders have every right to replace me if the company is not run at a profit."

Maytag said that National plans to become an all-jet airline by Jan. 1, 1963, and has plans to ground or sell its 30 piston aircraft. The program will leave National with 26 aircraft, consisting of nine Douglas DC-8s and 17 Lockheed Electras.

National is negotiating sale of its piston fleet of DC-7s, DC-6s, Constellations and Convair 240s to a broker —with the exception of four DC-7Bs used in its Panagra interchange—which might result in an over-all capital loss of $200,000-$250,000, Maytag said. Even if the sale is not consumated and the fleet is grounded, Maytag said, studies indicate grounding would be more economical than continued operation.

Value of the piston aircraft varies widely. Maytag said that no bid price is available for National's eight DC-7s, for example, and that an estimated market value placed on them is $75,000 each.

To bring the jet and prop-jet fleet up to the programed level, National will purchase three Electras from American Airlines, Maytag said. The carrier announced earlier the acquisition of three more DC-8s equipped with turbofan engines. These three, bringing National's DC-8 total to nine, will all be in service by November.

Maytag said that National, which only last week was still looking at the Sud Caravelle, did not feel it should undertake now the additional financing required for the purchase of short-haul jets.

"It is my hope that we will not be forced to purchase any short-haul jets in the near future," Maytag said.

He said that with the three additional Electras, National felt it could serve its markets profitably now without the Caravelle or BAC 111. Another point he emphasized is that National's routes are relatively long, and that it can get along without short-haul jets for some time yet.

Discussing mergers, Maytag attacked the proposed coalition between Eastern and American.

"Should the CAB approve this merger, it would, in the view of many in the airline industry, pave the way at some time in the future for the Big One—a single big, fat air carrier owned by the state and operated by the state."

He was likewise outspoken in opposing the continuance of Northeast Airlines in the East Coast-Florida market.

"Our position is unalterable: There was no excuse for permitting Northeast on the route originally. History has proved this to be a grave mistake, and there is no excuse for continuing Northeast in this over-supplied market."

Maytag said that this winter, National will begin DC-8 service between Newark-Miami, Boston-Miami, and between New York, Jacksonville and Tampa. National's new jets will provide this service expansion. However, he said this was merely a move by National to provide jet service for those cities it serves, and is not intended as a saturation drive against Eastern and Northeast.

"You won't find us guilty of saturation for saturation's sake," Maytag said.

Mergers are not the best solution to airline problems, Maytag said, especially mergers of the strong with the strong rather than the strong with the weak. The answer, he believes, is in realignment of routes to remove over-competition. National has no merger plans, he said, but cannot close the door to such a possibility in the future.

"National's planned expansion," Maytag said, "does not mean routes or airplanes or services necessarily. I'm against a policy of acquiring geography for geography's sake."

American Airlines' Shifts

Washington—American Airlines last week began realigning the duties of its top executives by naming F. J. Mullins as vice president of sales and service. Mullins will also remain as a vice president of field activities. He replaces R. L. Fitzpatrick, who has resigned. Vice President Charles Speers will handle passengers sales.

Walter J. Rauscher, former district sales manager in New York, was elected vice president of passenger services, replacing W. G. Whitney, who has resigned. Vice President L. E. Glasgow has assumed responsibility for the purchasing and supply department and advertising under Vice President T. J. Ross, Jr., who was transferred to public relations under Vice President Willis Player.

Businessmen Dominate Local Service Traffic

Washington—High-income businessmen traveling on expense accounts and credit cards continue to provide the backbone of local service airline revenues, according to the most recent analysis of an Ozark Air Lines passenger survey.

The survey, a continuing marketing study now in its third year, revealed little change in the travel habits of its passengers, based on 12,500 detailed questionnaires covering every Ozark flight throughout the week of May 21 through 27.

An estimated 30% of all Ozark passengers surveyed had annual incomes ranging from $10,000 to $14,999; 22% from $6,000 to $9,999; 14% from $15,000 to $19,999 and 10% from $20,000 to $30,000.

Expense account travelers remained nearly constant at 73.8% of the total surveyed over a three-year period. Universal Air Travel Plan members flying on Ozark increased about 5% over the three-year span and reached a 35.1% total in this year's survey. A breakdown of the cardholders showed that 19.5% used American Express credit cards; 10.8% used the Diners' Club; 11% Carte Blanche and 2.6% Ozark Air Lines credit system.

Last year Ozark calculated that 25.2% of its passengers made between 6 and 17 airline trips and 20.4% made between 1 and 5 trips.

Japanese YS-11 Makes First Flight

Japan's Nihon Aeroplane Manufacturing Co., Ltd.'s YS-11 jet transport made its first flight on Aug. 30. Aircraft is scheduled to enter production next year. For other photos and specifications of the turboprop-powered plane see p. 97.

Legislators See Photos of Alleged Pilot Laxity; Demand Crackdown

Washington—Congress issued a stern warning to the Federal Aviation Agency and the Civil Aeronautics Board last week to tighten up air crew safety standards after viewing a series of 39 photographs, submitted by the Flight Engineers International Assn., allegedly showing pilots asleep or reading newspapers while flying Eastern Air Lines' airliners (AW Sept. 10, p. 39).

At the same time, Rep. Jack Brooks (D.-Tex.), chairman of House Government Operations Subcommittee, issued a subpoena for a Trans World Airlines' flight engineer, who, according to testimony by FEIA witnesses, possesses a similar set of photographs involving alleged violations on TWA flights.

"The shocking pictures we examined here today," Brooks said, "graphically showed us that some pilots and crews of airliners are grossly neglectful of their duties while their planes are in flight, loaded with trustful passengers. Pilots who sleep on the job and put all their faith in letting George, the robot pilot, run the plane are asking for disaster that can mean death for themselves and their innocent passengers."

FAA Administrator Najeeb E. Halaby said the agency is investigating the alleged violations and would take action "if necessary," but cautioned that the validity of the pictures had not been established and that they might have been taken on the ground.

D. K. Carson, a striking Eastern Air Lines flight engineer, testified that he had personally taken the pictures in-flight with an infrared camera between mid-1959 and mid-1961. He said they were not shown to EAL, but that complaints to Eastern about such conduct brought a "so, what?" type reply.

Carson identified William J. Miller as the possessor of the other set of photos, and said that a complaint by Miller to the airline brought a similar uncooperative reply.

Rep. John E. Moss (D.-Calif.) said he found it "equally disturbing" that the pictures were not turned over to the FAA until more than a year after the last one had been taken.

Carson replied that he was afraid to do so, since once their existence became known within the industry, he received threatening phone calls advising him to keep his children off the streets. Miller had also been frightened, he said.

"Maybe I'm a coward," Carson said, "but I had my family to think of."

Under further questioning, Carson also conceded that the original intent of the photos was to help prove the FEIA contention that the Air Line Pilots Assn. had exaggerated the number of pilot-trained personnel needed in the cockpit. The pictures also failed to show what the copilots were doing, he added.

FEIA President Ron Brown's testimony also brought a heated exchange with Halaby after Brown told the subcommittee that FAA "took sides" in a labor dispute by approving lower training requirements for Eastern flight engineers, which allowed the company to train "strike-breakers."

Halaby labeled the charges "false, misleading to the American public and irresponsible." He said he had tried to be fair in his dealings with FEIA, but that the union had been "unfair and dishonest with me."

Replying to Brown's charge that FAA intentionally reduced the Eastern training requirements after the strike had started, Halaby pointed out that all flight engineers replacements at Eastern were trained pilots. These men have enough knowledge of instrumentation and aircraft controls to require less training as flight engineers, he said.

U.S. Urged to Better Its Foreign Air Rights

Washington—White House policymakers last week were urged by Sen. Jennings Randolph (D.-W. Va.) to demand a more equal exchange of airline routes and authority in bilateral negotiations with foreign governments.

During a Senate debate on legislation to expand foreign trade, Sen. Randolph stated that the exchange of international air services represents as direct an impact on the U.S. balance of payments position as does the exchange of actual commodities. Last year, he said, U.S. carriers earned $149 million from the transport of foreign nationals, while foreign flag lines earned $299 million from American travelers. In effect, this amounted to a balance of payments deficit of $150 million, he said.

Citing the heavy foreign competition over the North Atlantic, Randolph warned that a dozen other countries have also negotiated air rights which they have not yet activated and Africa now has 16 emerging countries, most of which intend to establish international routes.

An added problem has been the rate cutting and capacity violations by many foreign carriers, which could be solved by congressional passage of legislation giving the Civil Aeronautics Board authority to demand more detailed traffic data from foreign airlines. The bill as introduced by Sen. Warren Magnuson (D.-Wash.), would give the U.S. government "added bargaining power comparable to that provided under the pending trade bill," Randolph stated.

First Ethiopian 720B Rolls Out

Ethiopian Airlines Boeing 720B rolls from the Renton, Wash., plant. Plane will be delivered in October, and another in November, with scheduled service beginning Jan. 15, 1963. 720Bs are Ethiopian's first jets. Ethiopian Airlines conducts operations under a management assistance contract with Trans World Airlines.

Low Load Factors, Year-End Dip Offset Trunkline Traffic Increases

Washington—Domestic trunkline enthusiasm over the industry's apparent recovery from a two-year traffic relapse is being dampened by the fact that load factors are at one of their lowest points and the realization that anticipated traffic gains for the final quarter may be diluted by intense competition.

Last month the industry's revenue passenger mile total inched forward for the ninth consecutive month to reach 31.37 billion for a 12-month period, a gain of 8.3%—the highest in two years. On a monthly basis, 2.90 billion revenue passenger miles were recorded in August, just slightly under the industry's best performance in nearly three years—the June total of 2.95 billion.

Although the airlines appear to have succeeded in reversing the downward trends experienced during May, June, July and August of the past two years, traffic growth for the same months of this year has been minute: 0.3% from April's 12-month figure of 8.0% to last month's 8.3%. Observers note that fourth quarter traffic has customarily dropped 2%.

Assuming that the airlines can hold this slight lead, and adjusting predicted year-end traffic figures to reflect a possible seasonal reduction of 2%, the industry could emerge with a 1962 annual growth rate of 6%.

While this estimate generates optimism by some airlines, others point out that the significance of the traffic gain is offset by the fact that it is compared only with the meager gain of 1% in 1961—the worst traffic growth year in industry history.

The growing conviction that increased revenue passenger miles do not necessarily result in a like increase in profits is emphasized in further figures, which reflect a continued increase in available seat miles and a steady drop in average load factors.

Last month's total of available seat miles for domestic carriers reached a new peak of 4.98 billion, bringing the 12-month figure to a record 57.66 billion miles for a 14.5% gain in the past year. The last comparable rate gain was April, 1960, during the industry's mass switch to predominantly turbojet equipment.

Analysis of the industry's current load factors, yardstick of the airlines' break-even need, shows that while they have improved a great deal during the past two months, they remain in a steady decline for the year.

Trunkline load factors were 58.33% for 12 months ending in August, the highest since April, 1961.

However, when averaged over a one-year period, load factors remained at a near-record low for the industry and were 2.61% below the average for the same period of last year, which in turn was 2.02% below that of the 1960 period.

Allowing for an expected seasonal drop in load factor this fall, offset to some degree by a holiday increase at Christmas, the industry may expect to tabulate a year-end average load factor close to present percentage of 54%.

Local Service Lines Seek Subsidy Shifts

Washington—Local service airlines are requesting a series of changes in the new class mail rate subsidy plan which last year raised industry profits to $3.6 million and reduced subsidy needs nearly $2 million.

While generally satisfied with the plan, which has been in effect for more than a year, the airlines contend that Civil Aeronautics Board adjustments of the subsidy rate for individual carriers is complicating application of the simplified formula on an industry-wide basis.

The class mail rate, which is intended to apply a basic, sliding scale formula of subsidy payment to all local service airlines, lacks adequate provisions to cover the use of larger aircraft and inauguration of new routes by the airlines, according to an industry study prepared by Systems Analysis & Research Corp.

To correct this problem, the report suggested that CAB avert the need for continuous adjustments in the individual carriers' formula by first providing a revenue adjustment factor that would directly reduce subsidy on routes as traffic grows and revenues exceed those used in the formula to estimate needed subsidy.

Secondly, the report said, an additional formula should be included in the class mail rate plan to cover non-subsidy routes. As a basis for this added formula, local service airlines would agree that some routes would not receive subsidy, and if more than four daily flights were provided on the route, subsidy over their entire systems could be reduced.

Minor changes which the report suggested called for elements of the class mail rate formula involving daily schedules to be measured in terms of aircraft departures per station per day, rather than the present system of plane miles per station, which the industry feels penalizes carriers operating over longer stage lengths.

To further reflect the variety of operational problems among the local service carriers, the report also requested that the formula be expressed in various types of revenue and cost instead of only a final subsidy rate per available seat mile.

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AIRLINE OBSERVER

► Airline industry has begun an intensive campaign designed to caution news media on the use of unverified strike threat announcements. Industry representatives are contacting all media, pointing out provisions of the Railway Labor Act and claiming that publicized strike threats that do not materialize have caused heavy traffic losses.

► **Russian plans to provide air service from Moscow to Havana via Africa, hinge upon landing rights agreements with Latin American countries. Aeroflot, the Soviet-owned carrier, has already announced service from Moscow to Conakry, Guinea and Accra, Ghana, in Africa and has conducted a nonstop flight from Conakry to Havana. U. S. State Department says Russia has made preliminary advances to some Latin American countries for landing and refueling agreements necessary for a regular Africa-to-Cuba service.**

► Pan American World Airways and the Transport Workers Union have voluntarily settled their labor contract dispute under terms offered by a special presidential emergency board. Wage and working condition improvements were gained by 13,000 TWU members under a contract containing a permanent no-strike pledge at all existing or future defense or missile installations. TWU currently represents about 3,000 Pan Am workers employed at Cape Canaveral, Fla., and Yuma, Ariz.

► **United Air Lines began its first Caravelle overhaul this week in San Francisco. Overhauls are expected to take 10 days for each aircraft, on a schedule calling for completion of first-time overhauls on all 20 Caravelles by July 17, 1963.**

► Douglas Aircraft will reach a decision on Model 2086 short-haul jet production within the next 90 days. Competitive pressure from the British BAC 111 is rising and another order for it—particularly from a carrier like American Airlines—would leave Douglas with a slim chance to obtain the minimum of 125 orders required to build the aircraft. Douglas cannot begin production without firm orders because of financing problems.

► **Bonanza Airlines will most likely be the next local service carrier to order the BAC 111. An order from the Nevada-based airline could lead to similar moves by other local service carriers operating over comparable stage lengths.**

► Federal Aviation Agency will extend positive control over commercial turbojet flights above 24,000 ft. altitude on Oct. 18. First expansion of positive control, now in effect only from centers at Chicago, Indianapolis, Cleveland and Detroit, will be to the West Coast, with control from the Oakland, Calif., center, according to Administrator N. E. Halaby. By next year, Halaby said, further positive control will be extended to centers at Memphis-Atlanta-Jacksonville; Minneapolis; Ft. Worth-San Antonio-New Orleans-Seattle; Denver-Kansas City-Los Angeles; Phoenix-Albuquerque-El Paso-Washington, D. C.; Salt Lake City-Boston-New York, and Miami.

► **Frontier Airlines, under the new control of Goldfield Consolidated Mines, earned $89,628 last month for an estimated 74% gain over the same month of 1961. Net profits for the first eight months of this year amounted to $303,390 as compared with $216,863 in 1961.**

► Peruvian Civil Aeronautics Board has imposed a fine on Venezuelan International Airlines on charges that the carrier transported several Communist leaders without first having examined their visas following their arrival from Moscow, according to Lima radio sources.

► **Air/truck coordinated cargo shipments have registered impressive gains during the first full year of operation. Total of 73,487 shipments were handled and the volume of monthly shipments reached 8,469 last month, as compared with 1,386 for the same month of last year.**

► Delta Air Lines air cargo flights carried 10.3 million pounds of freight last month for a new company record of 3.4 million revenue ton miles. The weight tally was 19% above that of the previous month and ton miles increased 32%.

SHORTLINES

► **American Airlines** carried 807,000 passengers over more than 617 million revenue passenger miles in August, increases of 11% and 9%, respectively, over the same month last year. The airline reported 14,374,000 freight ton miles in August, claiming a monthly record for domestic carriers. Express ton miles totaled 1,462,000, and air ton miles reached 2,306,000 during August.

► **British Overseas Airways Corp.** will operate 52 flights weekly, including 40 from nine U. S. cities, under its fall-winter North Atlantic schedule. Two of the flights will be all-cargo services with DC-7F aircraft from points on the East Coast to Great Britain.

► **Central Airlines** set a monthly mark during August with 30,484 passengers boarded throughout the carrier's six-state system. The total was 28.5% above the figure for the same month in 1961.

► **Japan Air Lines** will change departure times Oct. 1 on flights from the U. S. West Coast to Tokyo via Honolulu to enable passengers to arrive in Japan during more convenient hours during autumn months. Los Angeles departures are scheduled at 10 a.m. PST on Mondays, Wednesdays and Saturdays and 12:15 a.m. Tuesdays and Thursdays. San Francisco departures will be at 12:30 p.m. Sundays, Tuesdays, Thursdays and Fridays.

► **Middle East Airlines** recorded a gross profit of $1,398,402 during 1961, highest ever achieved by the Lebanon-based carrier. Sheikh Najib Alamuddin, chairman and managing director, told stockholders that net profit was $249,079 and revenues increased 55% from $11,666,977 in 1960 to $18,137,469 last year. Passengers carried last year totaled 207,663 compared with 156,837 the previous year.

► **Pacific Air Lines** reported a net profit of $44,971 during July based on increases of 25.6% in passengers carried and 26.4% in revenue passenger miles over the same month in 1961.

► **Seaboard World Airlines, Inc.,** recorded the highest monthly volume in its history during August with 3,733,000 lb. of cargo and 10,492 passengers carried across the Atlantic. Seaboard made a total of 158 transatlantic crossings during August using seven Canadair CL-44 transports.

Infrared Sensors in Space–Part 1:

Lack of Infrared Data Hampers Midas

By Philip J. Klass

Washington—Troubles with the Midas early warning satellite which have been attributed to its infrared sensors actually result primarily from lack of data on infrared characteristics of the space environment rather than from basic shortcomings in the sensors themselves.

Many of the problems attributed to infrared horizon sensors used for satellite stabilization and/or orientation, such as the Mercury and the Nimbus meteorological satellite, also result from the same basic cause.

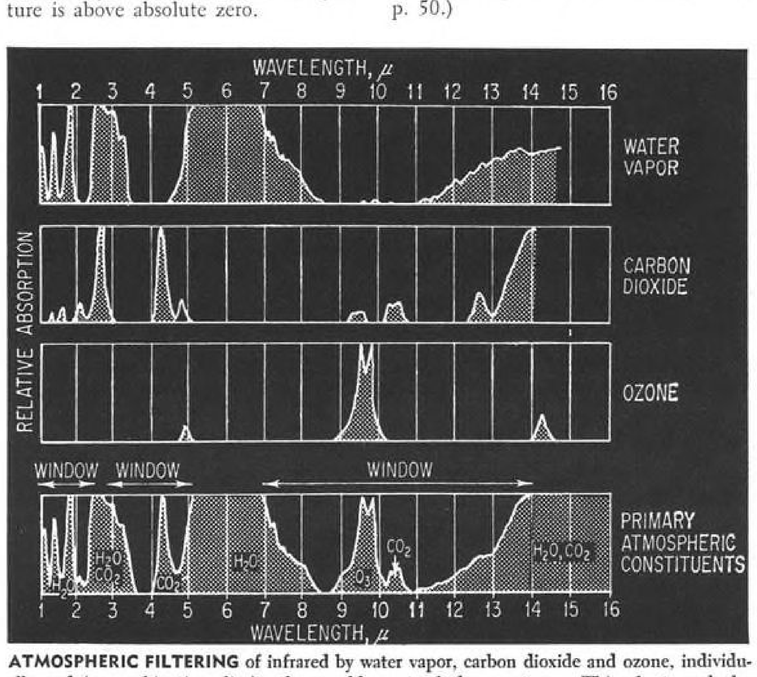
But the capability of infrared technology still is limited for lack of extremely sensitive detectors capable of operating at longer wavelengths without cryogenic cooling.

Many of the present difficulties stem from an important difference between radar and passive infrared systems. Where radar transmits energy that bounces off a target, a passive IR system depends upon the infrared radiation emitted by all objects whose temperature is above absolute zero.

While a radar can give its transmitted pulse characteristics to simplify recognition of the returning echo, a passive infrared detection system must rely upon inherent, but less distinctive, characteristics of radiation emitted by objects to distinguish between two different types of targets or between a target and its background.

There are two principal characteristics which distinguish the infrared radiation of two objects at different temperatures, such as the hot plume from an ICBM booster and the relatively cool background of the earth's atmosphere.

The first is that the temperature of the target determines the wavelength at which it emits the most intense infrared radiation. For example, a black body whose temperature is 100C emits its peak intensity radiation at a wavelength of about eight microns, while a body whose temperature is 1,500C emits its peak intensity at about 1.7 microns. However, both emit some radiation across the entire spectrum. (For more detailed discussion of infrared principles, see AW Mar. 4, 1957, p. 50.)



ATMOSPHERIC FILTERING of infrared by water vapor, carbon dioxide and ozone, individually and in combination, limits the useable part of the spectrum. This chart, and the chart on p. 55, are taken from Henry L. Hackforth's book, Infrared Radiation, which is published by McGraw-Hill.

A second differentiating characteristic is the total energy emitted by any object, which is the product of its area, its emissivity (blackness) and the fourth power of its absolute temperature. Thus, the total energy radiated by a hot object at its peak radiation wavelength will be considerably more than the energy radiated by a cool object at its peak radiation wavelength.

To detect a target such as an ICBM booster, it is necessary to determine the wavelength at which it emits its peak intensity as well as the power level of such radiation. This is referred to as its "infrared signature." Significant radiation may be emitted at a number of different wavelengths depending upon the chemical composition of the rocket fuels used. Thus the infrared signature for liquid propellants will differ somewhat from solid propellant boosters.

Additionally, it is necessary to make similar measurements of the wavelength(s) and intensity of radiation from the atmospheric background against which the booster must be detected.

Infrared Absorption

Because atmospheric constituents such as water and carbon dioxide absorb infrared at certain wavelengths, effectively blocking infrared radiation at these wavelengths, the transmissibility of the atmosphere at and near target peak radiation wavelength must also be measured to determine how much energy will penetrate the atmosphere during boost phase to reach Midas satellite sensors.

With such data, it is then possible to select an infrared detector which has its greatest sensitivity at or near the wavelength at which peak target emission occurs. Optical filters can be used to exclude other wavelengths which are not of interest.

When the infrared detector is looking only at the relatively cool atmosphere—cool compared with an ICBM plume—the infrared energy impinging on the detector will be at a low level. But when the detector is looking at an ICBM whose peak intensity is in the selected wavelength, there should be a significant increase in the energy level received by the detector, indicating the presence of a target of interest.

But in practice, the problem has proven considerably more complex than first envisioned. This stems from inhomogeneities in the atmosphere, its different chemical constituents at different altitude layers, and the reflection of sunlight from high clouds.

Many of the current problems with Midas, according to observers close to the program, result from the almost complete lack of data on the infrared characteristics of the atmosphere which existed when the program was initiated. In the early days of the Midas program there was some data available on the infrared transmission/absorption bands at sea level, but very little at extremely high altitudes where a Midas satellite would be operating. And little data was available on the composition of the upper atmosphere to permit theoretical estimates of its infrared characteristics.

Equally important, there was only meager data on the infrared signature of ICBM boosters, and this was from measurements made on the ground looking up rather than from space looking down.

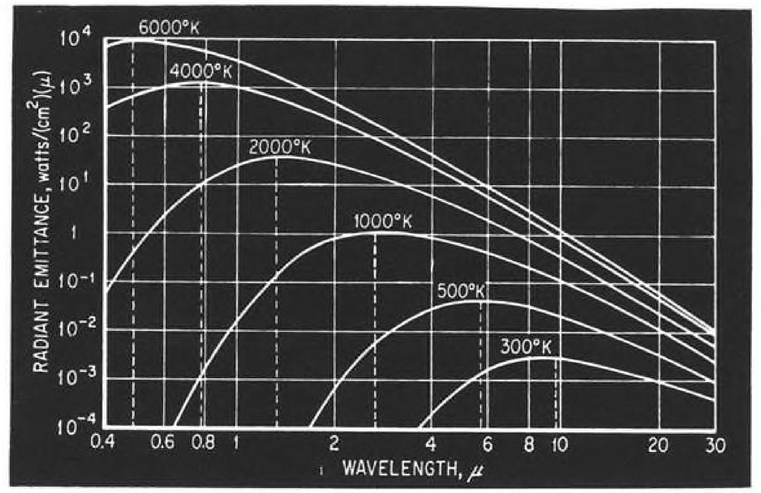
Despite this, the Midas program was launched because of the fast-growing Soviet ICBM threat and the urgent need to obtain increased warning time to launch the maximum number of Strategic Air Command bombers into the air in event of a surprise attack. Meanwhile, Air Force made plans for a program to obtain increased data on booster signature and atmospheric characteristics.

Approximately three years ago, a Boeing B-50 and a Lockheed U-2 were outfitted with infrared radiometers to measure ICBM signatures in flight. Simultaneous measurements were made from ground installations at Cape Canaveral to obtain correlation between the two sets of data. Measurements from space would have been preferable, but satellites were scarce, their payloads were limited, and there were no radiometers suitable for satellite use.

Even for the airborne measurements, unavailability of suitable radiometers limited measurements to shorter wavelengths of less than six microns, corresponding to temperatures above 225C, so that data on atmosphere characteristics could not be obtained at longer wavelengths.

The B-50 was outfitted and operated by Douglas Aircraft as part of its work under a $250,000 Air Force study contract to consider alternatives to Midas, a program known as Very Early Warning Systems (VEWS). Thompson Ramo Wooldridge had a similar contract.

The data obtained from this measurement program pointed up the need for a greatly expanded measurement program. As a result, the Advanced Research Projects Agency launched a three-phased program known as Tabstone (target and background signal to noise emission) as part of its Project Defender (ICBM defense) program. The Tabstone program includes the following:



INFRARED SIGNATURE which distinguishes objects with different temperatures includes wavelength at which peak radiation is emitted and total energy radiated, as shown above. This is basis for ICBM detection by Midas satellite.

• **Airborne measurements,** using a KC-135 equipped with radiometers, to obtain data at altitudes above 50,000 ft. This project is being carried out, under USAF's Aeronautical Systems Division monitoring, by Aerojet-General, one of the two companies under contract to provide detection sensors for Midas. The other Midas sensor contractor is Baird-Atomic, Inc.

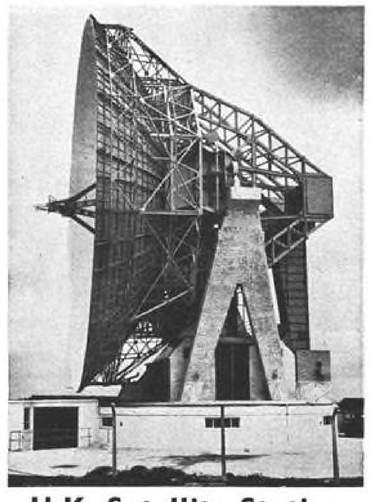
• **High-Tab,** using Aerobee and Astrobee rockets equipped with radiometers, to measure infrared and ultraviolet signatures of ICBMs and earth atmosphere from extremely high altitudes. The High-Tab vertical probes will be launched from Cape Canaveral, Pacific Missile Range, Wallops Island and Eglin AFB as well as from Alaska or Norway to measure characteristics of auroras to see if such natural disturbances could mask an ICBM attack or saturate infrared detectors in Midas. Naval Ordnance Test Station, China Lake, Calif., is assigned to conduct the High-Tab program, and has contracted out portions of the effort to Minneapolis-Honeywell. One High-Tab shot has been attempted, unsuccessfully, from Wallops Island.

• **Atmosphere study,** under cognizance of USAF's Electronic Systems Division, to determine effect of atmospheric attenuation on infrared radiation at extremely high altitudes. (For additional details on Project High-Tab, see AW July 17, 1961, p. 77.)

To supplement this program, Air Force recently has launched a program known as Project Trump, an acronym for Target Radiation Measurement Program. This is an in-house effort under the Space Systems Division conducted by the Air Proving Ground Center at Eglin AFB.

The program calls for launching Nike Javelin rockets equipped with infrared radiometers from the west coast of the Florida peninsula to measure target and background radiation of ICBMs launched from Cape Canaveral. Under consideration is a follow-on program, known as Trump 2, which would make measurements in both the ultraviolet and infrared spectrums (AW Apr. 2, p. 63).

Unfortunately, the vertical probe measurements can only obtain data on booster radiation after it has been attenuated by the atmosphere, with the amount of attenuation varying with altitude and the distance between the



U.K. Satellite Station

British communication satellite station at Goonhilly in southwestern England uses 85-ft. dish and maser amplifier. Station is equipped to transmit and receive television signals using British, European and American line standards, all of which are different.

RAYTHEON at work

Raytheon laser beams bright new visible light on vital space-age research and development

To speed knowledge of the world's newest energy source — laser light amplification systems — Raytheon now offers science and industry a valuable tool in the noteworthy new "visible light" laser.

Lasers' energy potential is truly awesome. Energy bursts powerful enough to penetrate steel have been generated by earlier methods, and just last May an M.I.T.-Raytheon science team bounced a light beam off the moon (and recorded its return) — across 477,714 miles of space. But the visible beam produced by such a laser was of such short duration that direct study of this beam was extremely difficult.

Raytheon's new visible light laser, however, emits a continuous thread-thin beam of precisely controlled, ruby-red, visible light that permits a detailed analysis.

The study of this visible laser light and its latent energy at Raytheon's Laser Advanced Development Center promises new uses in communications, radar, surgery, space vehicle guidance, manufacturing, and in many other still-unforeseen areas.

Raytheon Company, Lexington, Mass.

RAYTHEON

booster and the probe. An ingenious attempt to measure the true radiation signature while the booster is in flight is planned under an Advanced Research Projects Agency-sponsored program known as FLIP—Flight Launched Infrared Probe.

General Dynamics/Astronautics is outfitting an Atlas booster with a nose cone containing radiometers. When the booster reaches a suitable altitude, the nose cone will be kicked off to the side so that its radiometers can view the rocket plume for at least a few seconds at close quarters before the booster moves ahead of it. Measurement data will be telemetered back to the ground.

Midas Problems

Observers familiar with the current Midas program troubles blame them on two basic causes:

- **Measurement programs** now under way or planned should have preceded, not followed, the design of the satellite and its payload.
- **Over-optimism** by USAF and Lockheed on the amount of sophistication which could be employed in the Midas design and still achieve required reliability.

Some observers are willing to excuse the Air Force and Lockheed on the first count because of the tremendous pressure to develop an operational Midas to counter the expected Soviet ICBM threat and protect the SAC bomber fleet. They point out that neither the satellites nor radiometers suitable for satellite use were available several years ago to make the needed measurements.

Others concede these points but say that both the Air Force and Lockheed have been too preoccupied with less vital details, such as satellite station-keeping controls and construction of ground readout stations, giving far too little attention to the basic physics of the infrared detection problem. These critics charge that even today, when satellites and radiometers are available for measurements from space, there has been too little emphasis on this aspect of the problem.

Lack of Knowledge

Those familiar with basic detection problems say that today the principal lack of knowledge is that of the infrared emission from the sun-illuminated earth background, including high clouds seen from satellite altitudes, against which the ICBM must be detected.

Air Force Space Systems Division recently has disclosed plans to contract with Arthur D. Little, Inc., to gather spectral data on infrared background radiation from high clouds in the 1-3 micron region at high altitudes from an aircraft. The company currently is making similar measurements under contract with ARPA.

The problem of discrimination is complicated by the fact that the principal combustion products from a hot rocket exhaust are carbon dioxide and water vapor. But these also are the principal constituents of the atmosphere. The problem then is to detect hot carbon dioxide and water vapor radiation passing through an atmosphere which contains these same gases which differ only in that they are cooler and at lower pressure. And this must be done against a background which contains these same constituents at still lower temperature.

Air Force and Lockheed recently have submitted plans to the Defense Department for a new Midas design which will reduce over-all satellite complexity by eliminating station-keeping and use more satellites in random orbits to provide overlapping coverage (AW Aug. 6, p. 26).

Solutions Differ

Most infrared experts believe that the basic problem of detecting ICBMs by their infrared radiation can be solved, although they differ in their proposed solutions.

One of the problems with Midas has been the difficulty of distinguishing between an ICBM plume and sunlight reflected from high-altitude clouds. But since the peak intensity of sunlight is in the visible and ultraviolet region while the peak intensity of the booster is in the infrared, it is believed that the use of both infrared and ultraviolet sensors might solve the discrimination problem. This explains the current interest in making ultraviolet background and signature measurements.

Another Possibility

Another possibility which would enhance the ability of Midas to detect and discriminate might be the addition of detectors with sensitivities in the longer wavelengths, according to some observers. This would be in the three to five micron region in which there are two good "infrared windows"—regions in which there is relatively little atmospheric attenuation. But infrared detectors that have the necessary sensitivity in this part of the infrared spectrum must be cooled to cryogenic temperatures and it is difficult to provide a supply of liquid coolant sufficient to last the desired Midas operational lifetime of a year in orbit.

Using today's knowledge and technology, it should be possible to endow the Midas with the necessary detection and discrimination capability, but this might require satellite redesign for additional space, one observer says.

(The concluding article in this series on infrared sensor problems in space applications, describing the use of IR scanners for satellite earth-orientation and stabilization, will appear in a subsequent issue.)

F-100 Televises USAF Competition Missions

Television cameraman for Air Force's Project William Tell, the annual tactical weapons meet held this month at Nellis AFB, Nev., used a North American F-100 jet fighter outfitted with small TV cameras to cover aerial missions over an area of almost 1,000 sq. mi. Signals were transmitted to a ground station and re-broadcast over Channel 5 in Las Vegas and over a closed-circuit TV network at Nellis. The television system was supplied by Dage Division of Thompson Ramo Wooldridge under an Air Force contract.

Thin-Films Increase Computer Reliability

By Barry Miller

Santa Monica, Calif.—Small special-purpose spaceborne computer, which employs thin-film microcircuits extensively to increase over-all system reliability, will be completed and checked out here soon.

Unit is destined for service in a quasi-operational Air Force space system, and as such will be among the first generation of actual flight hardware to use extensively one of the increasingly popular techniques of microcircuitry.

Computer now is being assembled by the Solid State Physics Laboratories of Lear Siegler, Inc., which is fabricating the device under subcontract from Airborne Instruments Laboratory, a division of Cutler Hammer in Melville, N. Y. Airborne, in turn, designed the computer for an undisclosed manufacturer, which is prime contractor for the Air Force space system.

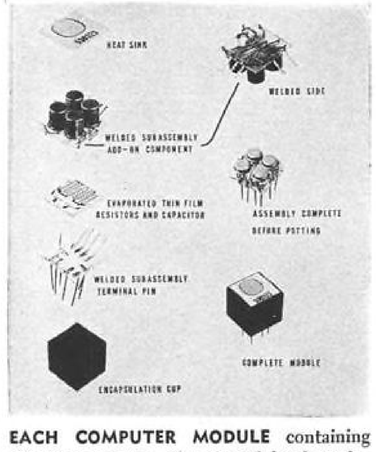
Conventional, non-microminiature versions of this computer currently are flying in the Air Force system. These computers are fabricated by the standard cordwood technique, in which components are assembled like a stack of cordwood with their terminations soldered to etched circuit boards. To boost reliability, Airborne decided to microminiaturize later models of the equipment.

Thin-film version of the computer is expected to achieve the increase in reliability through a reduction in the number of hand-made interconnections. This reduction is made possible by evaporating arrays of resistors and conductors.

As a secondary benefit, the thin-film unit offers significant size and weight savings. The entire computer, its 4,000 parts, mounting and interconnections occupy 70 cu. in., a 20 to 1 reduction in size from the original version. It will weigh approximately 5½ lb., including cabling, a 3 to 1 weight saving. Power consumption is 5.2 w., identical for both versions, as the microcircuit model employs the same basic circuitry.

Airborne says it cannot provide details on operational features of the unit due to security restrictions, although it points out that the computer is capable of accepting various analog inputs in parallel and converting them into suitable digital words which are read out serially.

The unit contains time counters, electronic analog-to-digital converters, data gates and a parity check system. A few electro-mechanical relays are required, and a scratch pad memory is used. Parallel or redundant circuitry provides an additional measure of reliability.



EACH COMPUTER MODULE containing thin-films consists of a several level stack—interconnecting board, glass substrate with thin-film resistors deposited on it and a top substrate containing individual components. Complete stack is then enclosed in potted plastic to form module.

Different Approaches

After considering several microcircuit approaches, Airborne explains, it selected the Lear Siegler approach of evaporating thin-films of passive elements on dielectric substrates because of:

- **Low cost** of these microcircuits in production.
- **Their reproducibility** in quantity.
- **Ease of tooling** fabrication processes to the company's proprietary circuitry.
- **Growth potential** for other system applications.
- **Availability** of a number of thin-film sources.

This latter reason is of particular interest because there are more sources of semiconductor microcircuits which have shown wide appeal to the Air Force and Navy (AW July 9, p. 46), than thin-film microcircuits.

Airborne explains that the tendency among semiconductor manufacturers to select particular forms of circuit organization or logic for their semiconductor microcircuits—which may not be compatible with one another—makes second sources for given types more scarce. One of the apparent trends at the recent Western Electronic show and convention was the introduction of favored logic approaches (AW Sept. 3, p. 26) by several semiconductor microcircuit companies, making the number of different logic organizations actually rival the number of companies making them.

Nevertheless, Airborne is building a new model of a more complex computer than the thin-film special purpose unit. This new computer is fabricated from semiconductor microcircuits made by Fairchild Semiconductor Corp. The prime objective in this case is to cut size and weight of this production computer, and the company hopes to encourage second-source suppliers to meet its own semiconductor microcircuit specifications.

Two Models

Lear Siegler is making two models of the special-purpose computer. Spares and an additional contract for more units probably will follow at the conclusion of the present contract, according to Airborne.

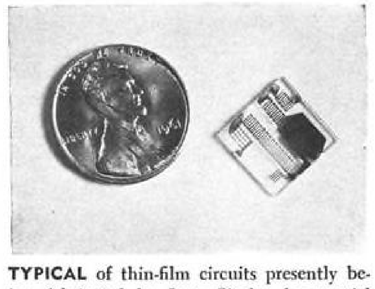
The computer employs vacuum-deposited nichrome resistors for all resistors except where values over 100,000 ohms or tolerances closer than 1% are required. In these exceptional cases, discrete resistors are added to the circuit.

In addition, discrete add-on capacitors are employed, as are Pacific Semiconductors' micro-diodes and Fairchild micro-transistors.

Computer components placed on stacked substrates are packaged within small plastic cases, or modules, the terminations of which protrude from one end. These, in turn, are inserted into one of four interconnecting boards which make up the complete computer. These are then packaged in a magnesium case.

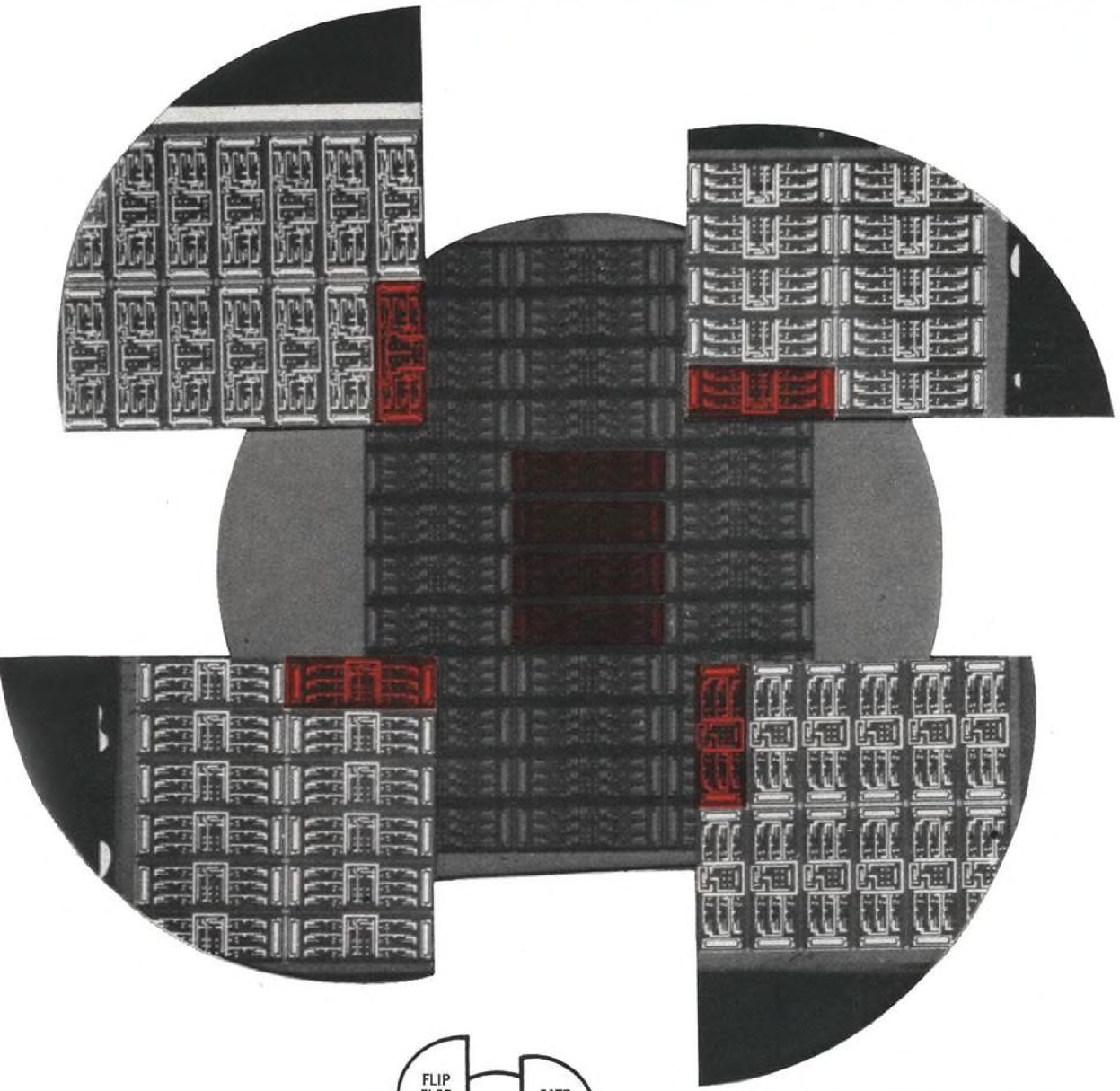
There are 36 types of modules in the computer, each representing a typical basic circuit type, i.e., flip flop, buffer, reset amplifier, etc. Fourteen of these module types do not contain any thin-films. They are cordwood-type construction of conventional micro components. These represent circuits which for one of several reasons did not lend themselves to conversion to thin-films.

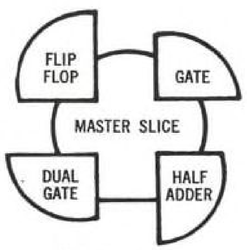
Each of the modules employing thin-



TYPICAL of thin-film circuits presently being fabricated by Lear Siegler for special purpose computer is shown here. This circuit has four different valued resistor grids and small capacitor in lower corner.

MASTER SLICE





(ACTUAL SIZE)

SOLID CIRCUIT semiconductor networks are manufactured from pure silicon "master slice" wafers (center illustration) which contain more than 30 separate circuit bars. Customized interconnection patterns (four corner wafer fragments) are then photo-etched in aluminum on "master slice" wafers, producing completely integrated semiconductor networks ready for packaging.

...the first economical answer to custom circuits

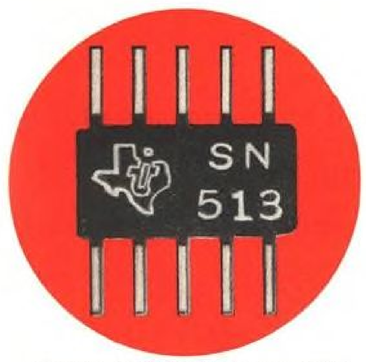
Texas Instruments now offers you hundreds of variations in SOLID CIRCUIT® semiconductor networks. Today you can get the exceptional reliability and miniaturization benefits of *SOLID CIRCUIT* semiconductor networks in many customized designs — at only slightly more cost than standard, catalog circuits. The flexible "master slice" design concept developed by Texas Instruments makes this achievement possible.

HERE'S HOW: First, standard "master slice" integrated circuit bars — complete except for interconnections — are taken from established, high-volume production lines. Second, a special interconnection pattern mask for your circuit is prepared. Third, your special interconnection pattern is photo-etched in aluminum on the "master slice" circuit bar.

YOUR BENEFITS: You get a complete semiconductor network, integrating resistors, capacitors, diodes and transistors into a single, high-purity silicon wafer — to *your* specifications. Evaluation samples can be available within several weeks from final design approval. Because preparation of the special interconnection pattern is the only custom step in the manufacturing process, you get most of the economy and delivery benefits of using standard TI production units.

Of course, "master slice" variations may not satisfy all your circuit requirements. Totally custom semiconductor networks — starting with the pure silicon — can be designed by Texas Instruments to meet an even greater variety of applications.

**Trademark of Texas Instruments Incorporated*



Completed *SOLID CIRCUIT* semiconductor network, enlarged 5½ times.

For more detailed information on how "master slice" design offers you the first economical answer to custom circuits, call your local TI Sales Engineer or write to Department 370 today for this brochure.

SEMICONDUCTOR / COMPONENTS DIVISION

TEXAS INSTRUMENTS
INCORPORATED
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19370

Estimated Shipments of Electron Tubes and Semiconductors During 1961[1]

Category	Quantity (thousands of units) Total	Quantity (thousands of units) Military	Value (thousands of dollars) Total	Value (thousands of dollars) Military
Power and Special Purpose Tubes	7,849.2	2,926.7	284,519	191,101
Receiving Tubes	379,214	24,896	326,812	45,789
Semiconductor Devices	504,962	126,195	564,822	221,668
Totals	892,025.2	154,017.7	1,176,153	458,567

[1] Estimated total industry shipments including intra-plant transfers.

Estimated Shipments of Selected Electronic Components During 1961[1]

Category	Quantity (thousands of units) Total	Quantity (thousands of units) Military	Value (thousands of dollars) Total	Value (thousands of dollars) Military
Capacitors	1,501,851 r	148,191	300,736 r	94,269
Complex Components[2]	45,091	3,496	37,961	23,259
Connectors	113,545	60,559	190,228	120,037
Quartz Crystals	7,225	2,406	28,353	6,384
Relays (for electronic applications)	29,969	7,810	182,146	81,877
Resistors	2,533,554	270,809	285,680	114,490
Transformers and reactors	33,214	6,781r	181,002	74,787 r
Totals	4,264,449	500,052	1,206,106	515,103

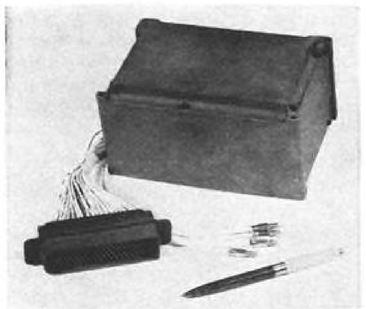
r Revised
[1] Estimated total industry shipments including intra-plant and inter-plant transfers.
[2] Includes packaged component assemblies ("PEC's," "PAC's," "Couplates," etc.), modules assembled from purchased components, and modules manufactured from components which were fabricated during the manufacturing process (including integrated semiconductor circuits).

films is ½-in. square and either 400 or 500 mils in height. The cordwood modules have the same heights, but the package dimensions are ½ in. by 1 in.

A typical module, a flip flop, which appears 91 times in the computer, contains 21 components, including add-on components.

Each module is potted with epoxy and covered with a beryllia heat sink.

A typical module employing thin-films contains a stack of substrates—one of glass containing the passive component films, another a reduced size, Chronaflex photo drawing or roadmap on which active or discrete components are mounted according to the drawing on the substrate, and finally an interconnecting board, made of Chronaflex.

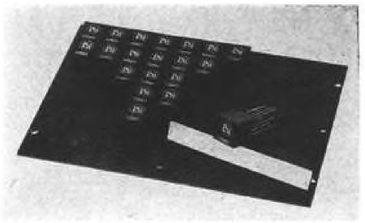


SPECIAL PURPOSE spaceborne computer slated for use in an Air Force space project employs thin films extensively in effort to increase system reliability. Computer weighs about 5 lb. including cabling; it is entering final stages of fabrication at solid state physics laboratories of Lear Siegler.

Ribbon leads are cemented through holes in the interconnecting board, then soldered to metallized tabs on the edge of the glass substrates placed above them, and these, in turn, align with ribbons on the active substrate. The ribbons are then welded to complete the substrate stack. The leads slip through small holes in a 0.09-in. center grid at the base of the module cube and align with perforations in the phenolic interconnection board.

Small tube terminations are driven into the grid holes of the phenolic board and serve as stiff receptacles for module leads. Then interconnections are made on the back of the board according to the reduced-size photo drawing. Only a single connection is made to each terminal tube, and to avoid crossover, layers of Chronaflex with interconnecting roadmaps and holes are placed over the termination tubes. Interconnections are made on several levels, and then the board is epoxied.

Film resistors for the computer are deposited in patterns of five rows of 26 bars of 4-mil-wide nichrome. The necessary value of resistors are synthesized by interconnecting the proper number of resistive bars with evaporated copper alloy conductive film patterns. Resistors are nominally 100 to 120 ohms/sq.

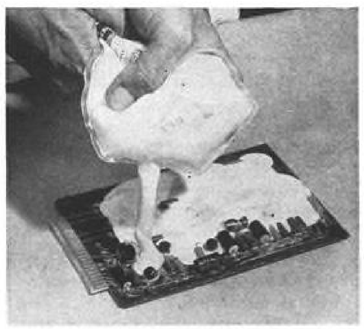


COMPUTER CONSISTS of four phenolic interconnecting boards into which are inserted individual modules, corresponding to necessary basic circuit types. Total of 36 module types, 24 of which employ thin passive films, make up computer.

Although the computer is being fabricated here in a research laboratory by research personnel, Lear Siegler has attempted to set up all processes so that they could be handled by normal production personnel.

All less practical steps which could not be handled by production personnel were eliminated. As in a production shop, there are numerous inspection processes, and checks and tests are made at various points in the fabrication of the modules and their assembly into the computer. The company exercises extensive quality control of processes, materials and active elements.

This has given Lear Siegler a production capability in thin-film microcircuits and has assured Airborne and its customer of flightworthy hardware.



Encapsulating Modules

Convenient dispensing package for encapsulating avionic modules, using room-temperature vulcanizing liquid silicone rubber, contains curing catalyst in a small metal squeeze tube attached to plastic envelope. Catalyst can be dispersed into silicone in premeasured quantity when ready for use. Self-dispensing package comes in variety of sizes ranging from 10 grams to 1 lb. Manufacturer: General Electric, Silicone Products Dept., Waterford, N. Y.

FILTER CENTER

► **Microcircuits for Minuteman Guidance**—Process begun last spring (AW Mar. 5, p. 45) of selecting sources for semiconductor microcircuits to be used in the guidance system of the Minuteman ICBM is now moving into high gear. Autonetics engineers completed facilities surveys of about a dozen prospective suppliers recently and expect to issue specifications for 17 or 18 microcircuit types slated for the guidance system's digital computer. Tentative plan is to ask for industry proposals this fall, select four prime suppliers for four or more microcircuit types each and ask for sample delivery by late winter. Each of the four prime suppliers would then act as backup sources for four or more other circuit types. Companies to be invited include Clevite, Fairchild, General Electric, Motorola, Philco, Pacific Semiconductors, Raytheon-Rheem, Signetics, Sylvania, Texas Instruments and Westinghouse. Changeover from individual components to microcircuits, expected to significantly improve reliability of the ICBM, is covered in Autonetics' prime Air Force guidance control system contract, and USAF reportedly has directed that source selection process be conducted. But money for the changeover, which could have a far-reaching effect on the evolution of the infant field of microcircuitry, has not yet been negotiated.

► **Fuel Cell Interest Expands**—About 45 companies, including a number of aerospace organizations, are now participating in Battelle Memorial Institute's fuel cell research program (AW Sept. 19, 1960, p. 23), reflecting widespread interest in these energy converters for aerospace, naval and industrial applications. While fuel cells are slated to see early practical aerospace service in the Gemini and Apollo programs, with experimental flight tests scheduled beforehand, the naval applications—particularly as power sources to replace diesel engines in conventional submarines—may be one of the larger impending uses.

► **Micro Telemetry Encoder**—Microcircuit version of pulse code modulation (PCM) telemetry encoder will be developed by Radiation, Inc., and delivered to Air Force's Aeronautical Systems Division in late 1963 under a contract for about $380,000. Encoder will employ special semiconductor microcircuits developed by Fairchild Semiconductor under subcontract to Radiation. A similar type of device was being developed by Texas Instruments for ASD's Electronic Technology Laboratory (AW Nov. 6, p. 83).

Army Expects to Double Purchases Of Micromodules in FY 1963

New York—Army expects to buy $8 million in equipment and systems using Micromodules in Fiscal 1963, roughly twice the figure for Fiscal 1962. The Micromodules, originally developed by Radio Corp. of America, consist of encapsulated stacks of 0.3 in. square ceramic wafers mounting components.

Army expects to buy even more hardware using Micromodules in Fiscal 1964, according to Maj. Gen. Earle F. Cooke, chief signal officer.

Production of Micromodules is expected to reach 250,000 units per year by March, 1963, a million a year by June, 1964, and to reach 3-5 million in 1965, based on present plans, Cooke said.

RCA, which has been prime contractor in development of Micromodules, will mass-produce them at its Semiconductor and Materials Division, Somerville, N. J. Two other companies, P. R. Mallory and Co., Inc., of Indianapolis, Ind., and Paktron Division of Illinois Tool Works, Inc., Alexandria, Va., have also been awarded production contracts by RCA.

Extensive use of Micromodules in Army Signal Corps equipment is generally still in the planning stage. Within the next year, however, the following equipment will have Micromodule circuitry, according to Gen. Cooke:

• **350 back-borne** Walkie-Talkie radio sets, being built by RCA using Micromodule circuitry in standard cases.

• **400 intermediate frequency** amplifiers. These high reliability units will replace conventional units requiring replacements at a rate as high as a thousand per month.

• **AN/VRC -12 multi-purpose** vehicular radio and subsystems. These units, presently in use, will have their circuitry converted to Micromodules within the next year.

Signal Corps is pushing use of Micromodules in its communications and computer equipment because of favorable findings in cost and reliability studies.

RCA claims that after several million hours of environmental testing, Micromodules have proven six times as reliable as conventional military electronic circuits and 60 times as reliable as tube equipment. Therefore, one of the biggest areas of savings, in comparison with presently available circuitry, is lower maintenance and logistics costs.

Over $18 million has been spent by Army and several million dollars more by RCA and 61 other companies which have aided in developing the Micromodule to the production stage.

At the present time, the initial cost of individual units is high. For example, a ten-part Micromodule costs $52 today as opposed to $20.45 for a conventional printed-board solid-state circuit. But Army surveys, taking the reliability factor into account, indicate Micromodule cost will equal that of conventional construction in 1965 at the projected production rate of three to five million per year.

Gen. Cooke listed six devices which have been chosen for research and development efforts as Signal Corps equipment in Fiscal 1963 and 1964:

• **Airborne high frequency** single sideband radio, which would replace existing high frequency AM equipment.

• **Lightweight hand-held** surveillance radar, AN/PPS-6, a Doppler radar for detecting moving targets. Now in the prototype stage it would be reduced in size by use of Micromodule circuitry.

• **Gun-flash** ranging set, AN/GAS-1, a unit to detect gun flashes through lead sulphide cells, amplify the signal and transmit the data to a recording device (which itself could use Micromodules).

• **Electronic teletypewriter,** which would supersede an electro-mechanical unit that is currently in the research and development stage.

• **Tactical digital** communications system, considered for Fiscal 1964 funding, which would require 91,000 modules.

• **Micropac small field** computer—production version. Prototype of this computer will be delivered to Army by RCA this November.

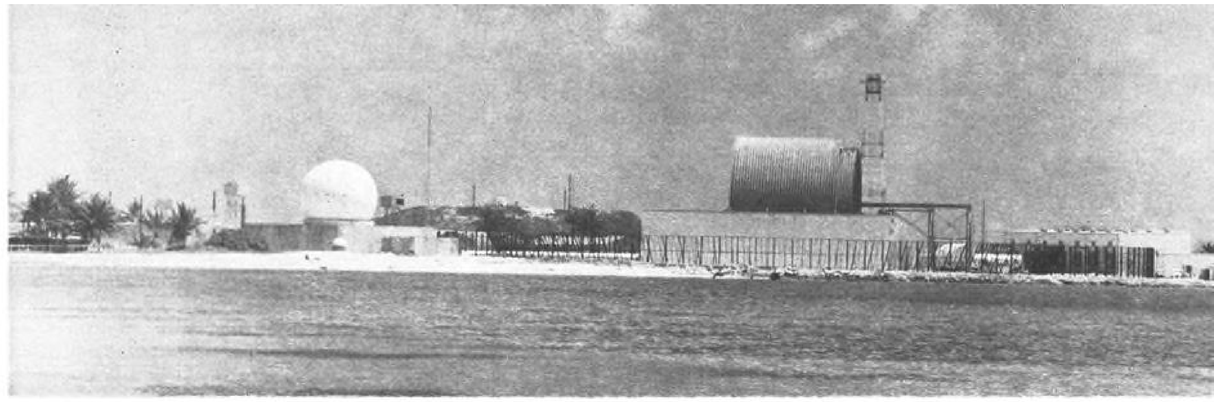
Commercial Laser

First commercial visible light laser, continuous-wave device using mixture of helium and neon, is priced at $7,900 with delivery in 30 days. New Model 110 was developed jointly by Perkin-Elmer Corp. and Spectra-Physics Inc., but will be marketed by the former. Excitation for laser is provided by 40-watt, 40.68 radio frequency oscillator at center of tube.

*Based on world time-to-climb records set in February, 1962.

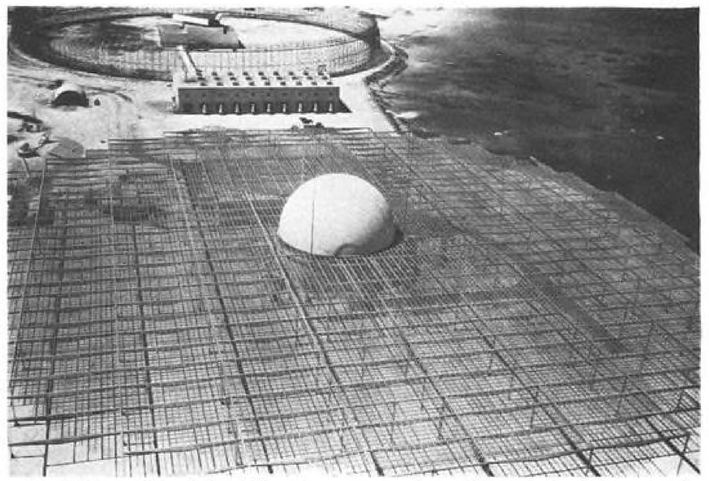
In just 68 seconds from brake release this twin-jet Northrop T-38 will be 6 miles high*

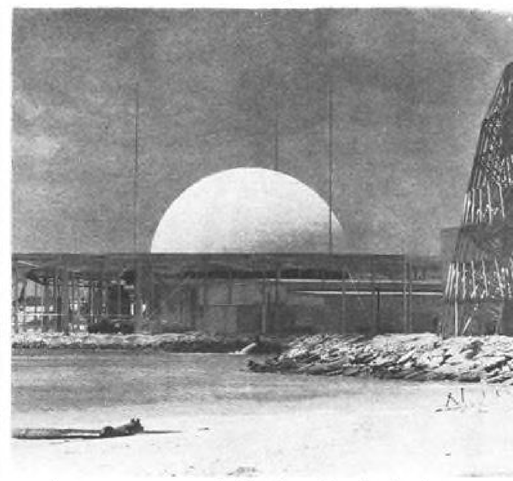
The supersonic T-38 trainer can reach operational altitude faster than most high-performance fighter aircraft. And it can operate above 55,000 feet. This rapid rate of climb can give instructor and student far more training time at high altitudes – at least 55 minutes out of every flight hour. High-performance characteristics such as this enable the T-38 to materially cut the total training time of pilots for advanced supersonic aircraft.



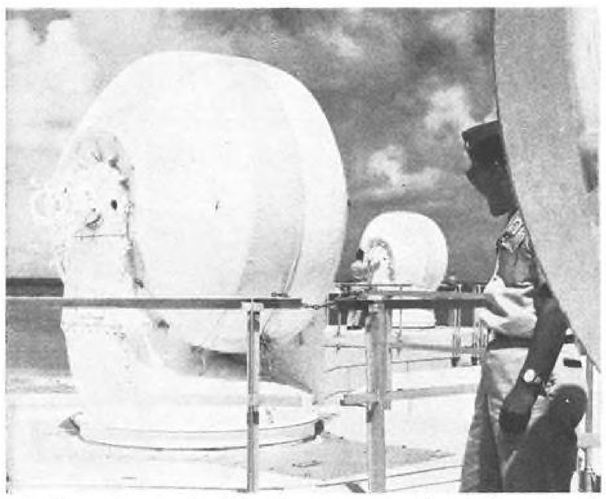
Discrimination radar, designed to distinguish between actual and decoy ICBM warheads, is being constructed under corrugated shelter, above right, for Army's Nike Zeus missile system on Kwajalein Island. Dome at left houses target tracking radar. Four ports on the white dome are for bore sight checks of the radar beam.

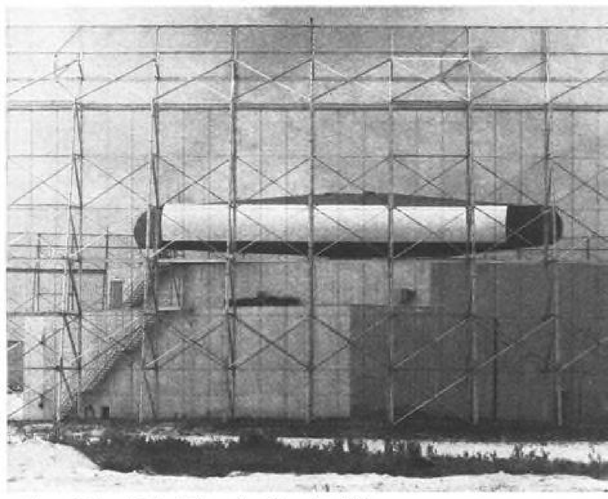
Four Radars Comprise Army Nike Zeus System





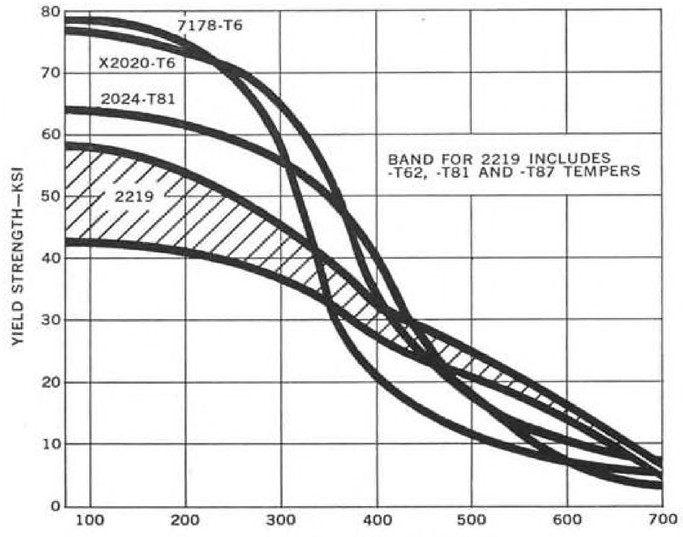
Acquisition radar of the Nike Zeus system, above left, includes high-powered transmitter at rear surrounded by beam-forming barrier. Powerhouse is concrete structure at center and in foreground is dome-covered receiver surrounded by ground reflecting plane. Close-up views of receiver, above right, and transmitter, below right, give an indication of size.





Smallest radars in the Nike Zeus system are the missile track radars, above left, which follow the Zeus in flight.

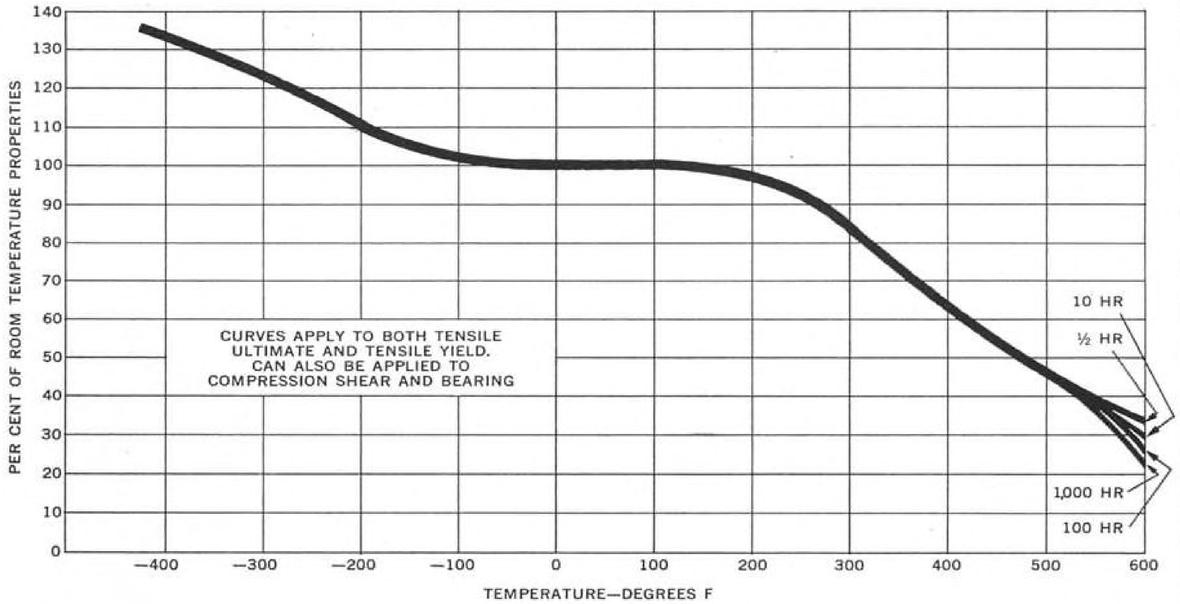
1. YIELD STRENGTH VS TEMPERATURE—100 HOUR EXPOSURE



2. TENSILE PROPERTIES OF WELDED 2219 AT −320°F

	Tensile Strength	Yield Strength	Elong. %	Notch Strength
2219-T81 or -T87 (as welded)	67,000	38,000	3.3	68,000
2219-T81 or -T87 (welded in -T31 or -T37, post weld aged)	68,000	46,000	2.0	65,000

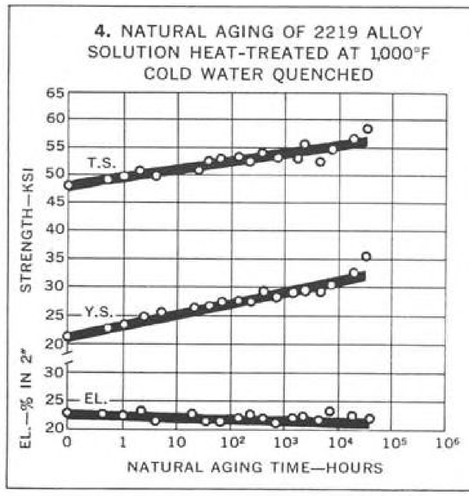
3. CHANGE OF MECHANICAL PROPERTIES WITH TEMPERATURE—ALLOY 2219-T81



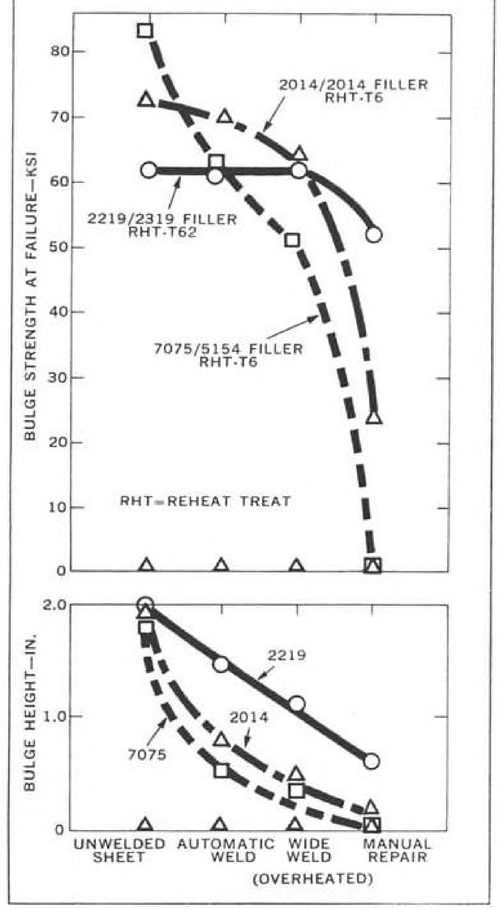
3A. TYPICAL ROOM TEMPERATURE MECHANICAL PROPERTIES

	Tensile Strength	Yield Strength	Elongation
2219-T87	69,000	57,000	10
2219-T81	66,000	51,000	11

4. NATURAL AGING OF 2219 ALLOY SOLUTION HEAT-TREATED AT 1,000°F COLD WATER QUENCHED



5. EFFECT OF WELDING CONDITIONS ON BULGE TEST PROPERTIES



Alcoa capability at work... gifted newcomer promises out-of-this-world performance on Saturn

The designers of the proposed *Saturn* C-5 rocket needed a metal loaded with talent for the first-stage fuel tank (33-ft dia). Steel? Out of the question—too heavy for the role. The designers picked a gifted, new aluminum alloy from Alcoa: 2219.*

Here's how alloy 2219 performs: It's the strongest conventional aluminum alloy in the 500-600°F heat range. At temperatures as low as −423°F, it has a tensile strength of 92,000 psi. It resists stress corrosion and cracking and it gets along nicely with current fuels and oxidizers. It has good ballistic characteristics. Alcoa® Alloy 2219 is easy to work. Easier to weld. Fusion-welds without harmful strength defects. 2219 weldments also give good performances at sub-zero *and* elevated temperatures.

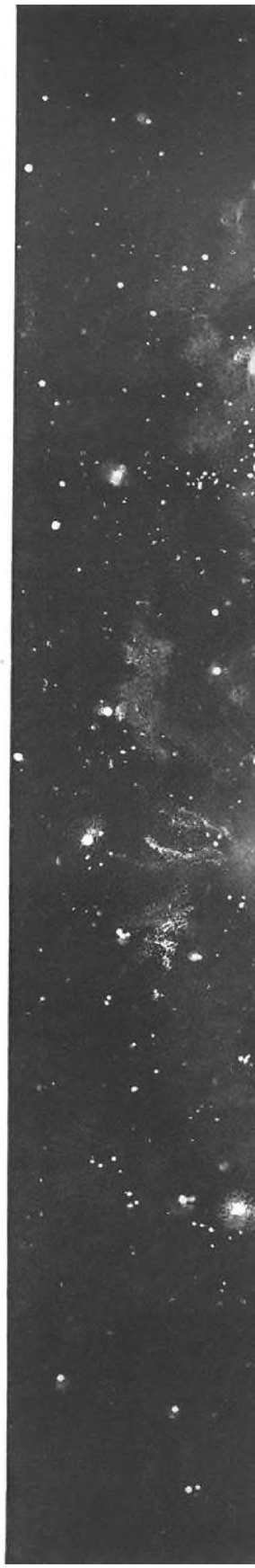
World's biggest light-metals workshop. It's Alcoa's. No other basic producer can match our facilities or knowledge. We can fabricate aluminum by any known method—rolling, casting, forging, impact, extrusion—we're not married to a single process. Alcoa's strong on research, development engineering and testing. Can you use our capabilities? Write Aluminum Company of America, 1865-J Alcoa Building, Pittsburgh 19, Pa.

*U.S. Patent No. 2,706,680

1. Yield strength vs temperature—100-hr exposure
2. Tensile properties of welded 2219 at −320°F
3. Change of mechanical properties with temperature
3.(a) Typical room temperature mechanical properties
4. Natural aging
5. Effect of welding conditions on bulge test properties

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA



Nimbus Lag Spurs Congressional Scrutiny

By George C. Wilson

Washington—Hearings on Nimbus weather satellite which closed recently dramatized the new trend in congressional inquiries into why generously funded space projects run into trouble.

Chairman Ken Hechler (D.-W. Va.) of the House Science and Astronautics Applications Subcommittee devoted the final day of hearings on the technical aspects of the Nimbus program to a panel discussion which placed representatives of the Defense Department, National Aeronautics and Space Administration and the Weather Bureau at the witness table at the same time. All three are directly involved in the Nimbus program.

Rep. Hechler, a former college professor, used this format in hopes of clearing up the contradictions which arose in previous hearings when witnesses were questioned separately on the Nimbus program. Nimbus is expected to slip as much as a year, to second quarter 1963 (AW Sept. 3, p. 17).

Basic Question

The subcommittee's basic question is why Nimbus is behind schedule and what can be done about it. This same question was also at the heart of earlier House space subcommittee hearings on the Centaur booster (AW May 28, p. 33) and Advent military communications satellite (AW Aug. 20, p. 25).

In all three hearings, the lawmakers who authorize the funds sat impassively as witnesses waved chart pointers and blamed delays on such things as "technical difficulties" and "pushing the state of the art." Seldom did either the lawmakers or the subcommittee staffers challenge the technical explanations, partly because they do not have the necessary background.

But representatives and senators do have strong ideas on management. Significantly, the management setup became the central issue in the House Centaur, Advent and Nimbus hearings. Rep. Hechler dramatized this interest—one that is intensifying as the national space program gains in both speed and complexity—by questioning the various managers all at once. The witnesses were: John H. Rubel, deputy director of defense research and engineering; Robert C. Seamans, Jr., NASA associate administrator; F. W. Reichelderfer, Weather Bureau chief; S. Fred Singer, director of the Bureau's National Weather Satellite Center which runs the Nimbus program.

Rep. Hechler said "this is a rather unique idea" to have a mass confrontation of witnesses by a congressional committee. And he urged frankness. "We are all letting our hair down," Rep. Hechler said. "Isn't there some way this [Nimbus management] could be improved to pinpoint and clarify the decision making process?"

NASA Responsibility

NASA is responsible for the development of the Nimbus satellite and its launching while the Weather Bureau is primarily concerned with the operational functions. Defense and other users of the system also have a say in the program through membership on several inter-agency committees.

Despite the fact that Weather Bureau officials have complained in private about the cumbersome Nimbus management setup, all the witnesses at the table said the present management structure was adequate. They had no suggestions for improvement. Singer, who became head of the Nimbus project June 1, ducked a question on how he would organize the management if he were starting from scratch.

This united front went even further. Rubel disavowed an earlier Air Force statement implying that because of the delay in Nimbus, the military might have to embark on a weather satellite program of its own. On Aug. 28, USAF Lt. Col. Leslie W. Cowan of the electronic systems office under the deputy chief of staff for systems and logistics, had decried slippage in the Nimbus program, and added: "If an urgent, unique military requirement for weather satellite observations could not be satisfied by the national program, consideration would naturally be given to incorporating it in a suitable military space program." Rubel, however, said last week there was no plan to embark on a separate effort, declaring, "the Nimbus program will meet the military requirements as presently planned." He endorsed using additional Tiros to fill the gap caused by the slippage in the Nimbus schedule.: "We can tide ourselves over at far less cost and with far more certainty of success than by inaugurating a new program," he said.

Similarly, Reichelderfer contradicted an earlier witness, Morris Tepper, NASA meteorological systems director, who had told the committee there was no indication at any of the inter-agency meetings that an urgency surrounded the Nimbus program. Reichelderfer said there certainly was "a sense of the urgency" but that it probably was not mentioned at the meetings because it was so obvious.

Subcommittee members also asked if they could use more money or a DX priority to help close the time lag in the Nimbus schedule. Both Seamans and Reichelderfer said this assistance was not needed. In short, Congress was told to let NASA and the Weather Bureau stick to their knitting—no outside help was needed. Defense Department expressed this same attitude when another House space subcommittee looked into the reoriented Advent.

At the hearing, Chairman Joseph E. Karth (D.-Minn.) of the House space sciences subcommittee said: "I am somewhat fearful you will have the same problems because you have to go to the same people to get the same decisions they had to go to before." The Defense Department's research and engineering office still is in over-all charge of the Advent program, although the reoriented management does give the Defense Communications Agency the job of coordinator. But Rubel said he was convinced the revised Advent management structure "will work very well."

Detailed Testimony

What is happening this session more than ever before is that the House is conducting pre-trial sessions on the management of expensive space programs. With the facts in hand in the form of detailed testimony by the officials involved, Congress has put itself in position to evaluate the management of space programs for itself rather than rely on the judgments of the executive agencies.

Next year programs like Centaur, Advent and Nimbus will be reviewed again and a judgment made. Some of these judgments may be rather severe, as indicated by the one in the recent report on the Centaur program: "Putting out fires is no substitute for effective program management. The [space sciences] subcommittee is forced to conclude that management of the Centaur development program has been weak and ineffective both at NASA headquarters and in the field, and that the program has suffered from a diffusion of authority and responsibility."

Such findings eventually could prompt Congress to deny funds for those space programs which now enjoy overwhelming support because of their urgency and promise to advance the U.S. in the space race with Russia.

North American Delivers Apollo Boilerplate to NASA

First boilerplate mockup of Apollo spacecraft command module was delivered recently to National Aeronautics and Space Administration's Manned Spacecraft Center, Houston, by North American Aviation's Space and Information Systems Division for water and ground testing and development tests of water recovery procedures. Test structure, left, next to a Mercury spacecraft, has the external size, shape and center of gravity of an actual Apollo command module.

Space Matter Analyzer Developed by USAF

Equipment designed to permit scientists on earth to study and analyze biological properties of specimens collected by astronauts on celestial bodies as the event occurs has been developed at USAF's School of Aerospace Medicine, Brooks AFB, Tex.

Device might also be utilized to allow aeromedical study of astronauts during the mission.

To use the Bio-telescanner, developed by Research Immunobiologist Dr. William G. Glenn, an astronaut would take an extract from the sample, such as a scraping of a lunar rock, transfer it to a glass tube about 2 in. tall and ⅛ in. wide containing a jelly-like substance that reacts in a known way with a specific biological substance. The tube is inserted in one of 50 numbered spaces in the instrument.

As the specimen diffuses downward into the material, the density of clouds formed and rate of movement of the specimen creates a distinguishable pattern, which is scanned electronically, translated into code and telemetered to ground stations. There, the nature of the substance is read as a tracing on a graph and may be compared with patterns of some of the many thousands of living organisms that exist on earth.

From the characteristics of the pattern, a biologist would be able to discern the chemical properties of the specimen provided by the astronaut and what sort of life it resembles, such as bacteria, virus, algae, mold, fungus, or something more organized and better developed, such as animal matter.

Equipment might also be used to analyze blood samples of astronauts while in flight. Device can be hand-carried or slung from the shoulder.

Seven Countries Plan Wind, Diffusion Study

First fully coordinated international rocket sounding program, using vapor trails to investigate winds and diffusions at altitudes from 44 to 100 mi., will take place later this year.

Seven countries, including United States, Great Britain, France, Italy, Pakistan, Argentina (under French sponsorship) and Japan have indicated they will participate in the week-long "International Sodiums Period." Local weather conditions and communications problems, however, will probably preclude the realization of a goal of near-simultaneous soundings to obtain an atmospheric profile over a wide area.

The open session is coordinated by COSPAR (Committee on Space Research) and individual countries have agreed to make their data available to other member nations, publishing results separately, rather than as a coordinated report.

Rockets used will be Nike-Cajun or Nike-Apache variants and both lithium and sodium vapor trails will be tracked by ground-based camera equipment of individual countries.

U. S. plans to launch 10 rockets from Wallops Island, Va., range and seven from the Ft. Churchill, Canada, range. Reason for the large number of U.S. launches is that, in addition to participation in the COSPAR effort, NASA wants to study density with pitot tube equipment and temperature through grenade detonations on other launches.

Space Test Facility

Cook Electric Co.'s Inland Test Laboratories recently opened a 17,600 sq. ft. laboratory in Anaheim, Calif., to provide space environmental, qualification and reliability testing and engineering services for West Coast government and industry facilities.

The new facility also will have laboratories for instrument calibration and repair and specification writing.

Equipment at the facility will provide for combined testing, Cook said. It will include a random vibration facility, several high vacuum chambers in the 10^{-8} mm. Hg. range with solar radiation, temperature environments ranging from −320F to 1,000F and humidity variation from 0 to 100%.

Cook said capabilities also exist to simulate salt spray, fungus, shock, combined high and low temperature loads, 300,000 ft. altitudes, vibration, rain, and centrifugal force.

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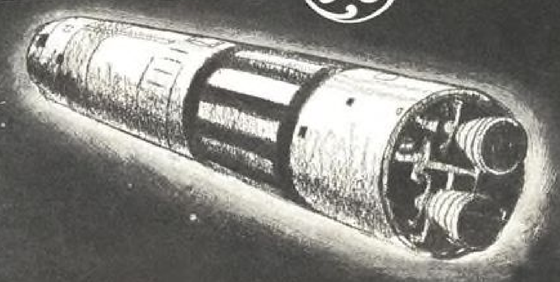
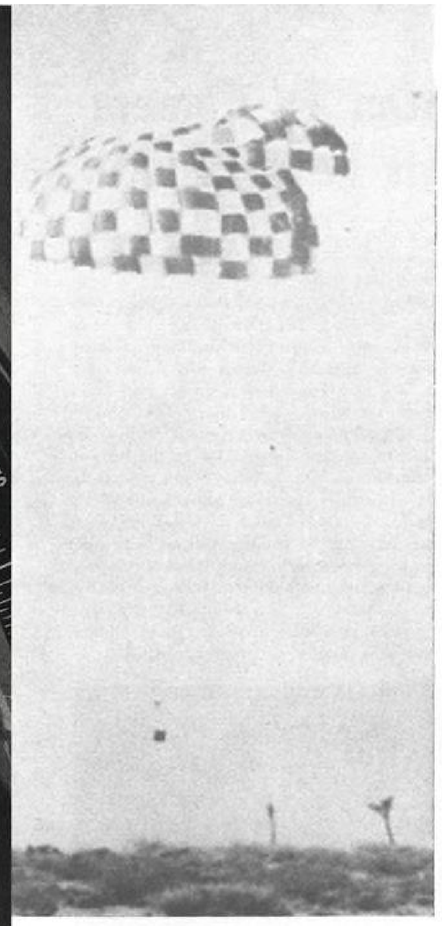




Controlled Descent

Glidesail parachute, developed by Northrop Corp.'s Ventura Division, makes controlled descent to demonstrate capability of steering payload to a selected landing site. Chute can make 360-deg. turns, shift from glide to vertical descent in seconds.

Photoelectric Cameras To Be Used on OGO

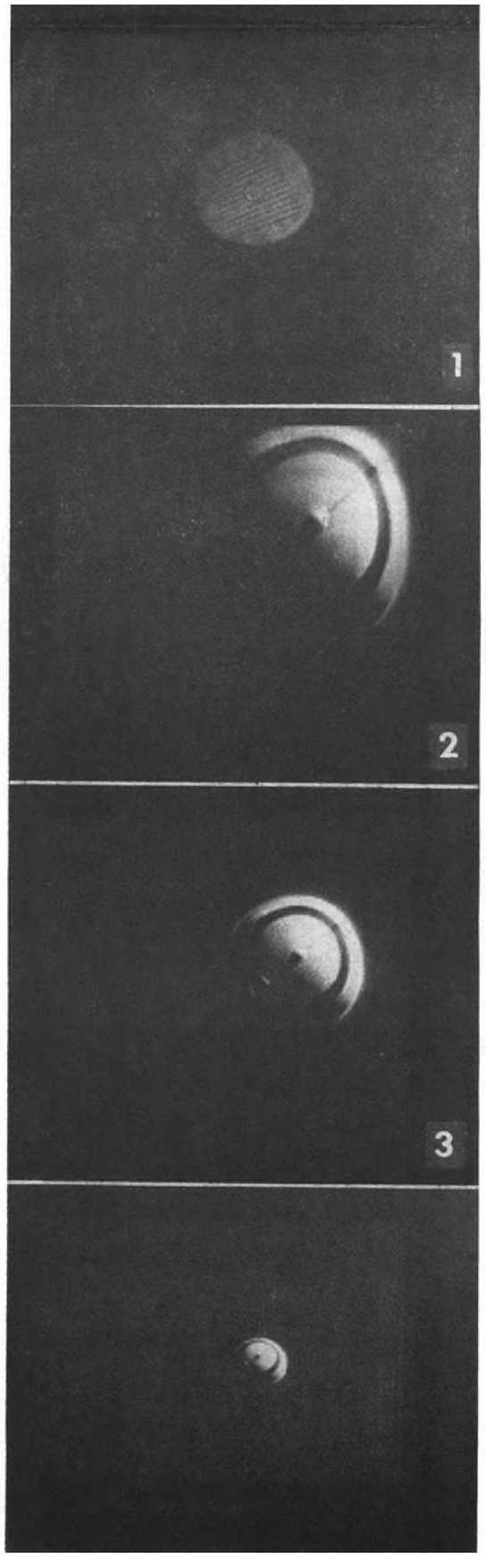
Photoelectric cameras, for use in the Orbiting Geophysical Observatory to determine nature and location of space particles that reflect sunlight and produce a faint green glow, will be built by International Telephone and Telegraph Corp.'s Industrial Laboratories Division, Fort Wayne, Ind.

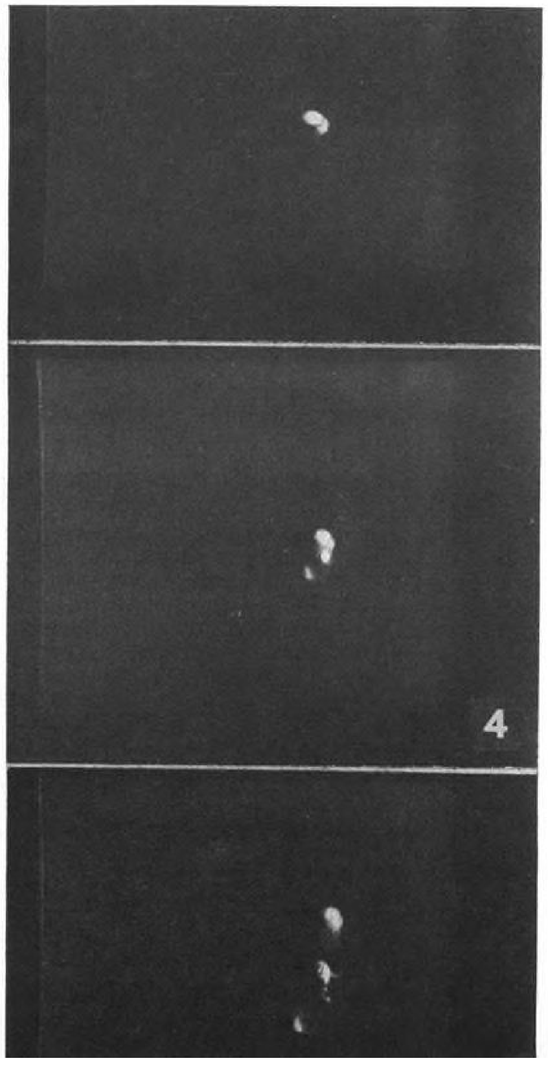
The cameras, part of the Gegenschein photometry experiment, will take series of pictures at high and low points of the observatory satellite's orbit to check location of the particles. Composition of the particles will be sought by analyzing pictures taken through colored and polarized filters.

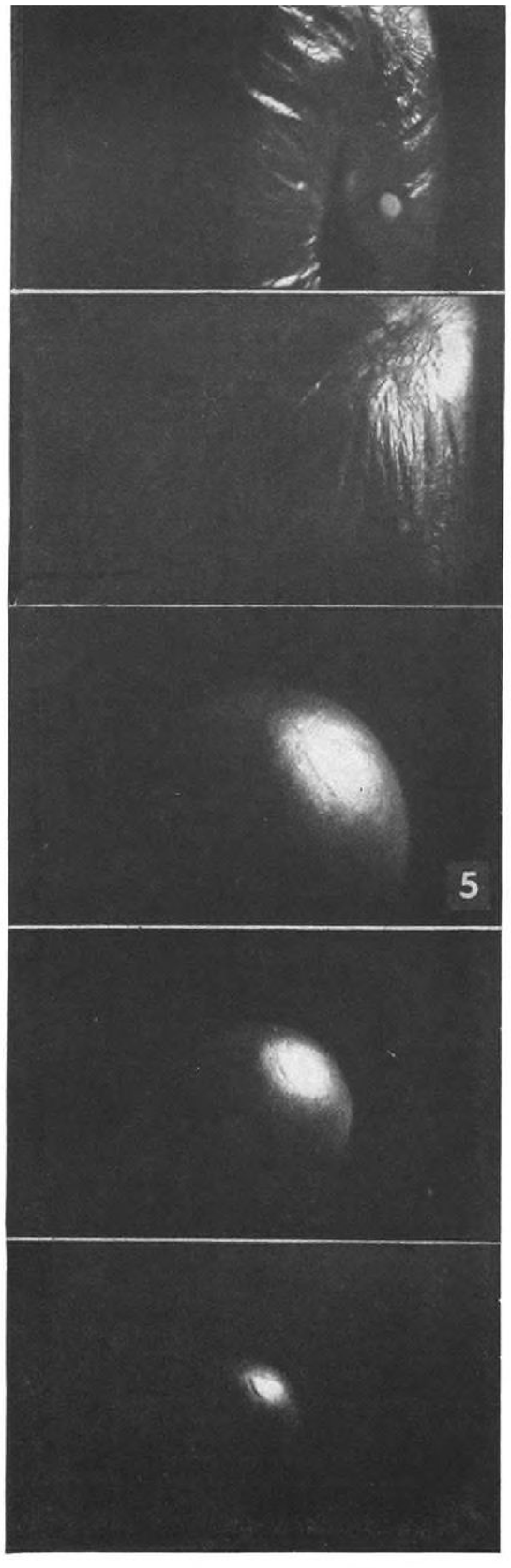
National Aeronautics and Space Administration's Goddard Space Flight Center is sponsoring development of the cameras with a $200,000 contract.

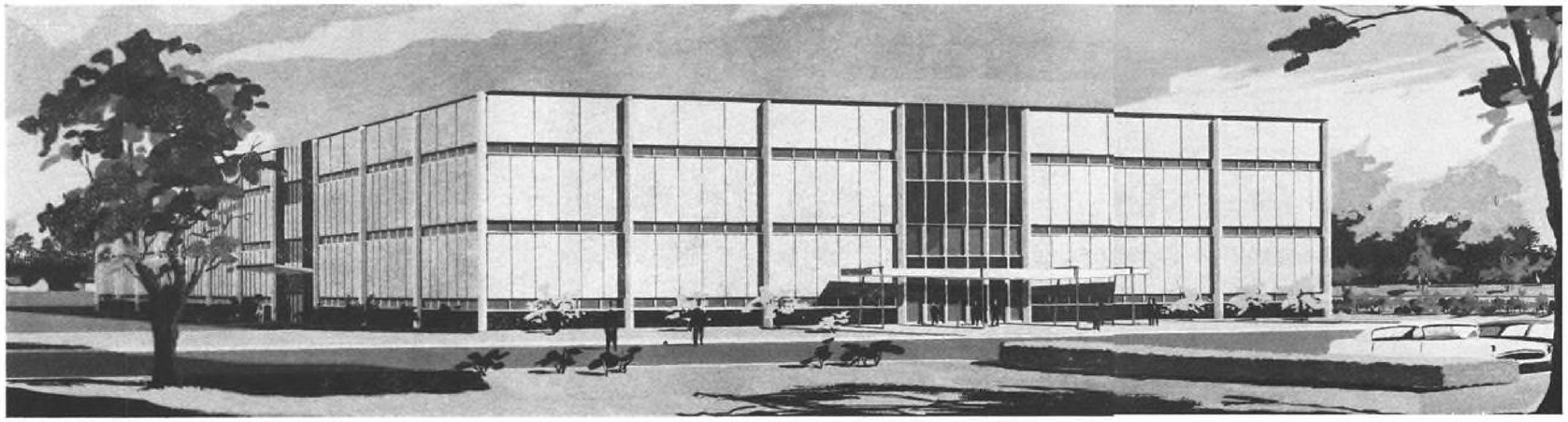
Fast-Scan TV Camera Records Echo Launch

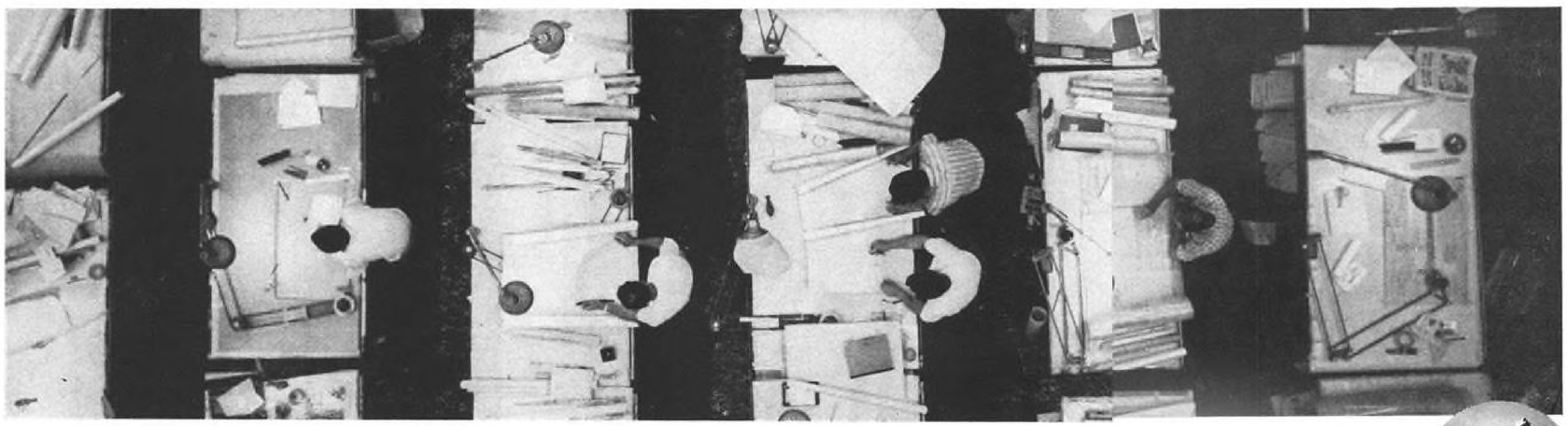
Fast-scan television camera mounted in the nose cone of the launch vehicle telemetered this sequence of the suborbital inflation of an Echo-type balloon by National Aeronautics and Space Administration recently (AW July 23, p. 19). Camera was manufactured by the Electronic Instrumentation Division of Lear Siegler, Inc., Anaheim, Calif. Test pattern, photo 1, indicated camera was working properly. Canister containing the balloon is shown still in the nose cone in photo 2. In the three-photo sequence beginning with photo 3, camera records the separation of the canister from the booster. Nine-shot sequence beginning with photo 4 shows opening of the canister and inflation of the balloon. In previous test last January, the balloon was destroyed by too-rapid inflation. Inflation procedure was modified for this attempt to prevent a similar failure. Photos beginning with photo 5 show fully inflated balloon drifting away from the booster. Television pictures were scanned and telemetered back to Cape Canaveral where they were reconstructed on 16 mm. kinescope. A total of 27 min. of TV film were obtained. Television camera was not recovered, but a motion picture camera also in the booster was returned to earth.











FACILITIES

Latest step in Grumman's long-range aerospace programming is construction of a new $5 million Space Engineering Center, shown here in an architect's drawing. Along with the recently completed Electronics Systems Center and in-progress Research Center, this new complex of aerospace facilities will give Grumman the physical capabilities and resources to undertake major space system assignments.

EXPERIENCE

In the early 1950's, Grumman instituted a comprehensive, long-range program of space studies. Significant areas were hypersonics, reentry, capsule retrieval, orbital transfer and lunar vehicles. Major accomplishment to date is acquisition of the OAO (Orbiting Astronomical Observatory) contract and the Echo II canister assembly. More recent study contracts include the performance study for Lunar Logistics Systems and a new contract study in Lunar Astrodynamics. Against the background of 33 years' experience in solving the man-machine equation in aircraft and weapons systems, Grumman now offers a fully integrated space capability.

AND ESPECIALLY

PEOPLE

Grumman's most valuable asset is people: scientists, engineers, technicians and craftsmen. This work force provides an unbroken network of interlacing aerospace experience and skills. Over all is a management team with the uncommon knack of fitting man and machine together . . . of correlating large-scale programs simultaneously . . . of ensuring "total company" effort . . . of transforming advanced ideas into reality. The Grumman work force is by far the most stable in the industry.

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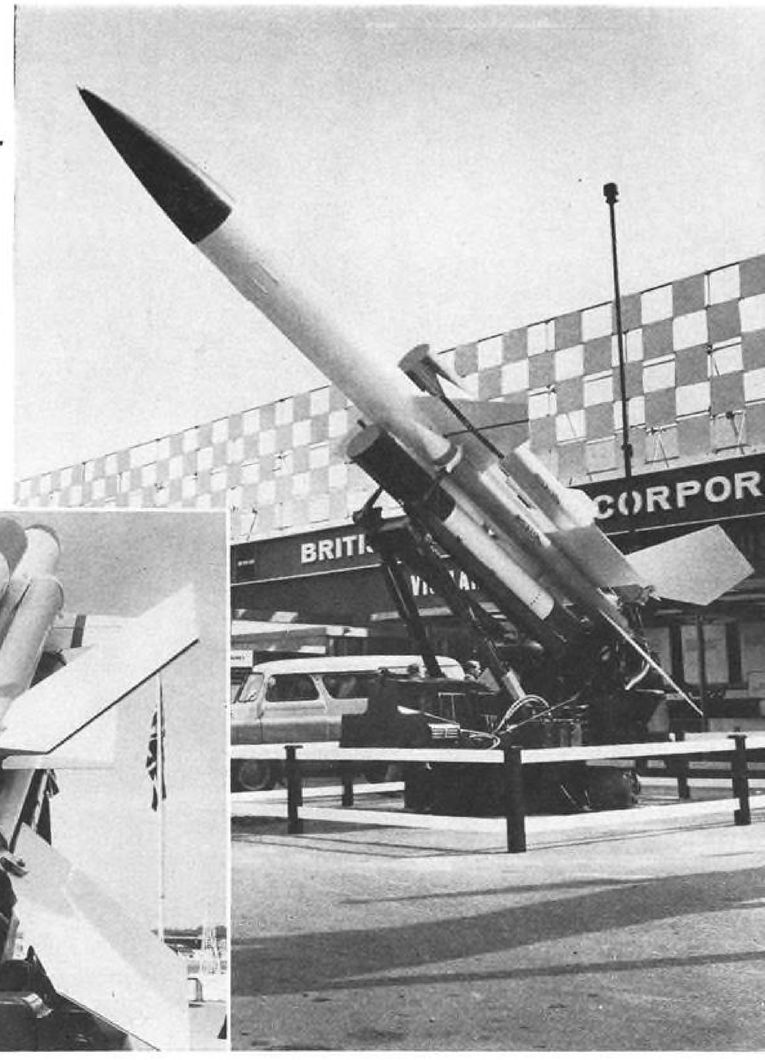
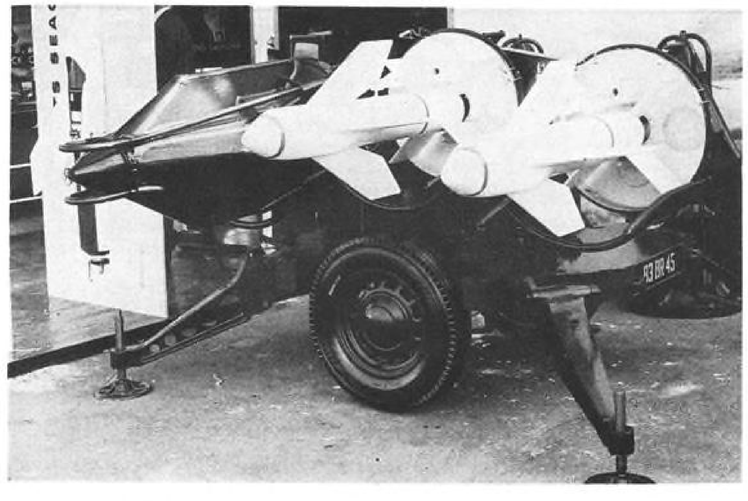
MISSILE ENGINEERING

Short Tigercat, Bristol Bloodhound Missiles Displayed



Mark 2 version of the Bristol Bloodhound surface-to-air missile (above), shown at Farnborough air show, uses continuous-wave radar for homing rather than the pulse-radar technique used in previous versions. The change gives the Bloodhound 2 better performance at both high and low altitudes and makes it less vulnerable to enemy countermeasures. Bloodhound 2 also has larger fuel tanks and solid-propellant booster systems plus two Bristol Siddeley Thor 3 ramjets. Cylinder on top of missile is located where the Thor 3 normally would be placed. Ramjets were removed, since dimensions and configuration could give indication of performance.



Land-based version of the Short Brothers & Harland naval Seacat—Tigercat—was displayed. Launch trailer carries three surface-to-surface, surface-to-air missiles. Note protective shield on missile at left.

Rocketdyne Expands Solid Facilities

Dallas—Expansion of solid-propellant rocket motor research and production facilities, including cast-cure pits capable of handling 160-in.-dia., 25-ft.-long motors with thrust ratings up to 1 million lb., is under way in a $2.3-million building program by North American Aviation's Rocketdyne Solid Rocket Division at McGregor, Tex.

Scheduled to be operational early next year, the new facility as yet has no programs designated. The company is seeking to develop a capability to handle large-scale production of mobile medium-range ballistic missiles (MMRBM), Minuteman and similar powerplants, in addition to larger-diameter research solid motors. The research motors will lead eventually to the 260-in.-dia. size. Rocketdyne's Solid Rocket Division is one of the current contenders for MMRBM motors.

First phase of the expansion program entails emplacement of two motor cast-cure pits, two propellant mixer buildings and a nondestructive testing facility, expected to be completed in October. Next phase starting in October would involve a test stand capable of handling motors up to 1.5 million lb. thrust and an oxidizer-processing building.

Feature of the 20-ft.-square by 30-ft.-deep cast-cure pits, according to the Solid Rocket Division's Vice President-General Manager T. E. Myers, is versatile design, permitting each to be used for handling either a single motor up to 160-in. dia. or four motors of varied sizes ranging up to the Minuteman first-stage.

One of the units in a cast-cure pit could conceivably be undergoing case preparation, one motor in the process of casting, one curing and the fourth cooling down.

Adjacent to each pit will be four blower systems to provide hot air for curing or ambient air for cooling down. Design of the pits provides for later installation of cooling coils and compressors to permit temperature cycling of finishing motors.

Test stand will be capable of handling motors in either vertical or horizontal firing attitudes. It will have a movable roof and walls to provide weather protection while units are being prepared for firing.

Mix buildings will house a 250-gal. and a 300-gal. propellant mixer, the new facilities providing a 50% increase in the division's propellant-processing capabilities, increasing capacity to 12 million lb. of castable propellant annually.

Non-destruct testing facility will house a new 13-million-electron-volt linear accelerator capable of penetrating 100 in. of propellant with an exposure time of approximately 1 hr. 45 min. The division now has a 400,000-electron-volt machine which can penetrate a maximum of 12 in. of propellant with 6-min. exposure. The new equipment is being built by Hughes Aircraft Co., Fullerton, Calif.

New facility is located adjacent to the plant's 280,000-sq.-ft. propellant manufacturing facility, which could be tied in directly to assist in boosting motor output, if needed.

USAF Contracts

Air Force Office of Scientific Research recently awarded the following grants and contracts valued at more than $1.7 million to universities and non-profit and industrial research laboratories.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y.—$91,165 for investigation of high speed low density and ionized gas flows.

Northwestern University, Evanston, Ill.—$17,890 for study of dynamic behavior of plates and shells.

University of Rochester, Rochester, N. Y.—$25,225 for measurement of electron and ion density profiles ahead of shock waves.

Space Technology Center, Redondo Beach, Calif.—$92,679 for continuation of research on ion beam neutralization.

University of Toronto, Toronto, Ontario, Canada—$20,451 for study of the distribution of energy in the products of reactions under flame conditions.

University of Pennsylvania, Philadelphia, Pa.—$34,335 for research on the use of a taped English word list in phonological and morphological studies.

Stanford University, Stanford, Calif.—$9,858 for study of applications of probability theory to problems in scientific methodology; $198,740 for studies of elastic and inelastic scattering of high energy electrons, production and interaction of various mesons, field theory and problems in quantum electrodynamics.

University of Brazil, Rio de Janeiro, Brazil—$4,500 for research on the electrophysiology of excitable tissue.

University of Buenos Aires, Buenos Aires, Argentina—$10,000 for research on ultrastructure and function of the retina; $39,600 for study of the effect of the Andes on the general circulation.

University of Chile, Santiago, Chile—$3,000 for study of the anatomical basis of pattern recognition.

University of Chile, School of Medicine, Santiago, Chile—$10,386 for research with sleep-wakefulness patterns in cats with chronic trisection of the brain stem.

Instituto de Investigacionde Ciencias Biologicas, Montevideo, Uruguay—$12,552 for studies of neuron degeneration and regeneration.

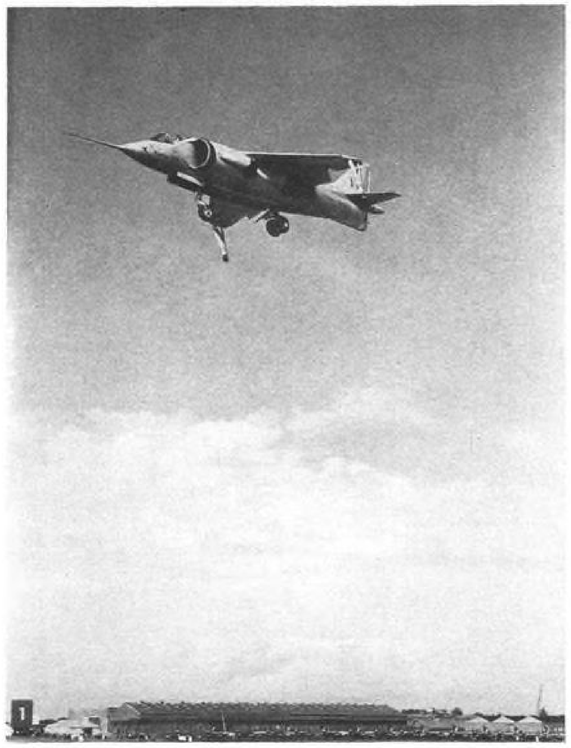
Universidad de la Republica, Instituto de Neurologia, Montevideo, Uruguay—$14,200 for research on attention, habituation and conditioning as related to evoked brain waves.

The Peace Research Institute, Washington, D. C.—$10,218 for a cross-cultural study of normative behavior.

University of Maryland, College Park, Md.—$60,000 for mathematical research in fields of fluid dynamics and applied mathematics.

University of Sydney, Sydney, Australia—$27,930 for study of two aspects of mathematical programing; $11,900 for an investigation into applications of Chebyshev series in numerical analysis; $20,206 for study of nuclear interactions at energies greater than 1,000 Bev.

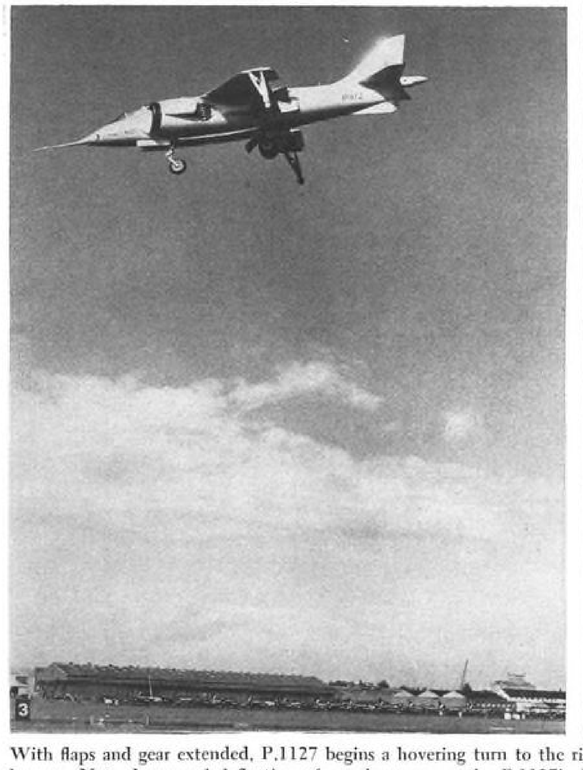
Yale University, New Haven, Conn.—$90,400 for establishment and operation of a research center for celestial mechanics.



Hawker P.1127 demonstrated hover maneuverability and control comparable to a helicopter at Farnborough Air Show. In photo No. 1, VTOL strike fighter has been brought to a hover. Note hangar in background as reference point.

Hawker P.1127 Demonstrates Ability to Maintain

At 90 deg. point in the turn, photo No. 5, P.1127's nose is pointed at hangar. Yaw, pitch and roll are controlled through bleed-air jets located in the nose, tail and under each wing. Aircraft maintains constant altitude and stability during turn.

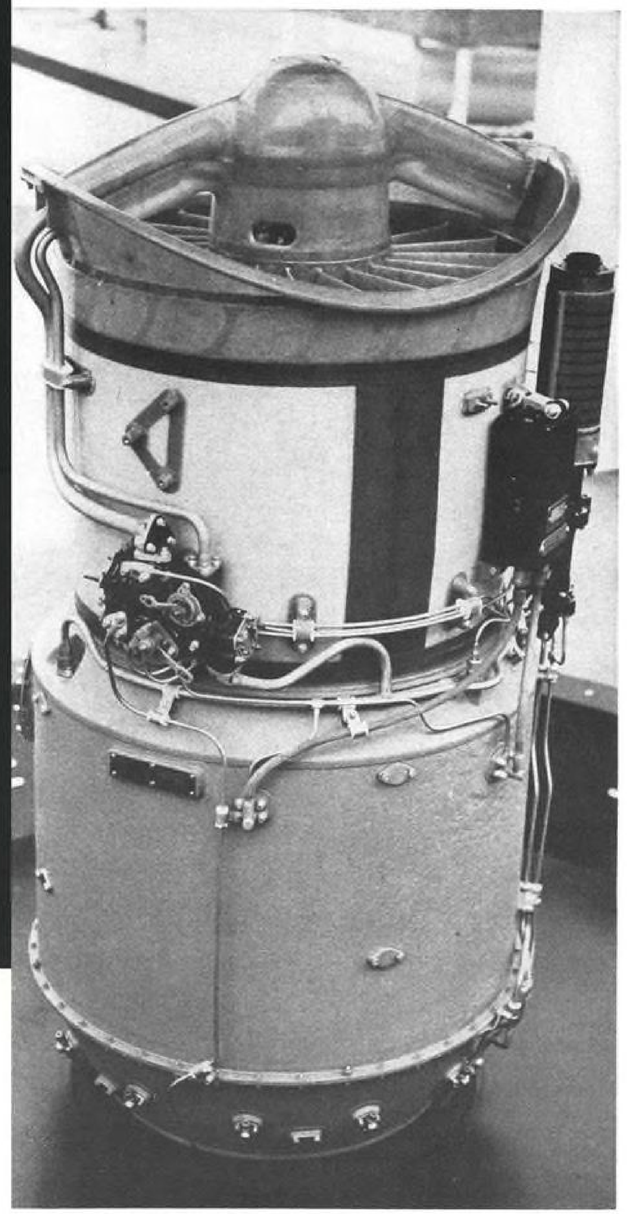


With flaps and gear extended, P.1127 begins a hovering turn to the right in photo No. 2. In photos 3 and 4, the aircraft turns toward hangar. Note downward deflection of nozzle vanes on the P.1127's Bristol Siddeley BS.53 vectorable thrust powerplant.

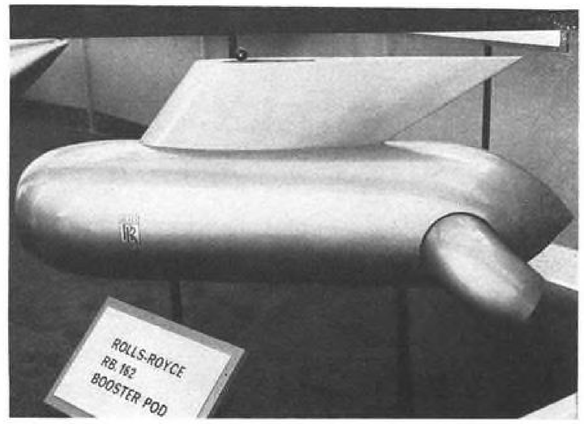
Stability and Constant Altitude in Hovering Turn

P.1127 is pointed at parked English Electric fighters in photo No. 7, in contrast to first picture in sequence. In photo No. 8, the aircraft has almost completed its 180 deg. turn and prepares to transition to horizontal flight.

Rolls RB.162 Lift Engine Uses Plastic Extensively

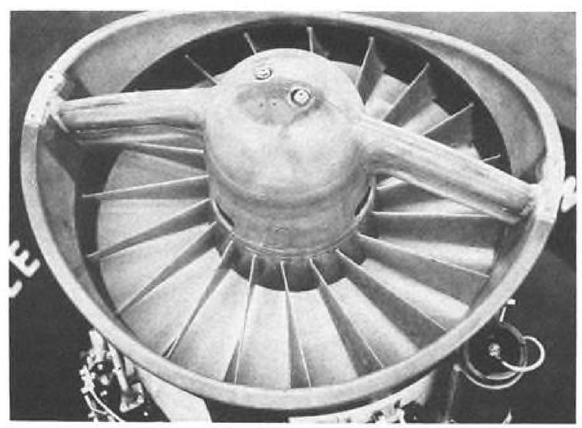


Rolls-Royce RB.162 lift engine on display at Farnborough weighs 267 lb., and has a present test-stand thrust rating of slightly more than 4,000 lb. and a design rating to 4,400 lb. for a thrust-to-weight ratio of more than 16-to-1. Rolls hopes to increase this ratio to 20-to-1. For installation on an aircraft, RB.162 has six connection points—fuel, oil, mechanical throttle, ignition, pressure indicator and bleed air gage. A maximum number of plastic components are used in construction of the engine.



Podded version of the RB.162 (above) for use on existing aircraft also is envisioned by Rolls-Royce for STOL applications. Outlets on either side of the wing-mounted pod can be swiveled through 180 deg. arc for alternate use for STOL thrust, normal power or braking. Pod application is planned for Transall C.160 transport. Engine probably would be all-metal, because of long running times.

Plastics in standard RB.162 represent about half the engine's bulk and a third of the weight. Nose cone, stator blades, intake casing (above), plus compressor casing and all rotor blades except the front row are of plastic. As part of the quick engine change philosophy, RB.162 nose cone (below), will support full weight of the engine. Lifts attach directly to nose cone supports.



Simulator Cutting ASW Training Costs

North Island, Calif.—Training of anti-submarine warfare air crews in the subtleties of ASW tactics while coping with aircraft systems management is being conducted on a 16 hr. per day basis in the 2F-66 weapon system simulator located at the Naval Air Station here.

Pilots and other crew members undergoing training in the Grumman S2F-3 Tracker at the Fleet Airborne Electronic Training Unit Pacific (FAETUPAC) are supplementing actual flight training with simulated missions in a newly-developed training device built by ACF Industries' Electronics Division.

Workouts in search, detection, classification, localization, attack and destruction of enemy submarines are provided by the 2F-66 simulator with a degree of realism that rivals actual missions.

Constructed at a cost of $1.3 million, the ACF simulator is housed in two large semi-trailer vans so that it can be moved from base to base as training needs dictate.

One van contains a 32-computer-circuit unit which receives problem and control inputs and drives the instruments and problems plotting board according to the received inputs. The other van contains the instructor's stations and a complete mockup of the cockpit and crew stations in the actual aircraft.

In the simulator, as in actual flight, the pilot acts as crew tactician while flying the aircraft; the copilot handles communications and assists the pilot, number one system operator handles the radar and Magnetic Anomaly Detection (MAD) gear, while the fourth crewman operates the Julie and Jezebel gear.

Julie (APR-58) is a working name applied to the use of sonobuoys, and Jezebel (AQA-3) is an echo-ranging technique using underwater explosives to locate submarines.

A typical ASW mission duplicated in the 2F-66 trainer begins with search of a given area by radar or ASH, an electronic device which "sniffs" the air for the products of diesel oil combustion.

Once a visual or radar pickup is made, the ASW crew closes in and rings the area with sonobuoys for further use with the Julie and Jezebel gear.

After the submarine's location is more closely determined by these means, the MAD gear is brought into play. Finally, the target is attacked with either nuclear depth charges or homing torpedoes. About the only sequence the trainer cannot simulate is an attack on a surfaced sub with the two 5-in. HVAR rockets carried by the S2F-3. The rockets are used to puncture a surfaced submarine's pressure hull.

The simulator actually is a dual pur-

ACF ELECTRONICS 2F-66 ASW simulator contains an exact duplication of the cockpit and crew stations in the Grumman S2F-3. Radar/Magnetic Anomaly Detection gear operator at left is being critiqued by instructor at right during simulated problem.

RADAR/MAD OPERATOR, left, prepares to release a sonobuoy while working on an ASW problem in the simulator. Crew members can be trained individually or as a four-man unit in the ACF Electronics-built simulator. Instructor's console, right, duplicates Grumman S2F-3 cockpit instruments and weapons management system. Plotting board behind instructors follows target-aircraft positions.

pose training device which can be used both as a flight and a tactics simulator. As a flight simulator, the 2F-66 will act and react with the proper instrument indications to all in-flight emergencies. Missions are conducted on instrument conditions just as many actual missions.

The instructors pose problems to the crew and operate the simulator so that the crew receives indications of a submarine's evasive tactics. At the same time, the instructor can introduce a host of emergency situations into the problem, such as engine failure, electrical difficulty, hydraulic malfunction, etc.

Realism even extends to a duplication of engine and aerodynamic noise, which changes to a spluttering when the instructor provides an engine failure to the pilot. A loudspeaker also will emit a "screech" as the wheels touch the runway at mission completion. The only factors not simulated are the dynamic response of the aircraft and the "adrenalin factor," something which considerably changes man's ability and capability under stress of ASW combat.

Complete S2F-3 cockpit and crew stations are duplicated in the simulator. With respect to emergency procedures in flight and the response of the aircraft to various control inputs, the simulator does the job. However, it is no different in this respect from hundreds of other simulators built by ACF and other manufacturers. The unique aspect of the 2F-66 is that in addition to flight simulation, it can imitate a tactical situation by providing targets which move in three dimensions, the aircraft's movements and the deployment of weapons against the targets.

Three targets can be worked simultaneously on the simulator's plotting board—two submersible and one surface target. The simulator operator can control the depth, speed and course of the targets. The device also can simulate various sea states, weather conditions, ocean temperatures and even compound the problem by cranking in the variables of submarine ocean currents and water temperature inversions.

This latter feature provides realism that is rarely possible under training conditions due to the limitations of the training area. Once an ASW crew has worked a problem against a submarine in known waters it has a distinct advantage over the target because the depth and bottom configuration is known, the area is limited, and currents and water temperature have been determined.

Flight training also involves a certain amount of non-productive flying time, such as that consumed in flying to and from the target area. Use of the simulator eliminates this and also cuts down on the number of missions scrubbed because of weather. Also, the use of active submarines for targets is limited by their availability away from other commitments and the cost of operation.

FAETUPAC simulator personnel compute the cost of operating the ground trainer at $155.40 per hour based on 8 hr. per day utilization including crew and maintenance. Cost of operating the aircraft, including crew, is figured at $1,500 per hour, and the training cost does not include the expenses of the submarine and crew. The Navy estimates that if the ASW simulator is used 16 hr. per day for three months on the same schedule as an aircraft with a submarine, the cost differential between the two forms of training would equal the cost of the simulator over a three-month period.

Another cost of the live training is sonobuoys with a price tag of $600 each. Eight million dollars worth of sonobuoys would be expended in actual training if used at the same rate as simulated in the trainer.

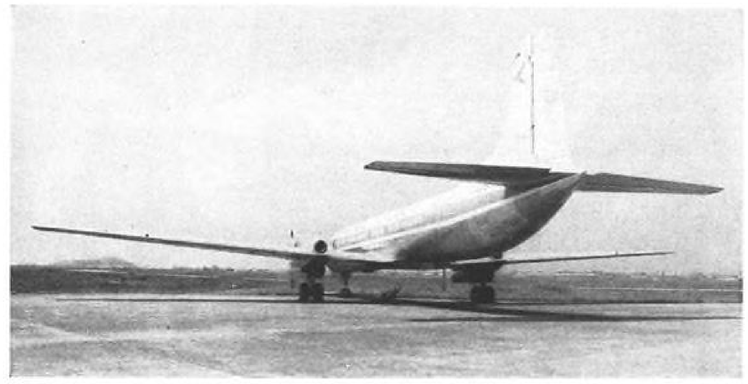
One of the most valuable training features of the simulator is a "freeze" feature which stops the problem at any point desired. While it is frozen, instructor and students can discuss the problem and point out corrective action.

Piasecki Airgeep 2 Being Test Flown

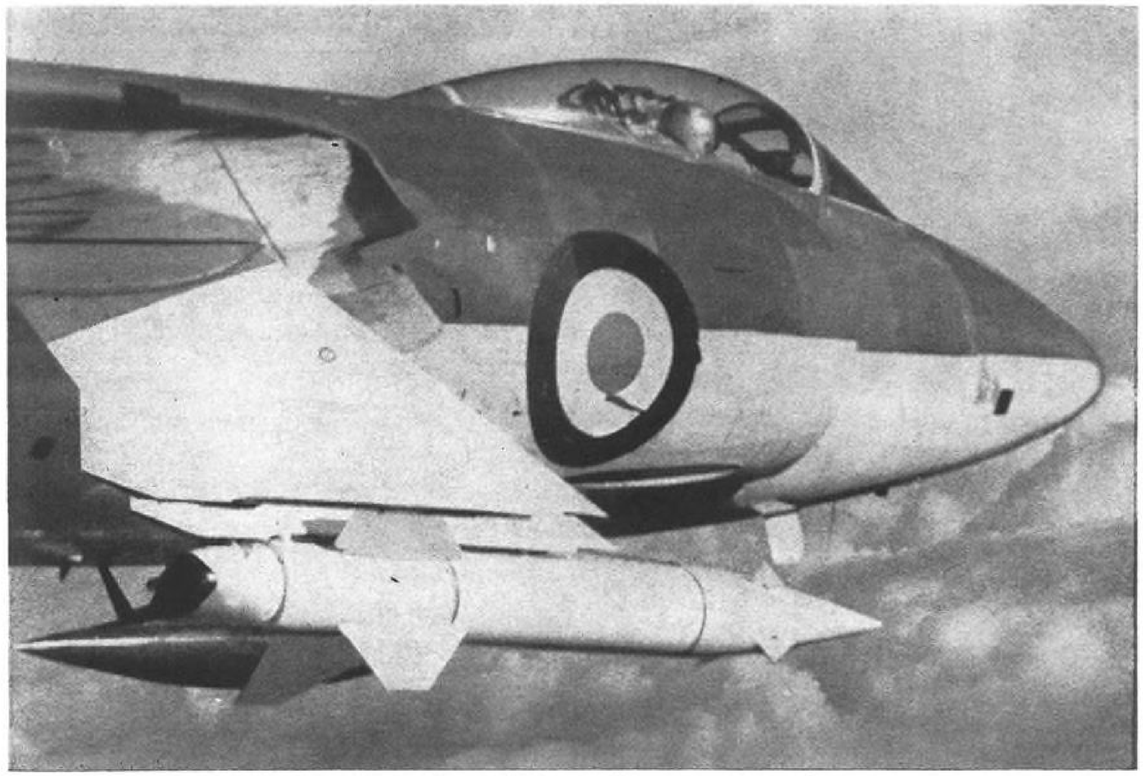
Piasecki Aircraft Corp.'s Airgeep 2, developed under Army contract as surface or air vehicle, uses ducted propellers and two Artouste 2C turbine engines.

Nihon YS-11 Enters Test Program Prior To 1963 Production

Details of Nihon YS-11 turboprop airliner, which recently made its first flight (AW Sept. 3, p. 27), are shown in these photographs. Wingspan is 105 ft., length is 86 ft. 3 in. and height is 30 ft.



YS-11 is scheduled to enter production next year. Aircraft is powered by Rolls-Royce Dart R.Da.10/1 engines which develop 2,660 ehp. dry or 3,060 ehp. with water injection. The YS-11 is designed to carry 52 passengers at 257 kt. at 20,000 ft. Basic operating weight is 31,217 lb. and maximum payload is 10,318 lb. Takeoff weight is 50,265 lb.



Bullpup Arms Royal Navy Supermarine Scimitar

Martin Bullpup air-to-surface missile is mounted on a pylon under the wing of a British Royal Navy Supermarine Scimitar strike fighter of the Fleet Air Arm. Picture was taken during flight test portion of Fleet Air Arm's evaluation program.

West Germany Pondering Decision On F-104 Zero-Launch Capability

West German Defense Ministry is expected to make final decision within the near future as to whether to go ahead with plans for providing its force of Lockheed F-104Gs with a zero-launch capability.

For evaluation purposes, Lockheed already has a contract to carry out 4 live and 10 dummy launches of the aircraft from zero-launch trailers in order to test the feasibility of the project. Factors being debated include cost and availability, particularly in view of the potential of follow-on VTOL fighters scheduled to appear in the late 1960s.

In a related move, the West German air force may place increasing reliance upon U.S. facilities for the training of its F-104 pilots. Lt. Gen. Werner Panitzki, former head of the training command who will take over as air force inspector general on Oct. 1, reportedly favors this approach rather than the near-complete national program as envisioned by his predecessor, Lt. Gen. Josef Kammhuber. Reasons for the proposed change include better weather conditions at the George AFB, Calif., training site than any that can be found in Germany, lower costs and the capability of turning out a greater number of pilots over a given period of time. Move also would help relieve the congested air space over West Germany.

German air force, however, will continue to train a substantial number of its own F-104 pilots plus a portion of those from other European consortium countries, Italy, Belgium and Holland, which, to date, have no two-place F-104F trainer versions of their own.

Final and long-delayed decision as to whether to modernize these facilities through an order for a quantity of Northrop T-38 advanced trainers is now expected sometime next month. Deliveries could be completed in 1964.

In the meantime, German training facilities already are turning out pilots to man the air force's second F-104G unit, the 33rd Fighter-Bomber Wing under activation at Buchel. The wing is scheduled to become operational before the end of the year.

Most of the pilots of the first unit, the 31st Fighter-Bomber Wing activated at Noervenich on June 20, also were trained by German instructors.

Each wing of 50 aircraft has a complement of 75 pilots to meet North Atlantic Treaty Organization standards of 1.5 pilots per plane.

Another four German wings are scheduled to be activated next year, and all programed units are slated to be operational during the 1965 calendar year.

F-104G candidates must have had a minimum of 500 jet hours, at least 150 of them in North American F-86F or Republic F-84F aircraft, before consideration for inclusion in the program. Pilots trained in the U.S., if the new plan is adopted, will receive additional navigational instruction upon their return to Germany before going into operational units to help them adapt to the poor-weather conditions often prevailing over much of northern and central Europe.

PRODUCTION BRIEFING

Goodyear Aircraft Corp., Akron, Ohio, will produce windshields and forward and aft canopies for both the Navy F4H and Air Force F-110 versions of the Phantom 2 aircraft under a $3,194,412 contract from McDonnell Aircraft Corp., St. Louis.

Ford Bacon & Davis, Inc., New York, has been awarded a National Aeronautics and Space Administration contract to direct the design of an advanced flight acceleration facility for NASA's Manned Spacecraft Center in Houston, Tex.

General Electric Co.'s Flight Propulsion Division, Cincinnati, Ohio, has been awarded an $11.7-million contract from Thiokol Chemical Corp. for continued production of rocket motor cases for Air Force's Minuteman ICBM (AW Aug. 27, p. 54).

Ball Brothers Research Corp., Boulder, Colo.; Republic Aviation Corp., Farmingdale, N. Y., and Space Technology Laboratories, Inc., Redondo Beach, Calif., have each received $100,000 study contracts from National Aeronautics and Space Administration's Goddard Space Flight Center to design a new series of spacecraft for study of the sun.

Garrett Corp.'s AiResearch Phoenix Division has been awarded a contract in excess of $2 million by Air Force's Aeronautical Systems Division for the production of cartridge pneumatic starters for the KC-135 aerial tanker and the B-52 bomber.

Ryan Aeronautical Co., San Diego, Calif., has received a $630,000 contract from National Aeronautics and Space Administration's Marshall Space Flight Center for the production of explosively formed aluminum segments for fuel compartment bulkheads in the Saturn C-5 rocket.

ManLabs, Inc., Cambridge, Mass., will study the physical, chemical, mechanical and thermodynamic properties of selected borides as part of an Air Force research program to determine feasibility of using borides as structural materials. Work is sponsored by a $394,400 contract from Air Force's Aeronautical Systems Division.

Beech Aircraft Corp., Wichita, Kan., has been awarded a $3.8-million follow-on contract from Republic Aircraft Corp. for the production of aft fuselage sections and ailerons for the F-105 jet fighter-bomber.

Defense Issues New Aircraft Designations

Washington—New tri-service regulations adopted by the Department of Defense for the designating, redesignating and naming of military aircraft will force the Navy to make extensive changes while the Air Force and Army will have to make only minor alterations. The regulations have been approved and are expected to be distributed in printed form in the next two weeks.

Very few of the Navy's designations will survive even in partially recognizable form, while almost all Air Force designations will remain unchanged. Army helicopters will have slightly altered designations.

The designation system in Air Force Regulation No. 66-11, Army Regulation No. 700-26 and BuWeps Instruction 13100.7 remains the same as first revealed in AVIATION WEEK (June 11, p. 26).

Complete Conversion

Complete conversion of documents will be delayed until it is necessary to revise a publication, drawing or other document for some other purpose. In the meantime, essential changes will be made in pen and ink. New cover pages for technical publications and manuals will be substituted for old ones.

The redesignations are to be effective upon publication of the regulations and are to be implemented as soon as possible.

New aircraft will be assigned the next consecutive design number within each basic mission-type with the exception of the bombers, which will begin with B-1A, cargo-transports, beginning with C-3A and the fighters, beginning with F-12A.

In the list of manufacturers and their designations, below, the Bell Aerosystems Co. was added with the designation BC and the designations of Piasecki Aircraft Corp. and Piper Aircraft Corp., were exchanged, becoming PI and PA, respectively.

The designation system consists of a letter representing the basic mission and type. This could be preceded by a prefix symbol indicating status, if, for example, it was an experimental aircraft. This in turn could be preceded by a modified mission symbol indicating a capability other than the current capability.

Source Code

Any combination of these three would be followed by a design number and a series symbol. A two-letter manufacturer's or source code would complete the designation.

The letters "I" and "O" will not be used as series letters because of the possibility of confusing them with the numerals "1" and "0."

These are the possible components of a designation and the assigned letters listed in the order they would be used:

• **Status prefix symbol** would indicate an aircraft or airship being used for experimental, service test or some other special purpose. They are: G—permanently grounded; J—special test, temporary; N—special test, permanent; X—experimental; Y—prototype; Z—planning.

• **Modified mission symbol** would indicate the capability of an aircraft after it has been modified. They are: A—attack; C—cargo/transport; D—director; E—special electronic installation; H—search rescue; K—tanker; L—cold weather; M—missile carrier; Q—drone; R—reconnaissance; S—anti-submarine; T—trainer; U—utility; V—staff; W—weather.

• **Basic mission and type** symbols would indicate the primary capability. In the case of helicopters, VTOL and STOL aircraft and airships a second letter indicating type will be used. They are: A—attack; B—bomber; C—cargo/transport; E—special electronic installation; F—fighter; H—helicopter; K—tanker; O—observation; P—patrol; S—anti-submarine; T—trainer; U—utility; V—VTOL or STOL; X—research; Z—airship.

Popular names will be assigned only to aircraft which have gone into production or have immediate prospects of going into production. The names will be one word and will fit the characteristics of the aircraft.

Over-all Administration

Over-all administration of the regulation is the responsibility of the Air Force Aeronautical Systems Division at Wright-Patterson AFB, Ohio. A single point of contact for administration of designation assignments within each service has been established. For the Air Force it is ASD, for the Navy it is the Bureau of Weapons and for the Army the Army Materiel Command.

A list of current designations and the services using the aircraft, as furnished by Department of Defense follows on pp. 103-109.

Aircraft Source or Manufacturer's Code Letters

Symbol	Manufacturer	Address	Symbol	Manufacturer	Address
AE	Aeronca Aircraft Corp.	Middletown, Ohio	HI	Hiller Helicopter Corp.	Palo Alto, Calif.
BH	Beech Aircraft Corp.	Wichita, Kan.	HU	Hughes Tool Co.	San Diego, Calif.
BF	Bell Helicopter Corp.	Ft. Worth, Tex.	KA	Kaman Helicopter Corp.	Windsor Locks, Conn.
BC	Bell Aerosystems Co.	Buffalo, N. Y.	LM	Lockheed Aircraft Corp.	Marietta, Ga.
BN	Boeing Co.	Renton, Wash.	LO	Lockheed Aircraft Corp.	Burbank, Calif.
BO	Boeing Co.	Seattle, Wash.	MA	Martin Co.	Baltimore, Md.
BV	Boeing Co. (Vertol Division)	Morton, Pa.	MD	Martin Co.	Denver, Colo.
BW	Boeing Co.	Wichita, Kan.	MF	Martin Co.	Orlando, Fla.
CE	Cessna Aircraft Co.	Wichita, Kan.	MC	McDonnell Aircraft Corp.	St. Louis, Mo.
CF	Convair	Ft. Worth, Tex.	ND	Noorduyn Aviation Co. Ltd.	Montreal, Canada
CO	Convair	San Diego, Calif.	NA	North American Aviation Inc.	Inglewood, Calif.
DH	de Havilland Aircraft of Canada	Toronto, Canada	NH	North American Aviation Inc.	Columbus, Ohio
DM	Doman Helicopter Inc.	Danbury, Conn.	NI	North American Aviation Inc.	Downey, Calif.
DL	Douglas Aircraft Co., Inc.	Long Beach, Calif.	NO	Northrop Aircraft Inc.	Hawthorne, Calif.
DO	Douglas Aircraft Co., Inc.	Santa Monica, Calif.	PI	Piasecki Aircraft Corp.	Philadelphia, Pa.
DT	Douglas Aircraft Co., Inc.	Tulsa, Okla.	PA	Piper Aircraft Corp.	Lockhaven, Pa.
FA	Fairchild Aircraft Division	Hagerstown, Md.	RE	Republic Aviation Corp.	Farmingdale, L. I., N. Y.
GO	Goodyear Aircraft Co.	Akron, Ohio	RY	Ryan Aeronautical Co.	San Diego, Calif.
GT	Grand Central Aircraft Eng. Co.	Tucson, Ariz.	SW	Schweizer Aircraft Corp.	Elmira, N. Y.
GR	Grumman Aircraft Eng. Corp.	Bethpage, L. I., N. Y.	SI	Sikorsky Aircraft Division	Stratford, Conn.
GY	Gyrodyne Co. of America Inc.	St. James, L. I., N. Y.	TA	Taylorcraft Aviation Corp.	Alliance, Ohio
HE	Helio Aircraft Corp.	Norwood, Mass.	VO	Chance Vought Aircraft	Dallas, Tex.

Department of Defense Aircraft Designations

ATTACK SERIES

Former Designation	Current Designation	Service
AD-5	A-1E	NAVY
AD-5W	EA-1E	NAVY
AD-5Q	EA-1F	NAVY
AD-5N	A-1G	NAVY
AD-6	A-1H	NAVY
AD-7	A-1J	NAVY
AJ-1	A-2A	NAVY
Y/A3D-1	YA-3A	NAVY
A3D-1	A-3A	NAVY
Y/A3D-1Q	YEA-3A	NAVY
A3D-1Q	EA-3A	NAVY
Y/A3D-1P	YRA-3A	NAVY
A3D-2	A-3B	NAVY
A3D-2Q	EA-3B	NAVY
Y/A3D-2P	YRA-3B	NAVY
A3D-2P	RA-3B	NAVY
A3D-2T	TA-3B	NAVY
Y/A4D-1	YA-4A	NAVY
A4D-1	A-4A	NAVY
Y/A4D-2	YA-4B	NAVY
A4D-2	A-4B	NAVY
Y/A4D-2N	YA-4C	NAVY
A4D-2N	A-4C	NAVY
A4D-5	A-4E	NAVY
Y/A3J-1	YA-5A	NAVY
A3J-1	A-5A	NAVY
A3J-2	A-5B	NAVY
A3J-3	A-5C	NAVY
A2F-1	A-6A	NAVY
A2F-1H	EA-6A	NAVY

NOTE: Future New Attack Aircraft will be designated starting at Design No. -7A.

BOMBER SERIES

Former Designation	Current Designation	Service
VB-26B	VB-26B	AF
B-26B	B-26B	AF
TB-26B	TB-26B	AF
B-26C	B-26C	AF
GB-26C	B-26C	AF
RB-26C	RB-26C	AF
TB-26C	TB-26C	AF
JD-1	UB-26J	NAVY
JD-1D	DB-26J	NAVY
TB-29A	TB-29A	AF
B-45C	B-45C	AF
RB-45C	RB-45C	AF
B-47B	B-47B	AF
DB-47B	DB-47B	AF
TB-47B	TB-47B	AF
WB-47B	WB-47B	AF
B-47E	B-47E	AF
E-47E	EB-47E	AF
RB-47E	RB-47E	AF
R-47E	RB-47E	AF
ER-47H	EB-47H	AF
RB-47H	RB-47H	AF
R-47H	RB-47H	AF
RB-47K	RB-47K	AF
R-47K	RB-47K	AF
TB-50D	TB-50D	AF
WB-50D	WB-50D	AF
RB-50F	RB-50F	AF
KB-50J	KB-50J	AF
KB-50K	KB-50K	AF
B-52A	B-52A	AF
B-52B	B-52B	AF
B-52C	B-52C	AF
B-52D	B-52D	AF
B-52E	B-52E	AF
B-52F	B-52F	AF
B-52G	B-52G	AF
B-52H	B-52H	AF
B-57A	B-57A	AF
RB-57A	RB-57A	AF
B-57B	B-57B	AF
RB-57B	RB-57B	AF
B-57C	B-57C	AF
TB-57C	TB-57C	AF
RB-57D	RB-57D	AF
B-57E	B-57E	AF
RB-57E	RB-57E	AF
TB-57E	TB-57E	AF
B-58A	B-58A	AF
YRB-58A	YRB-58A	AF
TB-58A	TB-58A	AF
RB-66A	RB-66A	AF
RB-66B	RB-66B	AF
RB-66C	RB-66C	AF
B-66D	B-66D	AF
WB-66D	WB-66D	AF
B-66E	B-66E	AF
XB-70	XB-70A	AF

NOTE: Future New Bomber Aircraft will be designated starting at Design No. 1A.

HELICOPTER SERIES

Former Designation	Current Designation	Service
HU-1	UH-1	ARMY
HU-1A	UH-1A	ARMY
HU-1B	UH-1B	ARMY
HU-1D	UH-1D	ARMY
HU-1E	UH-1E	NAVY
HU2K-1	UH-2A	NAVY
HU2K-1U	UH-2B	NAVY
Y/HSS-2	YSH-3A	NAVY
HSS-2	SH-3A	NAVY
HSS-2Z	VH-3A	NAVY
HO-4	OH-4A	ARMY
HO-5	OH-5A	ARMY
HO-6	OH-6A	ARMY
H-13E	OH-13E	ARMY
H-13G	OH-13G	ARMY
H-13H	OH-13H	ARMY
H-13H	UH-13H	AF
H-13J	UH-13J	AF
H-13K	OH-13K	ARMY
HTL-4	TH-13L	NAVY
HTL-6	TH-13M	NAVY
HTL-7	TH-13N	NAVY
HUL-1	UH-13P	NAVY
HUL-1G	HH-13Q	NAVY (C. G.)
HUL-1M	UH-13R	NAVY
H-19B	UH-19B	AF
SH-19B	HH-19B	AF
H-19C	UH-19C	ARMY
H-19D	UH-19D	ARMY
HRS-3	CH-19E	NAVY
HO4S-3	UH-19F	NAVY
HO4S-3G	HH-19G	NAVY (C. G.)
H-21A	CH-21A	AF
H-21B	CH-21B	AF
H-21B	CH-21B	ARMY
SH-21B	HH-21B	AF
H-21C	CH-21C	ARMY
H-23B	OH-23B	ARMY
H-23C	OH-23C	ARMY
H-23D	OH-23D	ARMY
H-23F	OH-23F	ARMY
HUP-2	UH-25B	NAVY
HUP-3	UH-25C	NAVY
XH-33A	XH-33A	AF
H-34A	CH-34A	ARMY
H-34C	CH-34C	ARMY
HYS-1L	LH-34D	NAVY
Y/HSS-1	YSH-34G	NAVY
HSS-1	SH-34G	NAVY
HUS-1	UH-34D	NAVY
HUS-1Z	VH-34D	NAVY
HUS-1A	UH-34E	NAVY
HUS-1G	HH-34F	NAVY (C. G.)
HSS-1F	SH-34H	NAVY
Y/HSS-1N	YSH-34J	NAVY
HSS-1N	SH-34J	NAVY
H-37A	CH-37A	ARMY
H-37B	CH-37B	ARMY
HR2S-1	CH-37C	NAVY
XH-40A	XH-40A	AF
YH-41	NH-41A	ARMY
H-41	UH-41A	AF
H-43A	HH-43A	AF
H-43B	HH-43B	AF
HUK-1	UH-43C	NAVY
HOK-1	OH-43D	NAVY
HRB-1	CH-46A	NAVY
HX/H-2	XCH-46B	AF
HC-1A	CH-46C	ARMY
HC-1B	CH-47A	ARMY
HX/H-1	XH-48A	AF
DSN-1	QH-50A	NAVY
DSN-2	QH-50B	NAVY
DSN-3	QH-50C	NAVY
NEW	XH-51A	NAVY

NOTE: Future New Helicopters will be designated starting at Design No. -52A.

ANTI-SUB SERIES

Former Designation	Current Designation	Service
S2F-1	S-2A	NAVY
Y/S2F-1	YS-2A	NAVY
S2F-1T	TS-2A	NAVY
S2F-1S	S-2B	NAVY
S2F-2	S-2C	NAVY
S2F-2P	RS-2C	NAVY
S2F-3	S-2D	NAVY
S2F-3S	S-2E	NAVY

NOTE: Next design No. for Anti-Sub is No. -3A.

RESEARCH SERIES

Former Designation	Current Designation	Service
X-13	X-13A	AF
X-15	X-15A	AF
X-20	X-20A	AF
X-21	X-21A	AF

NOTE: Next Design No. is -22A.

AIRSHIP SERIES

Former Designation	Current Designation	Service
ZPG-2W	EZ-1B	NAVY
ZPG-2	SZ-1B	NAVY
ZPG-3W	EZ-1C	NAVY

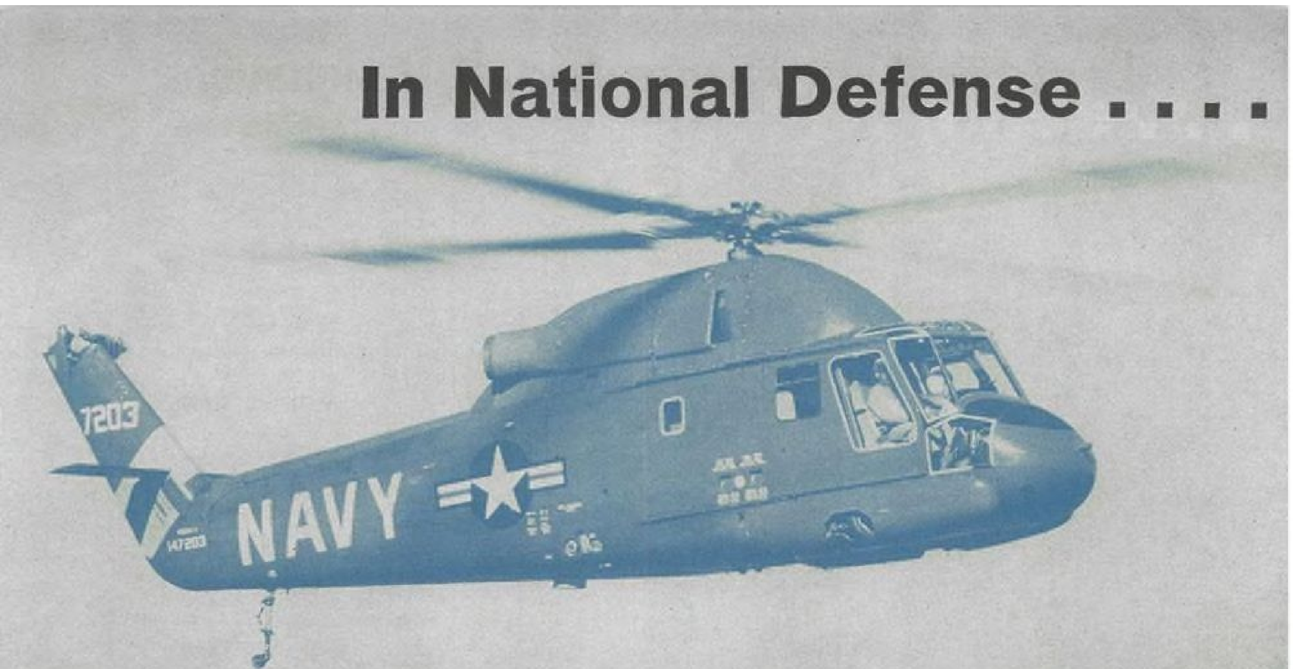
NOTE: Next Design No. is -2A.

TRAINER SERIES

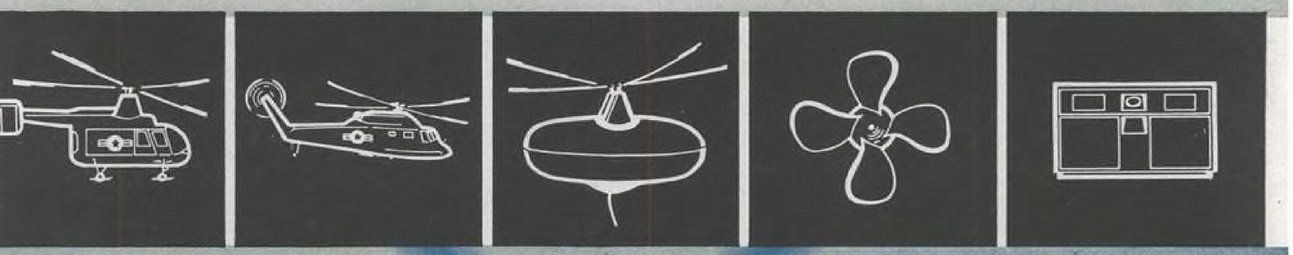
Former Designation	Current Designation	Service
T2V-1	T-1A	NAVY
Y/T2J-1	YT-2A	NAVY
T2J-1	T-2A	NAVY
T2J-2	T-2B	NAVY
T-28A	T-28A	NAVY
T-28A	T-28A	AF
T-28B	T-28B	NAVY
T-28B	T-28B	AF
T-28BD	DT-28B	NAVY
T-28C	T-28C	NAVY
T-29A	T-29A	AF
VT-29A	VT-29A	AF
T-29B	T-29B	AF
VT-29B	VT-29B	AF
T-29C	T-29C	AF
VT-29C	VT-29C	AF
T-29D	T-29D	AF
VT-29D	VT-29D	AF
AT-29C	ET-29C	AF
T-33A	T-33A	AF
DT-33A	DT-33A	AF
RT-33A	RT-33A	AF
WT-33A	WT-33A	AF
TV-2	T-33B	NAVY
TV-2D	DT-33B	NAVY
TV-2KD	DT-33C	NAVY
T-34B	T-34B	NAVY
Y/T-34B	YT-34B	NAVY
T-34A	T-34A	AF
T-37A	T-37A	AF
T-37B	T-37B	AF
T-38A	T-38A	AF
YT-38A	YT-38A	AF

(*Continued on p. 106*)

In National Defense . . . . . KAMAN is part of the plan



HU2K-1 SEASPRITE



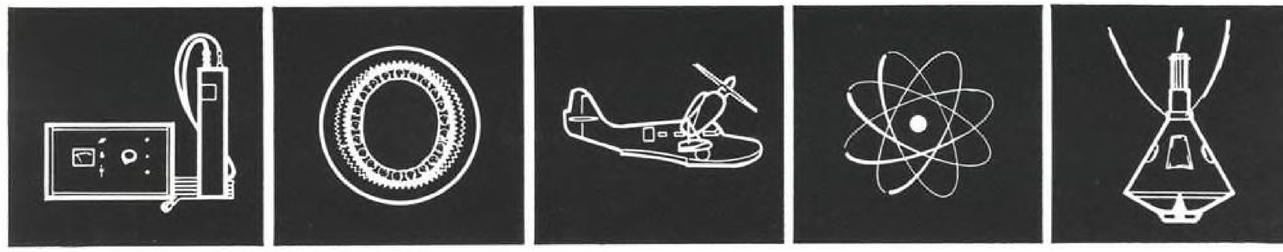
H43B HUSKIE

today . . .

Kaman helicopters are ranging the globe with ships of the fleet in defense of freedom. At far flung US Air Force bases Huskies of the Air Rescue Service are protecting the lives of our protectors. The name Kaman is synonymous all over the world for rugged, dependable performance . . . even behind the iron curtain because the Kaman H43B recently recovered for the free world the coveted world's altitude record for helicopters.

tomorrow . . .

in hours, if necessary, Kaman can pull out the stops and initiate a production program to meet the most urgent defense



requirements. Kaman is the nation's largest independent helicopter producer, and a careful program of growth and expansion has brought us to a position of optimum capability and flexibility . . . to design and produce everything from hardware to black boxes, with the efficiency and economy our Defense Program requires.

down the road . . .

as fast and as far as it goes, Kaman is astride today's galloping technology, and has made notable contributions of its own in the field of vertical flight. Our work with turbine powered helicopters, unloaded rotor systems, advanced helicopter weaponry and remote control concepts are fact, not fancy. To effect the projects essential to National Defense, Kaman has the people, plants and capability.

KAMAN AIRCRAFT CORPORATION, BLOOMFIELD, CONN.

TRAINER SERIES

Former Designation	Current Designation	Service
T-39A	T-39A	AF
T-39B	T-39B	AF
T3J-1	T-39D	NAVY
T-40A	T-40A	AF

NOTE: Next New Trainer design will start at No. -41A.

UTILITY SERIES

Former Designation	Current Designation	Service
U-1A	U-1A	ARMY
UC-1	U-1B	NAVY
U-2A	U-2A	AF
U-3A	U-3A	AF
U-3B	U-3B	AF
U-4A	U-4A	AF
U-4B	U-4B	AF
L-20A	U-6A	AF
L-20A	U-6A	NAVY
L-20A	U-6A	ARMY
L-21	U-7A	AF
L-23D	U-8D	ARMY
RL-23D	RU-8D	ARMY
L-23E	U-8E	ARMY
L-23F	U-8F	ARMY
L-26B	U-9B	ARMY
L-26C	U-9C	ARMY
RL-26D	RU-9D	ARMY
L-28A	U-10A	AF
UO-1	U-11A	NAVY
SA-16A	HU-16A	AF
SA-16B	HU-16B	AF
UF-1	HU-16C	NAVY
UF-1L	LU-16C	NAVY
UF-1T	TU-16C	NAVY
UF-2	HU-16D	NAVY
UF-2G	HU-16E	NAVY (C. G.)

NOTE: Utility series will continue with Design No. -17A.

VTOL & STOL SERIES

Former Designation	Current Designation	Service
AO-1A	OV-1A	ARMY
AO-1B	OV-1B	ARMY
AO-1C	OV-1C	ARMY
AC-1	CV-2A	ARMY
AC-1A	CV-2B	ARMY
NONE	XV-3A	ARMY
VZ-10	XV-4A	ARMY
VZ-11	XV-5A	ARMY
VZ-12	XV-6A	ARMY
AC-2	CV-7A	ARMY

NOTE: The next -V- Design No. will begin at 8A.

OBSERVATION SERIES

Former Designation	Current Designation	Service
L-19A	O-1A	ARMY
OE-1	O-1B	NAVY
OE-2	O-1C	NAVY
TL-19D	TO-1D	ARMY
L-19E	O-1E	ARMY

NOTE: Future New Observation Aircraft will be designated starting at Design No. -2A.

PATROL SERIES

Former Designation	Current Designation	Service
P2V-4	P-2D	NAVY
P2V-5F	P-2E	NAVY
P2V-5FD	DP-2E	NAVY
P2V-5FE	EP-2E	NAVY
P2V-5FS	SP-2E	NAVY
P2V-6	P-2F	NAVY
P2V-6M	MP-2F	NAVY
P2V-6T	TP-2F	NAVY
P2V-6F	P-2G	NAVY
Y/P2V-7	YP-2H	NAVY

(Continued on p. 107)

PATROL SERIES

Former Designation	Current Designation	Service
P2V-7	P-2H	NAVY
P2V-7S	SP-2H	NAVY
P2V-7LP	LP-2J	NAVY
Y/P3V-1	YP-3A	NAVY
P3V-1	P-3A	NAVY
P4Y-2K	QP-4B	NAVY
P5M-1	P-5A	NAVY
P5M-1S	SP-5A	NAVY
P5M-1T	TP-5A	NAVY
P5M-2	P-5B	NAVY
P5M-2S	SP-5B	NAVY

NOTE: Next Design No. will be -7A.

CARGO/TRANSPORT SERIES

Former Designation	Current Designation	Service
C-45G	C-45G	AF
C-45H	C-45H	AF
RC-45H	RC-45H	AF
TC-45H	TC-45H	AF
SNB-5P	RC-45J	NAVY
SNB-5	TC-45J	NAVY
C-46A	C-46A	AF
C-46D	C-46D	AF
TC-46D	TC-46D	AF
C-47A	C-47A	AF
R4D-5	C-47H	NAVY
R4D-5Q	EC-47H	NAVY
SC-47A	HC-47A	AF
R4D-5L	LC-47H	NAVY
RC-47A	RC-47A	AF
R4D-5S	SC-47H	NAVY
R4D-5R	TC-47H	NAVY
VC-47A	VC-47A	AF
R4D-5Z	VC-47H	NAVY
R4D-6	C-47J	NAVY
R4D-6Q	EC-47J	NAVY
R4D-6L	LC-47J	NAVY
R4D-6S	SC-47J	NAVY
R4D-6R	TC-47J	NAVY
R4D-6Z	VC-47J	NAVY
VC-47B	VC-47B	AF
C-47D	C-47D	AF
AC-47D	EC-47D	AF
SC-47D	HC-47D	AF
RC-47D	RC-47D	AF
TC-47D	TC-47D	AF
VC-47D	VC-47D	AF
C-47E	C-47E	AF
R4D-7	TC-47K	NAVY
C-54A	C-54A	AF
R5D-1Z	VC-54N	NAVY
R5D-2	C-54P	NAVY
R5D-2Z	VC-54P	NAVY
C-54D	C-54D	AF
R5D-3	C-54Q	NAVY
AC-54D	EC-54D	AF
SC-54D	HC-54D	AF
TC-54D	TC-54D	AF
VC-54D	VC-54D	AF
R5D-3Z	VC-54Q	NAVY
R5D-3	RC-54V	NAVY (C. G.)
C-54E	C-54E	AF
R5D-4R	C-54R	NAVY
R5D-4	EC-54U	NAVY (C. G.)
C-54G	C-54G	AF
R5D-5	C-54S	NAVY
VC-54G	VC-54G	AF
R5D-5Z	VC-54S	NAVY
C-54M	C-54M	AF
R5D-5R	C-54T	NAVY
C-97A	C-97A	AF
C-97C	C-97C	AF
C-97D	C-97D	AF
VC-97D	VC-97D	AF
KC-97F	KC-97F	AF
KC-97G	KC-97G	AF
C-97J	C-97J	AF
C-117A	C-117A	AF
R4D-8	C-117D	NAVY
R4D-8L	LC-117D	NAVY
VC-117A	VC-117A	AF
R4D-8Z	VC-117D	NAVY
C-117B	C-117B	AF
VC-117B	VC-117B	AF
C-117C	C-117C	AF
C-118A	C-118A	AF
R6D-1	C-118B	NAVY
VC-118A	VC-118A	AF
R6D-1Z	VC-118B	NAVY
MC-119	C-119J	AF
C-119C	C-119C	AF
R4Q-2	C-119F	NAVY
C-119G	C-119G	AF
C-119J	C-119J	AF
C-121A	C-121A	AF
C-121C	C-121C	AF
R7V-1	C-121J	NAVY
TC-121C	TC-121C	AF
WV-2	EC-121K	NAVY
Y/WV-2	YEC-121K	NAVY
RC-121D	RC-121D	AF
WV-3	WC-121N	NAVY
RC-121E	RC-121E	AF
VC-121E	VC-121E	AF
C-121G	C-121G	AF
EC-121H	EC-121H	AF
WV-2E	EC-121L	NAVY
WV-2Q	EC-121M	NAVY
C-123B	C-123B	AF
C-123H	C-123H	AF
C-124A	C-124A	AF
R4D-8T	TC-117D	NAVY
C-124C	C-124C	AF
C-130A	C-130A	AF
GC-130A	C-130A	AF
RC-130A	RC-130A	AF
C-130B	C-130B	AF
GV-1U	C-130F	NAVY
SC-130B	HC-130B	AF
SC-130B	HC-130G	NAVY (C. G.)
GV-1	KC-130F	NAVY
C-130BL	LC-130F	NAVY
C-130D	C-130D	AF
C-130E	C-130E	AF
SC-130E	HC-130E	AF
C-131A	C-131A	AF
VC-131A	VC-131A	AF
C-131B	C-131B	AF
C-131D	C-131D	AF
R4Y-1	C-131F	NAVY
C-131E	C-131E	AF
R4Y-2	C-131G	NAVY
C-133A	C-133A	AF
C-133B	C-133B	AF
RC-135A	RC-135A	AF
C-135A	C-135A	AF
KC-135A	KC-135A	AF
C-135B	C-135B	AF
VC-137A	VC-137A	AF
VC-137C	VC-137C	AF
C-140A	C-140A	AF
C-140B	C-140B	AF
VC-140B	VC-140B	AF
UV-1	C-140C	NAVY
C-141A	C-141A	AF
XC-142A	XC-142A	AF

Because of the size of the design numbers for Cargo Aircraft, this series will start over at -1A. Following are new assignments made under new series of numbers:

TF-1	C-1A	NAVY
TF-1Q	EC-1A	NAVY
NEW	C-2A	NAVY

NOTE: Future New Cargo/Transport Aircraft will be designated starting at Design No. 3A.

FIGHTER SERIES

Former Designation	Current Designation	Service
F-80C	F-80C	AF
F-84F	F-84F	AF
RF-84F	RF-84F	AF
F-84G	F-84G	AF
F-86D	F-86D	AF
F-86F	F-86F	AF
F-86H	F-86H	AF
F-86L	F-86L	AF
F-89D	F-89D	AF

(Continued on p. 109)

FIGHTER SERIES

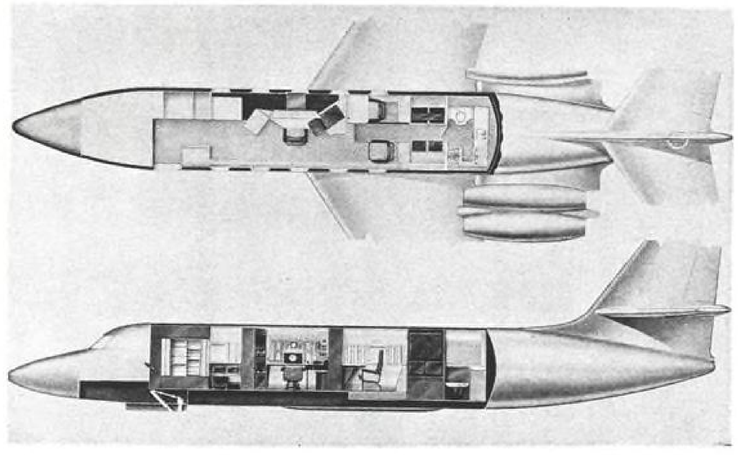
Former Designation	Current Designation	Service
F-89H	F-89H	AF
F-89J	F-89J	AF
F-100A	F-100A	AF
F-100C	F-100C	AF
DF-100C	DF-100C	AF
F-100D	F-100D	AF
F-100F	F-100F	AF
DF-100F	DF-100F	AF
F-101A	F-101A	AF
YRF-101A	YRF-101A	AF
RF-101A	RF-101A	AF
F-101B	F-101B	AF
TF-101B	TF-101B	AF
F-101C	F-101C	AF
RF-101C	RF-101C	AF
F-101F	F-101F	AF
TF-101F	TF-101F	AF
F-102A	F-102A	AF
TF-102A	TF-102A	AF
YF-102C	YF-102C	AF
F-104A	F-104A	AF
CF-104A	CF-104A	AF
F-104B	F-104B	AF
F-104C	F-104C	AF
F-104D	F-104D	AF
F-104G	F-104G	AF
RF-104G	RF-104G	AF
TF-104G	TF-104G	AF
F-104J	F-104J	AF
TF-104J	TF-104J	AF
F-105B	F-105B	AF
F-105D	F-105D	AF
F-106A	F-106A	AF
F-106B	F-106B	AF
YF-106C	YF-106C	AF
TFX	F-111A	AF
TFX	F-111B	NAVY

Because of the size of the design numbers for fighter aircraft, this series will start over at -1A. Following are new assignments made under new series of numbers:

Former Designation	Current Designation	Service
FJ-3	F-1C	NAVY
FJ-3D	DF-1C	NAVY
FJ-3M	MF-1C	NAVY
FJ-3D2	DF-1D	NAVY
Y/FJ-4	YF-1E	NAVY
FJ-4	F-1E	NAVY
YFJ-4B	YAF-1E	NAVY
FJ-4B	AF-1E	NAVY
F2H-3	F-2C	NAVY
F2H-4	F-2D	NAVY
Y/F3H-2	YF-3B	NAVY
F3H-2	F-3B	NAVY
F3H-2M	MF-3B	NAVY
F3H-2N	F-3C	NAVY
F4H-1F	F-4A	NAVY
F4H-1	F-4B	NAVY
F4H-1P	RF-4B	NAVY
F-110A	F-4C	AF
RF-110A	RF-4C	AF
N-156	F-5A	AF
N-156	F-5B	AF
Y/F4D-1	YF-6A	NAVY
F4D-1	F-6A	NAVY
Y/F2Y-1	YF-7A	NAVY
Y/F8U-1	YF-8A	NAVY
F8U-1	F-8A	NAVY
F8U-1D	DF-8A	NAVY
F8U-1KD	QF-8A	NAVY
Y/F8U-1P	YRF-8A	NAVY
F8U-1P	RF-8A	NAVY
F8U-1T	TF-8A	NAVY
F8U-1E	F-8B	NAVY
Y/F8U-2	YF-8C	NAVY
F8U-2	F-8C	NAVY
Y/F8U-2N	YF-8D	NAVY
F8U-2N	F-8D	NAVY
Y/F8U-2NE	YF-8E	NAVY
F8U-2NE	F-8E	NAVY
F9F-5KD	DF-9E	NAVY

USAF JetStar Configuration Shown

First showing of the U. S. Air Force version of the Lockheed JetStar four-engine executive transport took place earlier this month at the Air Force Assn.'s Aerospace Power Panorama at Las Vegas, Nev. USAF will use the aircraft as an all-weather "airgoing communications/electronics system," according to Air Force Communications Service. Aircraft shown is first of five to be assigned to AFCS to carry communications, air traffic and navigational aids equipment wherever forces are deployed to cope with limited war situations. USAF designation is the C-140. Drawing below shows top and side cutaway view of the USAF JetStar's interior configuration when transporting AFCS gear. The five planes will be used initially in training programs for air and ground crews at Robins AFB, Ga. Eventually, one will be assigned at Scott AFB, Ill., two at Clark Air Base in The Philippines, and two at Rhein Main Air Base, Germany.



Former Designation	Current Designation	Service
F9F-6	F-9F	NAVY
F9F-6D	DF-9F	NAVY
F9F-6K	QF-9F	NAVY
F9F-6K2	QF-9G	NAVY
F9F-7	F-9H	NAVY
F9F-8	F-9J	NAVY
Y/F9F-8B	YAF-9J	NAVY
F9F-8B	AF-9J	NAVY
Y/F9F-8T	YTF-9J	NAVY
F9F-8T	TF-9J	NAVY
F9F-8P	RF-9J	NAVY
F3D-1	F-10A	NAVY
F3D-2	F-10B	NAVY
F3D-2Q	EF-10B	NAVY
F3D-2M	MF-10B	NAVY
F3D-2T2	TF-10B	NAVY

Former Designation	Current Designation	Service
Y/F11F-1	YF-11A	NAVY
F11F-1	F-11A	NAVY

NOTE: Future New Fighter Aircraft will be designated starting at Design No. -12A.

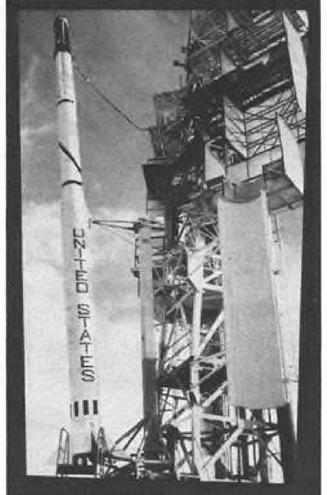
SPECIAL ELECTRONIC INSTALLATION SERIES

Former Designation	Current Designation	Service
WF-2	E-1B	NAVY
W2F-1	E-2A	NAVY

NOTE: Future New Special Electronic Installation Aircraft will be designated starting at Design No. -3A.

a lot of people know something about space...

PROPULSION TESTING



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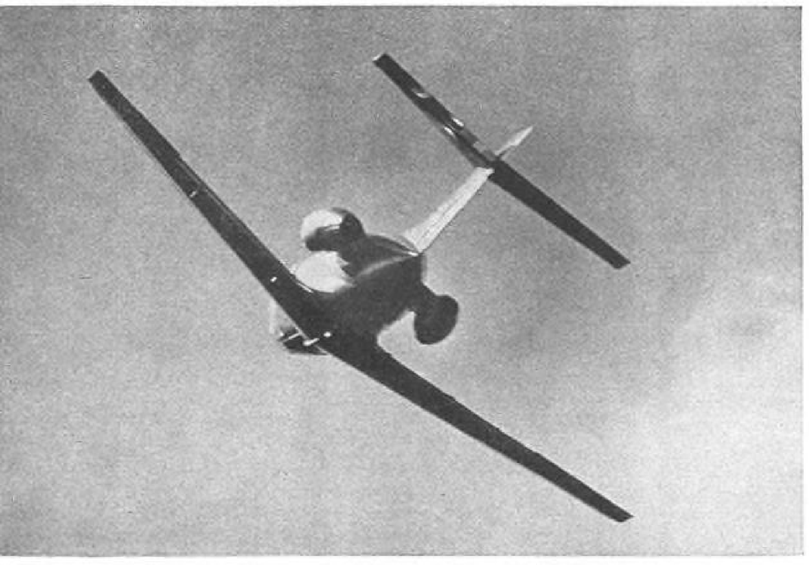
V/STOL

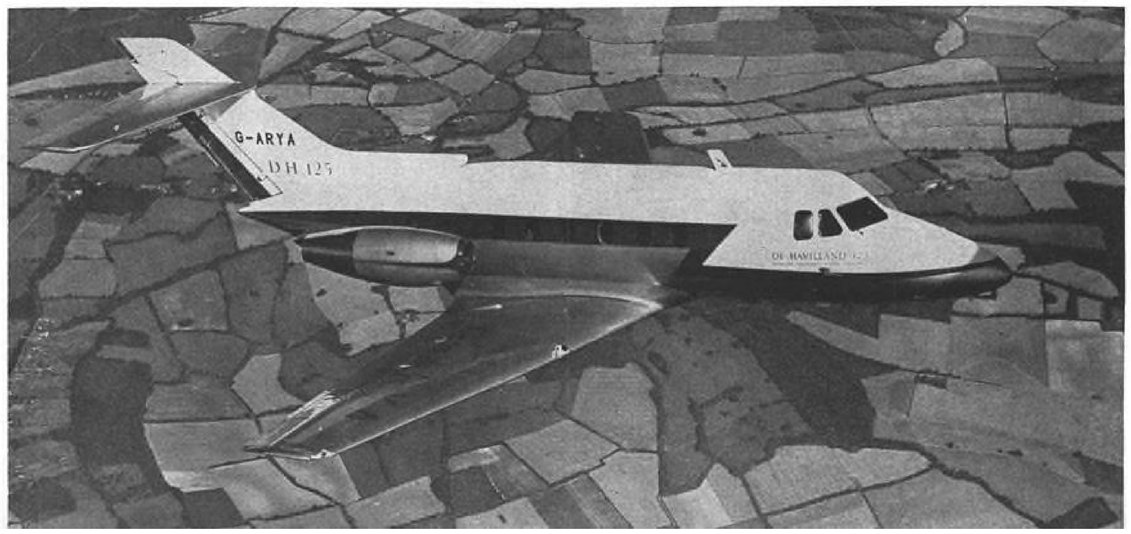
DYNA SOAR

First production de Havilland DH-125 executive jet has lengthened wing and an increased tail area.

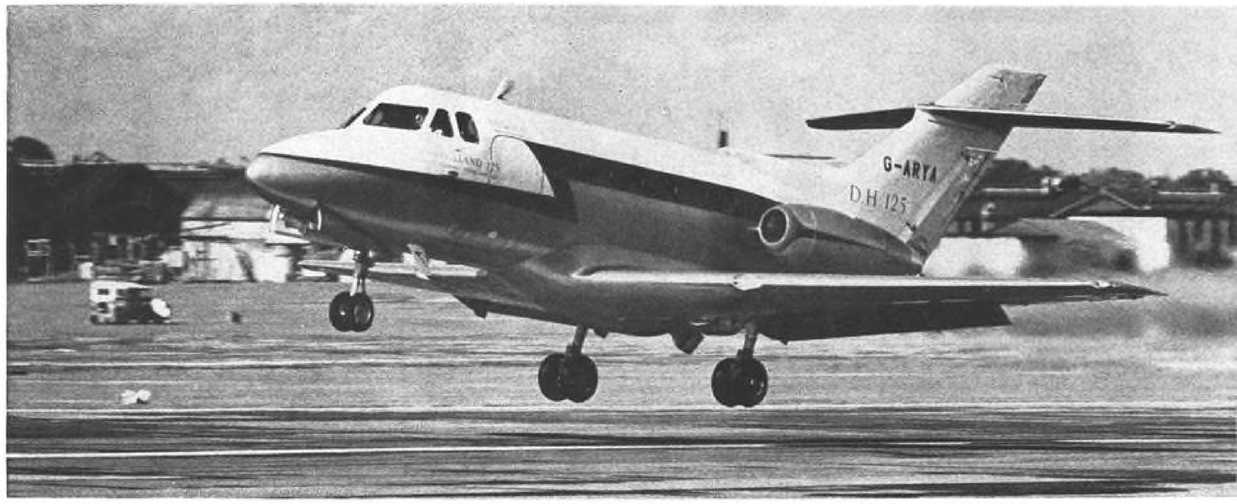
Production DH-125 Has Larger Wings, Empennage



Two DH-125s have been sold and the company is considering increasing initial production batch of 30 in view of Royal Air Force order for 22 (AW Sept. 10, p. 29). Commercial sales have been made to Bristol Siddeley Engines, builders of the Viper 20 powerplants and to an unnamed West German buyer. Bristol Siddeley will use the aircraft to run up time on the engines. Company plans to uprate the 3,000 lb. thrust engine by means of higher temperatures and new blade alloys to increase heat capability. De Havilland designed engine pods to take the General Electric CJ-610, if customers desire. Flight tests are aimed at certification by both Federal Aviation Agency and British Air Registration Board by August, 1963. Wingspan on production aircraft will be 47 ft., three feet longer than on prototype. Fuselage on third and subsequent aircraft will be lengthened 1 ft. to 47.5 ft.

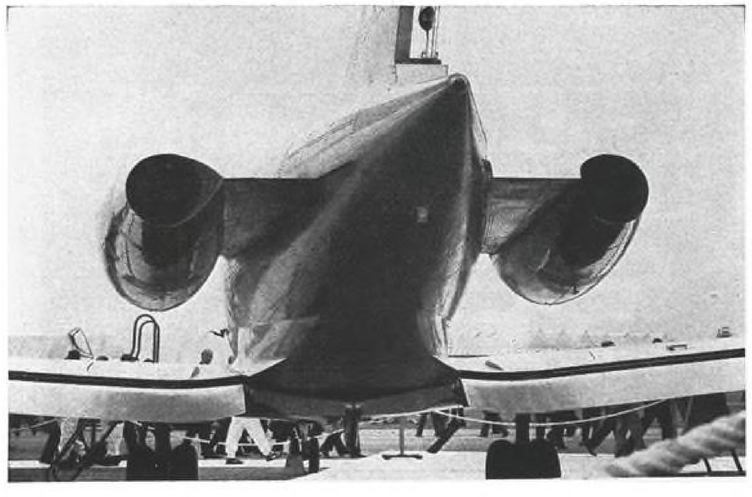


Gross weight of the DH-125 is 19,000 lb. and maximum design landing weight is 17,500 lb. Company presently is studying methods of increasing aircraft's total fuel capacity without using external tanks.



Small intake forward of dorsal fin provides ram air to heat exchanger of cabin pressurization and air conditioning system.

Semi-monocoque fuselage of the DH-125 rests on a wet wing which contains 1,038 imp. gal. of fuel. Construction provides 5-ft. 9-in. cabin headroom and eliminates need for main wing spar to run through cabin area. Double-slotted flaps, which extend over 55% of wing span are visible in photos above. To keep airplane control system simplified and cut costs, de Havilland hung the flaps from the rear spar, using heavy external hinge brackets. Speed brakes are attached to the main spar and ailerons are the conventional horn-balanced type. Rear view, right, shows engine mounting arrangement. Powerplant is a development of the Viper 11 with a zero stage added and mass flow increased from 44 lb./sec. to 52.8 lb./sec.



PRIVATE LINES

Cessna Aircraft Co. reported a 9% increase in commercial aircraft sales for the first nine months of Fiscal 1962 ending June 30. Dwane Wallace, Cessna president, also noted that operations of all the company's divisions, with the exception of the military division, were up during the period over a similar period in Fiscal 1961. Commercial sales totaled $42,676,000, an increase of $3,600,000 over the $39,040,000 for the 1961 period. Export sales jumped 25%, from $8,408,000 in Fiscal 1961 to $10,540,000 in 1962. Total sales for the nine month period ending June 30 were $72,053,000. After tax earnings were $4,448,000 or $1.35 per share based on 3,309,937 shares of common stock outstanding. Earnings for a comparable period in 1961 were $4,793,000 or $1.46 per share. Sales of two subsidiaries, McCauley Industrial Corp. and Aircraft Radio Corp., were up 27% and 19% respectively. Agricultural and hydraulics sales rose 8%. Wallace said the firm also had received more than $4,000,000 in follow-on military orders which were not included in the figures.

Omni coupler and heading selector are available as optional components of the Minneapolis-Honeywell H-14 adaptive autopilot. The omni coupler enables the pilot to intercept and track desired radials to or from omni stations. Only the addition of a different circuit card to the autopilot computer is required for this capability. Heading selector is a 360-deg. dial which is turned to the desired heading. When engaged, the selector turns the aircraft to the desired heading at a rate of approximately three degrees per second. Addition of the omni option adds no weight to the H-14. Addition of the heading selector adds .9 lb. The H-14 is being offered by both Cessna and Beech on their twin-engine aircraft.

Dallas Airmotive, Inc. plans to begin overhaul of JT12 turbojet engines by fall, 1963, about nine months earlier than previously announced. The company has been overhauling Rolls-Royce Dart turboprop engines since May. The company also has contracts to overhaul various piston engines which power U.S. Army helicopters.

Van Dusen Aircraft Supplies reports sales of $2,139,962 for the first three months of the current fiscal year, ending June 30, an increase of 74% over a comparable period in 1961. Net income after taxes was $38,333 or 7 cents a share on 538,718 shares of common stock outstanding. Net income for a comparable period in 1961 was $31,078 or 6 cents per share.

Superchargers Boost Apache Speed 25%

Long Beach, Calif.—Installation of exhaust-driven superchargers to standard Piper Apaches increases the light twin's cruising speed by 25% and raises the single engine ceiling to 11,500 ft. Weight penalty of the supercharger installation is 20 lb. per engine and fuel consumption increases about one gallon per hour for both engines.

Developed by the Rayjay Co., the Turbo-200 turbosupercharger uses a turbine and impeller section manufactured by Thompson-Ramo-Wooldridge for use on diesel-powered earth moving equipment. Installation is adaptable to either 150 hp. or 160 hp. Apaches and the company presently is working on installations for both single and twin-engine light aircraft. The Turbo-200 installation enables an Apache to attain a cruising speed of 200 mph. at 12,000 ft. on 80% power with corresponding increases at lesser power settings.

Comparative performance data with and without the turbochargers operating was obtained in the Rayjay-owned Apache, N 3293P. Gross weight at takeoff was about 3,500 lb. With the turbochargers inoperative, the Apache reverts to standard performance because the installation when not operating does not affect manifold pressure, available power or fuel consumption. Aside from the 40 lb. weight of the superchargers, the craft is a standard Apache when the turbocharger is bypassed.

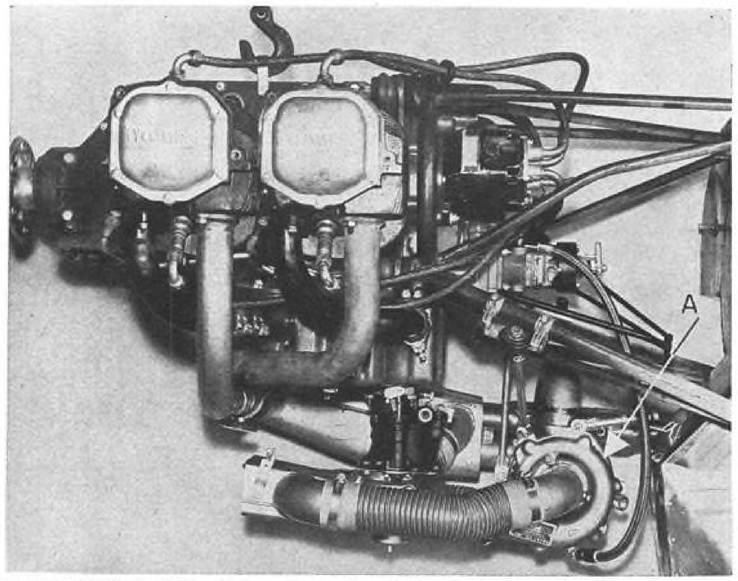
Apache initially was levelled off at 11,000 ft. above sea level and airspeed allowed to stabilize. About 55% power was obtainable with the normally unaspirated engines running at 2,300 rpm. with manifold pressure of 19 in., full throttle. Top indicated airspeed was 136 mph. which corrected to 166 mph. true airspeed with free air temperature of 10C.

The turbochargers then were brought into use by pulling up on the two vernier controls located aft of the fuel selectors on the floor between the pilots' seats.

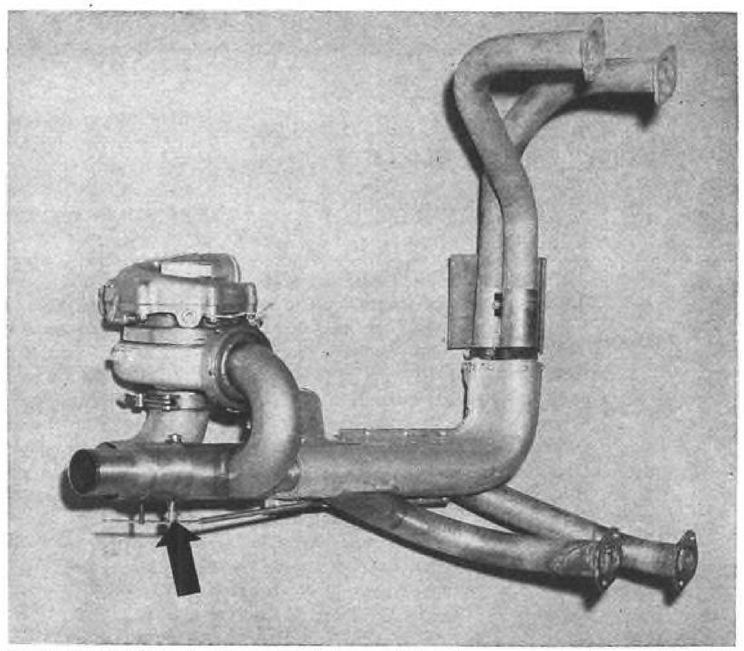
Some lag was discerned in the manifold pressure readings until pressure builds up in the supercharger inlet pipe, so it is advisable to bring the units into operation slowly so as not to over-boost the engines.

Without increasing rpm., manifold pressure was increased to 25 in.—70% power—by use of the turbo controls. The throttles were left open. Indicated airspeed increased to 156 mph., or a true airspeed of 190 mph. At 65% power, 2,300 rpm. and 23 in., indicated airspeed dropped to 150 mph., true airspeed to 183 mph.

Effects of the turbocharger were noted on the cylinder head temperature



COMPLETE Turbo-200 turbosupercharger installation fits in the standard Apache cowling. Arrow shows the exhaust-driven blower. Installation shown is on a Lycoming O-320. Rayjay Co. is developing other installations for a variety of single-engine and light twin-engine aircraft. Supercharger installation adds about 40 lb. to the aircraft's weight, and can be completed in about two days. Price for the installation in an Apache is $4,375 complete, including new Lear-Romec fuel pumps for higher altitude operation. The modification is certified by the Federal Aviation Agency.



EXHAUST SYSTEM of a Piper Apache is modified to incorporate the Turbo-200 installation. Waste gate valve (arrow) is spring-loaded to the off position so that the engine will automatically revert to normal unsupercharged operation in the event of a malfunction. Supercharger installation increases Apache fuel consumption about one gallon per hour.

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We're at work on the long-range development of vehicles for space, air, land, water and underwater applications. This broad new spectrum of activity is a far cry from the "old" Convair which gained eminence as one of the world's largest manufacturers of airplanes. **But despite the new scope of interest, Convair remains an engineer's company.**

For more than two decades Convair has recognized that any company producing highly engineered products must build its organization around engineers. Engineering groups and individual engineers are given a loud voice in product development. To us this is simple logic, simply because it has consistently resulted in superior products.

Added advantages enjoyed by engineers at Convair are the superb community benefits. Uncrowded, resort-like San Diego has excellent schools, abundant housing at uninflated prices, plus four colleges and universities offering a wide range of courses, including advanced studies in engineering and the sciences.

Current requirements are detailed on the next page. If they stimulate your interest, we invite your inquiry — either on the attached inquiry card, or directly to Mr. S. H. Imdieke, Engineering Personnel Administrator, Department 6-128.

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SENIOR ENGINEERS

The new spectrum of activity at Convair has created immediate, long-range openings for highly qualified engineers in a variety of fields. These are responsible positions and require individuals who possess not only technical competence, but who have demonstrated qualities of leadership and the ability to communicate their ideas at a management level.

The most urgent requirements are for specialists in the following fields:

ELECTRONIC SYSTEMS DESIGN

Development of both ground and airborne systems in the fields of instrumentation, telemetry, control systems, and communications. A BSEE and a minimum of five years' experience in development of electronic systems required.

AERODYNAMICS

To conduct studies of aerodynamics performance, stability, and control in the areas of S/VTOL, GETOL, supersonic configuration analysis, and hypersonic configuration analysis. An appropriate engineering degree and five years of related aerodynamic experience required.

THERMODYNAMICS

To conduct studies involving hyper-velocity impact, aerodynamic heating, reentry heat transfer, nuclear and rocket propulsion, and internal aerodynamics and propulsion for ground effect machines, VTOL and GETOL applications. Work also concerns environmental control systems for both manned and unmanned space vehicles. A degree in AE or ME and five years of related experience required.

GUIDANCE DYNAMICS

Current guidance work involves application to missiles, high-performance aircraft, spacecraft, underwater systems, celestial mechanics, insertion analysis, and trajectory analysis. Specific experience in one of these areas desirable; background in various guidance disciplines and in non-linear control system techniques required. A degree in AE, EE, ME, Physics or Applied Mathematics and Mechanics, plus three years of experience in this field necessary.

CONTROL DYNAMICS

Work involves the analysis, synthesis and development of complex flight control systems. A background of servomechanism theory is preferred. Familiarity with non-linear analytical techniques and a working knowledge of analog computing techniques highly desirable. A degree in AE, EE, or ME and two years of applicable experience required.

RELIABILITY

To prepare, direct, and conduct advanced research and analytical studies which require extensive application of mathematical and statistical theory. Requires a thorough understanding of engineering principles involved in order to estimate the reliability of complete missile and support equipment systems. Must be able to determine and evaluate mathematical approaches for solving complex and unique reliability problems. A degree in Mathematics or Physics, plus experience in dealing with advanced reliability problems, required.

POSITIONS ALSO EXIST FOR SENIOR-LEVEL ENGINEERS IN THE AREAS OF STRESS, MATERIALS RESEARCH, AND HYDRODYNAMICS.

To learn more about Convair's new and rapidly expanding spectrum of activity, mail the attached inquiry card or write to Mr. S. H. Imdieke, Engineering Personnel Administrator, Department 6-128, General Dynamics | Convair, 3312 Pacific Highway, San Diego 12, California.

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which rose to 400F—maximum is 475F—and on the carburetor inlet temperature which rose to 130F. At the same time however, smoother engine operation was noted with the turbochargers in use, possibly due to better fuel distribution.

Climb setting of 75% power was applied—2,400 rpm. and 26 in.—and a 750 fpm. rate of climb recorded between 13,000 and 14,000 ft. at a steady 120 mph. indicated airspeed.

Further speed/power trials were conducted at 15,000 ft. where the free air temperature registered 1C. With the turbochargers off, the Apache stabilized at 125 mph. indicated with 2,400 rpm. and full throttle, 16 in. manifold pressure. This yielded a true airspeed of 162 mph. Both turbochargers then were brought into use until manifold pressure climbed to 26 in. with rpm. maintained at 2,400, yielding 75% power. The airspeed stabilized at an indicated 155 mph. for a true airspeed of 201 mph.

Fuel consumption increases approximately one gallon per hour over-all with the turbochargers in operation, according to Rayjay tests. However, the increase of one gallon per hour in fuel consumption was more than offset by the airspeed increase of 39 mph. Put another way, the aircraft was averaging about 39 mpg.

Single engine performance was investigated by feathering the more-critical left engine at 10,500 ft. At a minimum stabilized airspeed of 90 mph. indicated, the Apache descended at 400 fpm. with the right engine running at 2,400 rpm. and full throttle. The supercharger then was cut in and manifold pressure on the right engine brought up to 28 in. for 85% power. Holding 90 mph. indicated, which is about minimum for control, the rate of climb increased to plus 100 fpm. Thus it was apparent that the Rayjay claim of an 11,500 ft. single engine ceiling is valid.

During supercharger operation, it is advisable to have the throttles wide open and if a power reduction is required, it should be made by closing the supercharger controls. This will prevent overboosting the engines in the event of sudden power application.

The Turbo-200 modification installation time is two days. Price for installation in an Apache is $4,375 complete, including new Lear-Romec fuel pumps for higher altitude operation.

The Turbo-200 system is so designed that any malfunction of the system will result only in reversion to standard unsupercharged Apache operation. Modification is certificated by the Federal Aviation Agency and if care is used in operation so as not to over-boost, engine life should not be affected by use of the turbos. One higher grade octane fuel is recommended for turbocharger operation.

CARGO EXTRACTIONS were made with an Air Force C-130B on the ground and in the air using All American Engineering system.

Military Cargo Snatch System Developed

By Larry Booda

Safe delivery of military cargo by snatching it from moving aircraft has been demonstrated to the Army and Air Force by the All American Engineering Co. of Wilmington, Del.

Using an arresting hook and wire system developed by the company, vehicles and packages mounted on pallets were pulled out of rear cargo doors while the aircraft were making touch-and-go landings or in the air several feet above the ground.

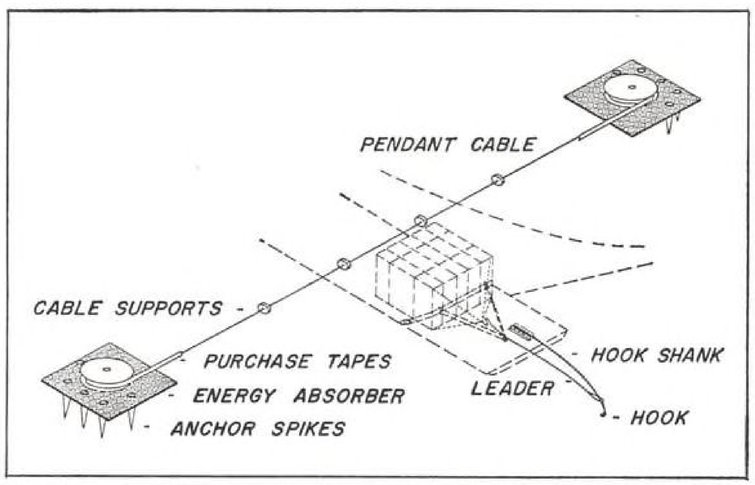
Demonstrations were conducted for the Army at Georgetown, Del., and Ft. Bragg, N. C., early in July using a de Havilland AC-1 Caribou twin-engine assault transport short takeoff and landing aircraft. Demonstrations for the Air Force were conducted at Georgetown late in August using a Lockheed C-130B four-turboprop transport.

Both feasibility demonstrations were performed under contract. The Army contract for $20,478 grew out of proposals submitted to the Tactical Mobility Requirements Board headed by Lt. Gen. Hamilton H. Howze (AW June 25, p. 26).

This aroused the interest of the Air Force Tactical Air Support Requirements Board headed by Lt. Gen. Gabriel P. Disosway. The board arranged with the Aeronautical Systems Division at Wright-Patterson AFB, Ohio, to let a contract with All American Engineering for $44,634.

Additional demonstrations are scheduled to be made for the Tactical Air Command's First Air Combat Applications Group at Eglin AFB, Fla., with Fairchild C-123 assault transports.

All American calls the system the Ground Proximity Aerial Cargo Delivery. It is an outgrowth of numerous developments which the company has been working on since the 1930s. One of the earliest practical applications was the snatching of mail pouches suspended from trapezes on the ground at communities without airfields.



GROUND INSTALLATION includes pendant, nylon tapes and water-filled energy absorbers.

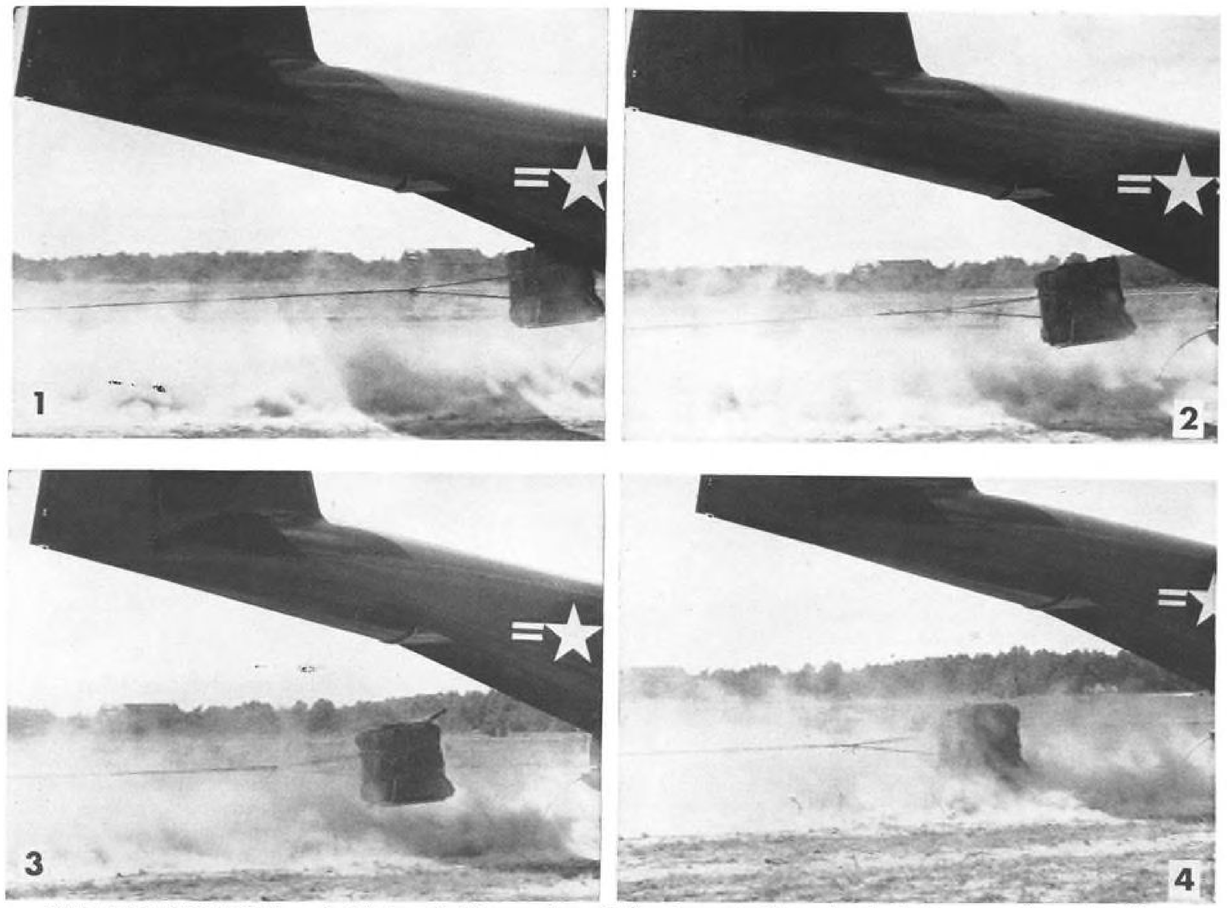
Basic Idea

The basic idea for the present system was developed from a patent issued to All American Vice President Robert B. Cotton in 1947. Essentially, the system operates by having an arresting hook, which is attached to the pallet inside the aircraft, engage a pendant on the ground. This pendant in turn is attached to two water brakes which absorb the engagement shock when the cargo is pulled from the aircraft.

The test programs involved extracting loads from 2,000 lb. to 13,649 lb. On touch-and-go landings with the AC-1, equipped with the Model 26 and 26A Aerial Cargo Delivery Kit, the loads were extracted at speeds of 80 kt. The Model 26 kit can take loads up to 5,000 lb. and the Model 26A up to 8,000 lb.

In the demonstrations it was shown

ARMY DEMONSTRATION involved pulling dummy palletized loads from de Havilland AC-1 Caribou STOL aircraft at Georgetown, Del.



EXTRACTION SEQUENCE shows load being pulled from an Army Caribou transport. Photos show load at moment of extraction (1), at peak deceleration g load (2), and the loaded pallet settling to the runway (3 and 4) during demonstration.

that five men could install the ground equipment in 15 min. The same number of men could move the cargo and reset the equipment in 2 min., making it possible to deliver a load every 2½ min.

The cargo runout distances for the two models are 200 and 300 ft., respectively. A cleared strip of from 1,200 to 1,500 ft. in length is necessary to allow the aircraft to make its delivery.

C-130B Test

In the test with the C-130B the loads delivered were a 2,500 lb. block of concrete, an M-151 quarter-ton truck, an M-37 three-quarter-ton truck and an M-47 2½-ton dump truck. The concrete slab was mounted on standard skate wheel conveyors while the trucks were mounted on platforms which are normally used for parachute delivery of loads from aircraft utilizing the Brooks and Perkins dual-rail conveyer system.

The cargo to be delivered is lashed to the platform. A 60-ft. extraction line connects the cargo with the extraction, or arresting, hook which is held in a trail position below the aircraft by a shank attached to the aft end of the cargo ramp at the rear of the fuselage. A short shank is provided for touch-and-go landings and a longer one is provided for flying deliveries.

Shear pins hold the load in place in the aircraft. These are designed to break at a predetermined load stress when the hook engages the pendant.

The ground equipment consists of two rotary hydraulic "water twister" energy absorbers.

These are designed with vaned rotors and vaned stators operating in a housing filled with water.

Rotor Shaft

Each rotor shaft is attached to a drum around which is wrapped nylon purchase tape. Each tape terminates at the pendant which engages the extraction hook.

An energy absorber is located on each side of the delivery path. The pendant is held a few inches above the ground across the delivery path.

When a touch-and-go delivery is made, the aircraft makes a normal landing approach. In the case of the C-130, the delivery is made at 90 kt. The nose wheel can be in the air or on the ground. When the hook engages the pendant the tapes are pulled, rotating the drums, which turn the rotors. The water imparts drag to the rotors, creating tension in the tapes.

The shear pins break and the cargo is pulled from the fuselage, landing on the ground.

In the case of a flying delivery, the pilot flies about 5 ft. above the ground between 110 and 120 kt.

A typical flying delivery made by the C-130 was the three-quarter-ton truck. The truck was strapped to the pallet. It carried 3,100 lb. of steel plate as ballast. The delivery was made 5 ft. above a concrete runway. The pilot reported that the extraction had no effect on his control of the aircraft.

After extraction the truck and pallet stopped 440 ft. from the point of hook engagement. After hook engagement the tapes started to pay out and the cargo was pulled from the aircraft. The platform landed flat and slid for 115 ft. The truck experienced a horizontal acceleration load of 2g as it was jerked from the aircraft and touched the ground at 23 fps.

USAF Requirements

Air force requirements stated that the acceleration load should be 2g. All American says that it can make this as low as three quarters of 1g or higher than two.

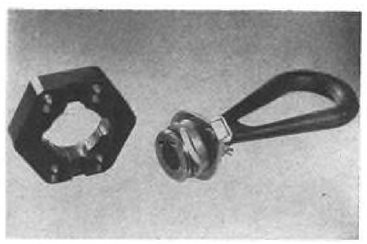
Horizontal extraction forces in this delivery system are higher than with parachute extraction and delivery. The vertical forces from the 8½-ft. delivery height are the same or less.

In 13 tests made on concrete with the C-130B, the only damage was to the extraction equipment itself. In several instances the tape broke or jammed in the drum, but in each case the load skidded to a halt without incurring any damage.

The tests generated interest to the extent that the Tactical Air Command ordered the ASD project officer, G. Varbel, to brief top USAF headquarters officers.

Plans are being made to design "people pods" for delivery of troops by this method.

No definitive contract has been signed for the development of "people pods," however.



U.K. Freight Lashing

Aircraft freight lashing, developed by Short Brothers and Harland, Belfast, has been adopted as standard equipment by British Ministry of Aviation. Unit was designed for Belfast turboprop freighter for Royal Air Force and can withstand load of 25,000 lb. Two-part fitting includes aluminum alloy base. Top surface is flush with flooring or wall. Lashing link has swivel fitting and spring-loaded plunger which engage in the aluminum alloy base.

CAB Accident Investigation Report:

Starling Ingestion Causes Electra Crash

On Oct. 4, 1960, at 1740 EDT, an Eastern Air Lines Lockheed Electra N 5533, crashed into Winthrop Bay immediately following takeoff from Runway 9 at Logan International Airport, Boston, Massachusetts. Ten of the 72 persons aboard survived the crash. The aircraft was totally destroyed.

A few seconds after becoming airborne, the aircraft struck a flock of starlings. A number of these birds were ingested in engines Nos. 1, 2, and 4. Engine No. 1 was shut down and its propeller was feathered. Nos. 2 and 4 experienced a substantial momentary loss of power. This abrupt and intermittent loss and recovery of power resulted in the aircraft yawing to the left and decelerating to the stall speed. As speed decayed during the continued yaw and skidding left turn, the stall speed was reached; the left wing dropped, the nose pitched up, and the aircraft rolled left into a spin and fell almost vertically into the water. An altitude of less than 150 ft. precluded recovery.

The Board determines that the probable cause of this accident was the unique and critical sequence of the loss and recovery of engine power following bird ingestion, resulting in loss of airspeed and control during takeoff.

N 5533, a Lockheed Electra, had arrived in Boston at 1533[1] on Oct. 4, 1960, as Eastern Air Lines Flight 444 from New York City. The aircraft and its crew were scheduled for turn-around and were to depart as Flight 375 to Philadelphia, Pa.; Charlotte, N. C.; Greenville, S. C.; terminating at Atlanta, Ga.

There were 67 passengers and a crew of five aboard Flight 375. Fifty-nine passengers and three crew members sustained fatal injuries. Nine of the 10 survivors received serious injuries.

Routine preparations for the flight, which included filing an Instrument Flight Rules (IFR) flight plan to Philadelphia via Victor Airways 3 and 147 at 10,000 ft., were completed by the crew.

No maintenance was necessary during the turn-around. The aircraft was serviced for the flight to a total of 24,900 lb. of fuel and the total gross weight at the ramp was calculated to be 97,987 lb. This weight was properly distributed with respect to the center of gravity and was well below the maximum allowable for this aircraft.

Flight 375 departed the ramp at 1735. It was issued an IFR clearance in accordance with its flight plan with instructions to cross Natick Intersection at 3,000 ft. and to maintain runway heading for two minutes after takeoff. The flight taxied to Runway 9 where takeoff was commenced at approximately 1739.

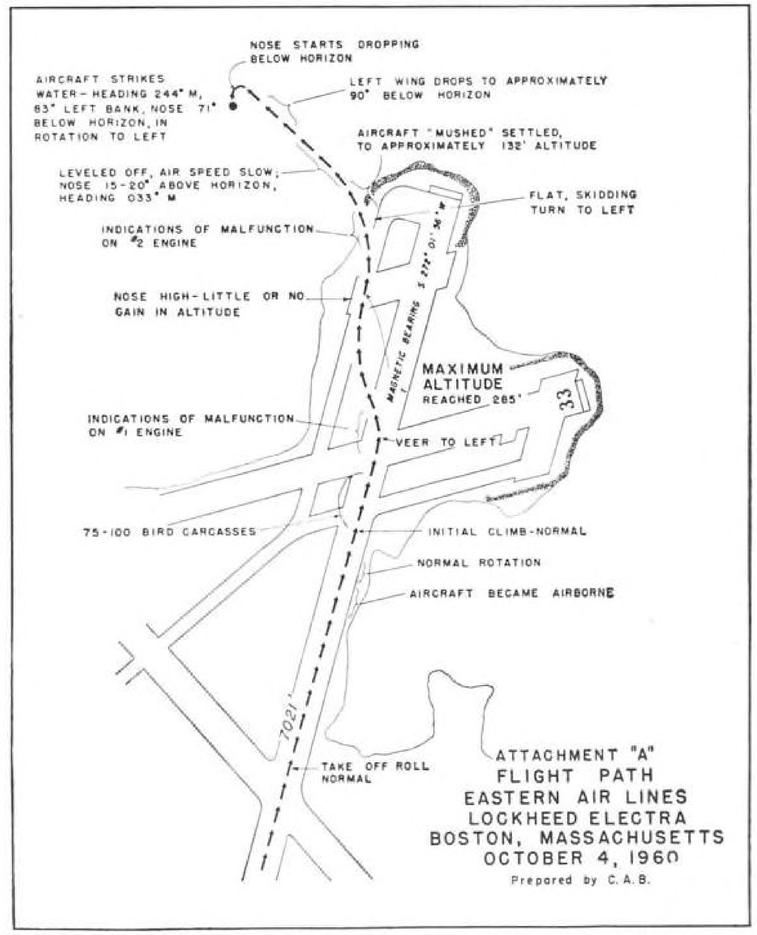
Takeoff airspeeds computed for this flight based on the conditions present at the time were: V_1 104 kt.; V_R 116 kt.; V_2 121 kt.

The weather observation taken at the time of the accident as reported by the U. S. Weather Bureau was: 6,000 ft. scattered; 12,000 ft. scattered; visibility 15 mi.; wind east-southeast 11 kt. The weather is not considered a factor in this accident.

Numerous groundwitnesses were interrogated as to their observations of the flight during its takeoff and crash. A probable flightpath and sequence of events have been developed from the statements of these witnesses.[2] The aircraft taxied to Runway 9 in a normal manner. Takeoff was commenced and the aircraft lifted off the runway after a ground roll of about 2,500 ft. and attained a height of 30 to 40 ft. It continued at this height in nearly level flight for a distance of several hundred feet before establishing a normal climb attitude. During this time the landing gear was retracted after which the airplane climbed straight ahead for a short interval. While the airplane was in this initial climb several of the witnesses observed an unusual puff of gray smoke from engine No. 1; others saw a ball of fire from engine No. 2. None of the witnesses saw these indications of trouble from both engines.

During this climb several persons described the aircraft as veering to the left and then returning to its original course; its speed was described as very slow. After reaching an altitude of 100 to 200 ft. the aircraft made a flat left turn from the run-

[2] See map below—Attachment "A".



TAKEOFF AND CRASH sequence of the EAL Electra developed from witness reports.

[1] All times herein are Eastern Daylight based on the 24-hr. clock.

PROBLEMATICAL RECREATIONS 137

My house is on a road where the numbers run 1, 2, 3, 4...consecutively. My number is a three digit one and, by a curious coincidence, the sum of all house numbers less than mine is the same as the sum of all house numbers greater than mine. What is my number and how many houses are there on my road?

—*Contributed*

Did you chance to see the new Aero Digitork in action at WESCON last month? If not, be advised that this fully automatic, solid state X and Y plotter uses Digitork stepping motors which respond to digital commands, manual controls, punched tape or cards and magnetic tape. Result: automatically programmed plotting over a 47¼" x 47¼" surface to ±.0025 of an inch. Our Aero Service Corporation Division can tell you more. Write them at 210 E. Courtland St., Philadelphia 20, Pennsylvania.

ANSWER TO LAST WEEK'S PROBLEM: $998{,}001 = (998 + 001)^2$.

way heading of 090 deg. magnetic to a heading of about 030 deg. While on this heading the aircraft maintained its nose-high attitude but appeared to settle approximately one-half the height it had attained.

Two witnesses adjacent to the takeoff area of Runway 9 snapped photographs of the aircraft at this point in the flightpath. Assessment of the first picture confirms that the aircraft was on a heading of 030 deg. magnetic, at an altitude of 121 ft. M.S.L., and had reached a position approximately 7,000 ft. down the runway but was displaced about 1,350 ft. to the north. It also appears that the deck angle at the time was about 9 deg. above the horizontal and the aircraft was at an angle of bank of 8.5 deg. to the left. The second photograph, taken about one second later, was also assessed. This photograph showed the airplane to be at an altitude of 121 ft. M.S.L., on a heading of 030 deg. magnetic as before; however, at this time the deck angle had increased to 14 deg. and the angle of bank to 14 deg. Witnesses testified that the aircraft was then seen to execute a maneuver most closely described as a wing-over. During this maneuver the nose came up higher while the left wing dropped to near vertical. The nose then fell through rapidly and the aircraft descended, striking the water almost vertically and while still rotating to the left. The impact area was in Winthrop Bay approximately 2,000 ft. to the left of the centerline of Runway 9 and approximately 7,000 ft. from the point takeoff was started. The time of impact was calculated as 1740 or 47.5 sec. after takeoff was commenced

Three persons, all experienced pilots, aboard an Aero Commander approaching Runway 15 for landing had an excellent view of the Electra's takeoff. Their attention had been attracted to it because they knew that their landing was to follow the Electra's passing the intersection of Runways 9-15. They first observed the departing aircraft, already airborne, at about the time it passed the intersection. They noted that the Electra appeared to be starting a left turn well before crossing the end of the runway and assuming a noseup angle which they considered excessive. Thus, their attention was concentrated on the Electra until its contact with the water. The altitude of the Aero Commander was approximately 400 ft. when its occupants first observed N 5533, and thereafter decreased normally, commensurate with a landing approach. These three men stated that N 5533 never attained an altitude equal to that of their aircraft. The copilot stated that he saw either a puff of smoke or flame come from the No. 2 nacelle shortly after the Electra passed Runway 15. The passenger also observed this emission but described it as a white puff of smoke.

Nine of the 10 survivors were interviewed, and their descriptions generally corroborate the statements of the witnesses on the ground and in the Aero Commander. Both stewardesses, seated on the left side of the lounge, felt a considerable amount of vibration shortly after becoming airborne. Both recalled "a sudden burst of power" following their initial realization of trouble; both felt a sharp left turn; one recognized the sound of the engines as "unsynchronized."

Four of the passengers interviewed indicated a sharp, flat turn to the left shortly after becoming airborne. One passenger, seated amidship on the right side stated, "one of the engines on the left side 'shot' some flames off." Another, seated in the right rear of the cabin, recalled feeling a slight "bump," unlike that associated with wheel retraction, shortly after takeoff. Looking out the right window he saw a pattern which he described as a dark smudge and which he said passed through the propeller arc and over the engine nacelle. A former military pilot, seated in the lounge opposite the stewardesses, stated that "shortly after takeoff, something happened to the engines on the left side." While he could not recall specifically, he said his awareness of trouble was through a combination of that which he felt and heard. He was most conscious of the difference between noise of the left engines and the right engines. He also estimated that the time from lift-off to the skidding left turn was about five to seven seconds.

Bird Carcasses

Shortly after the accident, Board investigators received a report that a number of bird carcasses had been found on the runway. Bodies and pieces of bodies representing approximately 75 birds, identified as starlings, were scattered predominantly on the left side of Runway 9 between the intersections of Taxiway 33 and Runway 33. The remains were strewn over an area roughly 400 ft. long by 200 ft. wide, the midpoint of which was about 3,800 ft. from the approach end of Runway 9. After autopsies of the birds several ornithologists as well as personnel from the U. S. Fish and Wildlife Service concluded that they had been killed during the late afternoon of Oct. 4.

The U. S. Coast Guard maintained security of the impact area throughout the night following the accident and was instrumental in the initial efforts to recover the wreckage. Recovery operations were conducted by the U. S. Navy and the wreckage was transported to a warehouse for study. It was determined that the aircraft struck the water almost vertically but slightly left wing first and while still rotating to the left about its longitudinal axis. The Nos. 1 and 2 engines broke up and over the left wing and Nos. 3 and 4 broke down and under the right wing.

All flight control surfaces were recovered. Impact marks made by the aileron counterweights on rear spar vertical stiffeners indicated the left aileron was in the neutral position at the time of left wing breakup. Corresponding marks made by the right aileron counterweights indicated that this aileron was displaced downward about one-third of its travel when the right wing struck the water. The elevator and rudder surfaces were undamaged prior to salvage and the position of each at impact was indeterminable.

Control cables, push-pull rods, and linkage from the surfaces to the boost packages showed no abnormal conditions. Damage noted in these areas was determined to be the result of impact forces. The landing gear was found in the fully retracted position. The wing flaps were found at the takeoff setting and were symmetrical.

Several feathers were found in the nacelle air scoops[3] which supplied cooling air to the generators and oil coolers of engines Nos. 1 and 4. In addition one gull feather was found in the cooling duct to the generator of engine No. 3.

All four engines and propellers were recovered from the bay. The No. 1 propeller was fully feathered and the engine was not operating at time of impact. Engines Nos. 2, 3, and 4 were operating at impact and their propellers were found at approximate blade angles of 40, 41, and 41 deg., respectively. Mechanically, all four engines were found to be in good condition with the exception of impact damage. No. 1 engine showed no rotational damage to the compressor and turbine sections, whereas the remaining engines displayed extensive rotational damage to the rotors from impact. There was no evidence of overtemperature in any of the engines and all appeared capable of normal operation prior to impact.

Numerous samples of foreign matter were removed from the different sections of the gaspaths of the four engines. The specimens removed from the Nos. 1, 2, and 4 engines contained a small amount of material identifiable as bird remains, i.e., tissue and feathers. Some of the feather fragments were identified as starling feathers. There was substantially more of this material in

[3] The nacelle air scoop is located on the bottom of the nacelle whereas the engine air inlet is at the top.

No. 1 engine than in Nos. 2 and 4. Portions of the material not identified as bird remains consisted primarily of metal particles, carbon and marine life. There was no evidence of bird remains found in any of sections of gaspath of No. 3 engine.

There was no evidence of any malfunction or failure in any of the propeller reduction gear assemblies or actuating mechanisms. All appeared to have been capable of normal operation prior to impact.

The No. 1 emergency shutoff handle, which is located in the cockpit, had been pulled. Actuation of this handle feathers the selected propeller, electrically closes the oil tank shutoff valve, and stops the engine fuel flow by closing the cutoff valve in the fuel control and at the firewall. The Nos. 2, 3, and 4 manual shutoff handles had not been actuated. Both the autofeather system and the manual emergency shutoff levers require electrical power to complete the feather process. The time required to feather is approximately eight seconds at 120 kt.

Most of the aircraft instruments and systems components were recovered. Readings of all instruments were taken immediately upon recovery and the instruments were then disassembled to determine extent of damage and reliability of the readings. All instruments were subjected to ultraviolet light examination to determine, if possible, whether any marks were made by instrument pointers at impact. The results of this examination were negative.

Various readings of engine operating parameters were noted:

Engine Number ..	1	2	3	4
Turbine Inlet Temperature (°C) ..	400	978	950	960
Torquemeter Gauge (shp)	=850	3350	3360	3540
Torquemeter Phase Detector (shp) ..	=875	3315	3310	3555

All fuel flow indicators were recovered; however, it was determined that the readings were subject to change after impact and were therefore inconclusive.

All four engine-driven a.c. generators were recovered; however, the bell housing for the No. 1 was missing due to impact. Detailed examination of the generators showed no indications of any in-service failures. The examination of generators Nos. 2, 3, and 4 showed circumferential scoring of the air inlet hoods by the cooling fans over arcs from 30 to 60 deg. which indicated generator rotation at the time of impact.

Emergency Inverter

The emergency inverter which operates automatically when all four generators are off the line was not rotating at impact. This inverter will come up to speed in about 1 to 2 sec. following disruption of a.c. power to the Essential a.c. Bus (which can only occur if all four generators drop off the line). After a.c. power is restored to the Essential a.c. Bus the emergency inverter is automatically deactivated. Under these conditions the time for the inverter rotation to coast to a stop is approximately 13 sec.

The two approach horizon flight instruments which are electrically powered from Priority Bus A were recovered. Inspection and disassembly of these units revealed almost identical readings; the positions of both indices were registering a left bank of 150 deg. at impact.

The two Collins Course Indicators were recovered in relatively good condition. The azimuth rings of the instruments indicated 319 deg. and 311 deg. Because of the extensive gear reduction in these instruments the readings are considered reliable. Both of these instruments receive electrical power from Priority Bus A.

Boost Controls

Examination of the three hydraulic boost control packages did not reveal any conditions which would have precluded normal operation prior to impact. The damage to these units, which occurred at impact or during recovery operation, consisted of ruptured diaphragms and a bent elevator piston rod.

The boost control systems are actuated by two independent hydraulic systems. Either system is capable of handling all hydraulic boost control demands. Three electrically driven hydraulic pumps supply pressure for the two systems. Pumps 1 and 1A serve system No. 1 and pump No. 2, system No. 2. Pumps 1A and 2 receive electrical power from Priority Bus A; pump 1 from Priority Bus B. A standby pump is incorporated in the No. 2 system and receives its power from whichever bus was supplying the pump it replaces.

Examination of the hydraulic pumps and filters showed extensive corrosion due to water immersion; however, these compo-

nents were free of any evidence of operating failure or damage prior to impact.

Passenger seats, except 19C and 19D, and the lounge seats, all located in the rear of the cabin, failed at impact and were torn from their mounts. In most cases initial failure occurred at the wall attachment followed by failure of the plate on the bottom of the aisle side of the seat. The seats then left the floor forward and upward at an angle of about 20 deg. In addition, 14 of the 33 center seat belt attach fittings, common to both seat belts in the double seats, failed completely. In seven others there were partial failures. Many of the service trays mounted on the backs of seats showed evidence of having been struck from the rear.

Engine Tests

As stated before, several eyewitnesses reported seeing smoke or fire emitted from the engines. This evidence, together with that of the bird remains found in the engines during teardown, indicated a need for more information concerning engine operation after bird ingestion. A series of tests was conducted by the Allison Division of General Motors, the engine manufacturer, in which starlings were introduced into an operating engine in varying numbers and sequences. In view of its immediate availability, a static test stand was utilized. Although the test was limited in simulating the in-flight engine response to ingesting birds, much valuable information was obtained. The tests demonstrated that substantial power interruptions and emissions of flame from the tailpipe would occur when starlings were ingested; however, quantitative information was lacking with respect to the engine behavior under flight conditions.

Wind Tunnel Test

Subsequently another test program was incorporated in the study of the broad problem of turbine engine bird ingestion being conducted under the auspices of the Federal Aviation Agency. In cooperation with Board personnel, the test program was planned to provide information pertinent to the circumstances which prevailed at the time of the accident. These tests were conducted in the Lockheed Aircraft Corporation wind tunnel in Burbank, California. An Electra QEC[1] was installed with modifications in the inlet duct to permit controlled introduction of birds. Various numbers of starlings were ingested into the engine at different power settings and tunnel speeds. Pertinent operating parameters were recorded during each test. Besides substantiating the results of the static test stand program, these tests afforded the following information:

- **The Allison model 501-D13 engine** demonstrated excellent resistance to structural damage from starling ingestions.
- **Single-starling ingestion** at cruise and takeoff conditions revealed negligible power interruption and approximately 90% of pretest power was recovered.
- **Two-starling ingestion** at cruise power decreased shaft horsepower approximately 15% after recovery; at takeoff power, approximately 10%. In both cases, at least 50% power was always available.
- **Four-starling ingestion** at takeoff power decreased shaft horsepower approximately 15% after recovery. Power fell to approximately 500 shp. and was below 50% rated from one to three seconds. An autofeathering signal occurred in one of the three tests conducted.
- **Six-starling ingestion** at takeoff power decreased shaft horsepower approximately 23% after recovery. In one instance, the engine failed to recover. In another test less than 50% power was available for four seconds. In the last test the engine flamed out, relighted and produced 50% or more power after seven seconds. All tests indicated that autofeathering would occur.
- **Eight-starling ingestion** at takeoff power produced an autofeather signal in all three tests. The engine failed to recover in two of the tests. In the remaining instance the engine flamed out, relighted and partially recovered when surging and overtemperature necessitated shutdown.
- **Ingestion of eight starlings** in time-sequenced groups of four each critically complicated the recoverability of the engine. One test terminated in shutdown because of surging and overtemperature. In the other test, the engine flamed out, relighted and recovered steady 50% or more power after a 10-sec. interruption. In both instances the propeller would have autofeathered.

The Board extracted information from reports of bird strikes experienced by commercial air carriers. During the period, Feb. 25, 1961, to Sept. 13, 1961, 14 bona fide bird strikes were reported on the 501-D13 engine. In all instances, the damage proved to be minor. The most critical flight regime was takeoff. The majority of bird strikes (57%) including three multiple strikes occurred at this power setting. In a multiple strike involving all four engines, only one engine experienced a slight decrease in horsepower; however, the other multiple strikes, each involving two engines, autofeathered a propeller in both instances. Most of the bird ingestions at takeoff power (62%) resulted in an engine shutdown in which the propeller was usually autofeathered (80%); engines which recovered after ingestion experienced 100 to 250 hp. deterioration in rated power. The nature of in-flight ingestion precluded any accurate determination of bird number and/or weight required to cause an engine shutdown. In flight regimes other than takeoff, the bird ingestions caused neither an engine shutdown nor a reported loss in power.

Analysis and Conclusions

The bird remains extracted from the engines and the carcasses which were found on the runway provided evidence that during takeoff starlings were ingested by engines Nos. 1, 2, and 4. The Board concludes that the No. 3 engine did not ingest any birds, because detailed examination of material specimens from its interior revealed no traces of bird remains. The possibility that sea life may have destroyed the bird remains in No. 3 engine was considered and discarded.

All of the engines were removed from the water within a few hours, with No. 3 being first; consequently the exposure of all the engines to sea life was about the same.

Evaluation of the results of the bird ingestion tests indicates that these tests reasonably simulated engine behavior in flight. This is further substantiated by a number of reports of bird ingestions which have occurred subsequent to this accident. Apart from possible structural damage, birds ingested into the engine affect power output by blocking airflow, decreasing compressor airfoil efficiency with surface debris, distorting gaspaths, etc. Component efficiency may deteriorate until the engine is unable to provide external power or is even incapable of surge-free steady operation. It also appears that ingestion of more than three starlings can actuate the autofeather system, cause engine flameout, or reduce

[1] QEC—"Quick Engine Change"—Allison 501-D13 engine, equipped in this case with an Aeroproducts 606 propeller, mounted in the forward detachable section of the nacelle.

British Army Evaluates WA.16

Beagle-Wallis WA.16 autogyro is being evaluated by the British army. Aircraft was developed by Wing Cdr. K. H. Wallis. Light cockpit enclosure can be installed.

the power substantially for several seconds. Engine recovery after ingesting eight or more starlings simultaneously appears very improbable. Post-test inspections indicate that bird debris lodges within the engines after an ingestion.

No. 1 propeller was feathered, most probably by a thrust sensitive signal, generally known as autofeather. The thrust sensitive signal is produced when the power lever is advanced beyond 75 deg., the system is armed by a switch in the cockpit, and propeller thrust decays below 500 lb. Autofeathering of any one propeller disarms this feature from the remaining propeller systems, which would account for a like action not occurring to any of the remaining propellers. Autofeathering of No. 1 propeller further suggests that its engine was the first to be materially affected by bird ingestion and that at least four birds were ingested.

It is believed that No. 2 engine ingested about six birds; consequently, its power was the most adversely affected of all the engines, excluding the autofeather action of No. 1 propeller. Since no direct method is available to determine the number of birds ingested by an engine, this conclusion is induced from several factors. The obviously critical and rapid deterioration of airplane performance and the initial yaw to the left after penetrating the flock of starlings indicated a prolonged substantial power interruption on the left side. In addition, witnesses observed flames emitting from an engine on the left wing and several specified the No. 2 engine. This is further substantiated by recalling that the No. 1 engine was shut down in conjunction with the autofeather action. The flames emitted from the tailpipe of No. 2 engine indicate a torching relight after a flame-out. The flames emitted during engine surges observed in tests appear to be too short to extend through the long exhaust duct in the Electra installation. The only conclusion compatible with all the circumstances of this accident is that No. 2 engine ingested about six birds, flamed out, relighted and recovered substantial power within several seconds. Tests indicate that less than 50% rated power would be available for 6 to 7 sec., following which a recovery to stable operation would occur with some semi-permanent power loss.

There was no evidence that No. 3 ingested any birds. It is concluded that it operated normally from the start of takeoff until impact.

The No. 4 engine probably ingested fewer birds than Nos. 1 and 2; consequently, its power transients were least severe with substantial decrease most likely not exceeding two or three seconds. This belief is based on the indications that the starling flock was concentrated more on the left side of the airplane and lack of observations of flames on the right side of the airplane as contrasted with observations of flames on the left side. Furthermore, the path of the aircraft suggests considerable power asymmetry with the most power being on the right side.

Except for No. 1, the engines were producing near takeoff power at impact. This somewhat limits the number of birds that may have been ingested. Wind tunnel tests indicate that power recovery is improbable when eight or more birds are ingested and it is obvious that there was recovery of No. 2 and No. 4 engines before impact.

Shaft horsepower readings obtained from the instruments are not compatible with the semi-permanent power losses that the wind tunnel tests indicated would occur following bird ingestion. Assuming the semi-permanent power losses occur as indicated by the wind tunnel tests, the instrument readings also are not compatible with the bird ingestion pattern that is known to have occurred, i.e., the shp. reading of No. 3 engine which did not ingest birds was about the same as No. 2 and less than No. 4, both of which ingested birds. Consequently, it is concluded that the instrument readings obtained are not valid criteria by which to determine the number of birds ingested by the individual engines.

Based on examination of the aircraft's primary hydraulic and electrical systems components, it can be concluded that they experienced no in-service failures prior to impact.

Since the No. 3 engine showed no evidence of power loss during the flight, its generator would be supplying electrical power for essential system units throughout. Even if generators Nos. 1, 2, and 4 were initially lost due to engine power loss because of the ingestion of birds, the No. 3 generator would automatically supply electric power to Priority Bus A; hydraulic pumps 1A and 2 would have electrical power available to them and consequently both hydraulic power systems would be available for flight control booster operation.

Using an arbitrary 3 sec. delay between lift-off and the selection of gear up, and the nominal 9.5 sec. for landing gear retraction time, a period of hydraulic and electrical capability is shown to cover approximately the first 12.5 sec. of flight following lift-off.

Six seconds after takeoff the aircraft struck a flock of birds and the No. 1 propeller was feathered. The time required to feather the propeller is approximately 8 to 9 sec. when the engine is at takeoff power. The feathering operation confirms the availability of generator power, and covers the first 15 sec. of the flight after lift-off.

Engine Shutdown

During the feathering operation or a short time later, the No. 1 engine shutdown handle was actuated. One function of this control is to close the fuel cutoff and engine oil shutoff valves electrically. These valves receive their power from the Essential d.c. Bus and, since they were found fully closed, this condition verifies the existence of power. The Essential d.c. Bus is also the power source used by the emergency inverter.

Had all generator capability been lost more than four to five seconds prior to impact, the emergency inverter would have started operation at the time of the electrical power loss and would have shut down automatically upon any restoration of power. Since the rundown time of the emergency inverter is approximately 13 sec. and examination of the recovered inverter disclosed clear evidence that its armature was not rotating at impact, it can be concluded that there was no interruption of electrical power from the time of feathering the propeller to the time of impact. Hence, it can also be concluded that hydraulic boost assist to the primary flight controls was available throughout the flight.

Flight Tests

Lockheed Aircraft Corp. undertook a series of flight tests to study the controllability of the Electra L-188 under conditions of multiple powerplant failures and operating under circumstances considerably more critical than those required for certification. Specifically, the tests determined the minimum control speed (V_{mc})[5] of the aircraft while in various bank angles, and with one or two engines inoperative. In addition, the tests defined the maximum asymmetric power at which the aircraft heading could be maintained at a constant low airspeed.

It was found that with the No. 1 propeller feathered and the other three engines developing 3,800 hp., V_{mc} ranged from 110 kt. with five degrees of right bank to 136 kt. with five degrees of left bank.

In similar tests with the No. 1 propeller feathered, No. 2 propeller windmilling, and engines Nos. 3 and 4 each developing 3,800 hp., V_{mc} was found to be 125 kt. with five

[5] V_{mc} as used in this report differs from V_{mc} as defined in Civil Air Regulations. In this case it refers to the minimum speed at which a constant heading can be maintained under any prescribed power configuration and angle of bank.

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degrees of right bank and up to 154 kt. with five degrees of left bank.

Another group of tests was conducted with the No. 1 propeller feathered, No. 2 propeller windmilling and various power combinations on engines No. 3 and No. 4. The aircraft was flown at bank angles of five degrees left and right. Under these conditions it was demonstrated that in order to maintain directional control of the aircraft with two engines inoperative on the left side, the total power output of both engines on the right side could not exceed the maximum power output of a single engine.

The results derived from these tests provided the Board with valuable information concerning the capabilities of the Electra under predetermined adverse conditions and also formed a basis for evaluating the operating limits which may have prevailed at the time of the accident.

The test flights did not exactly duplicate the conditions under which N 5533 was operating, in that they were conducted at constant, rather than fluctuating, engine power conditions. The aircraft at Boston, after striking the birds, experienced a power loss on the No. 1 engine which resulted in the feathering of its propeller. The Nos. 2 and 4 engines experienced an abrupt loss and nonsimultaneous recovery of power while the No. 3 engine remained at full power throughout the flight.

It was brought out during the Board's public hearing that after striking the birds and with No. 1 propeller feathered and No. 2 engine power output interrupted, it would require 3,500 total horsepower to place the aircraft at the observed points in space; more or less horsepower would have produced a different flight profile. The flight test, wherein it was demonstrated that an Electra, similarly configured, could not be controlled with more than 3,800 horsepower on its right side, tended to corroborate this.

Following the hearing, further study was made of the performance and control of the Electra under critically adverse conditions, particularly the drag aspects of large yaw angles. It was determined that the previous information on required horsepower can only be applied if the aircraft does not have a high drag count over and above that produced by interrupted power output. The excessive yaw angle associated with a flat turn of small radius produces drag to the extent that abnormally high power is required to maintain flying speed or, in fact, to prevent rapid deterioration of airspeed to the stalling point.

Inspection of a plot of power required versus turning radius reveals that, at 110 kt. and 10 deg. bank angle, the power-required curve becomes asymptotic at a turning radius of 2,000 ft.

The Board recognizes that N 5533 was not at precisely this speed and bank angle throughout the final stages of flight, but it was near enough to make the data applicable. It is known that the radius of the flat turn from an easterly heading to northeasterly was less than 2,000 ft. It logically follows that if the drag, which is related to power required, is many times higher than the total thrust available under any engine condition, additional thrust is available only by assuming a steep nose-down attitude; otherwise the aircraft will rapidly lose airspeed.

Calculations based on the Electra lift curve and on the deck angles reflected in the two photographs taken by witnesses produce an airspeed of 118 kt. at the time of the first photograph and 103 kt. at the time of the second. During the approximately 1-sec. interval between the first and second photograph the aircraft was approaching the stall at the rapid rate of about 15 kt. per second, and at the time of the second photograph was well below the stall speed which, for the weight, flap position, and attitude of the subject aircraft, was 108 kt.

Extreme yaw angles also cause the fuselage to partially shield one wing from the airflow. The skidding turn also reduces the lift on the shielded wing. These two phenomena, together with, in this case, the additional lift due to slipstream on the unshielded wing, produce a condition commonly referred to as roll due to yaw. This condition is normally countered by aileron and rudder application to the opposite side, but becomes uncontrollable at low airspeeds where control surface effectiveness is low. There is, then, a point where the induced rolling moment is higher than the countering moment produced by control surface deflections.

In an effort to explore all facets of control difficulties that may have been encountered by the crew of N 5533, the Civil Aeronautics Board devised and observed a series of tests utilizing an Electra L-188 flight simulator owned by National Airlines and certificated by the Federal Aviation Agency. While recognizing the limitations of the trainer, the tests were designed to simulate the conditions of airspeed, altitude, and, insofar as possible, various power interruptions which might have affected the subject flight. These tests provided the Board, through qualitative observation, a more thorough understanding of the complex problems confronting the crew of N 5533 during the fatal emergency. The results of the tests made by qualified Electra pilots who flew the trainer under conditions simulating those that prevailed at Boston demonstrated that control of the aircraft, under such conditions, could have been an insurmountable task.

The total time from the start of takeoff until the crash was 47.5 seconds. It is believed that the takeoff roll and lift-off were normal. The time required to the lift-off point was 20 sec. The speed would have been approximately 121 kt., which was V_2 for the existing conditions. It is therefore evident that the airplane was in the air approximately 27.5 sec.

Based on the relative locations of the bird carcasses and the point of lift-off, it is concluded that the aircraft struck the birds approximately six seconds after lift-off. Assuming a reasonable acceleration of 2 kt. per second, the speed at this point would have been about 133 kt. Allowing 1 sec. for ingestion to occur, it would then require an estimated additional 6 sec. for total power recovery, excluding the No. 1 engine. There would then be a period of 14.5 sec. remaining during which the aircraft was in the air. This 14.5 sec. would be further reduced by a 3-sec. interval allowed for the aircraft to plunge uncontrolled into the bay. It is recognized that these times are estimated, but it is believed they are sufficiently accurate to emphasize the extremely

short period of time (approximately 11 to 12 sec.) that was available to the pilot to take effective corrective action.

From all the evidence available, the Board concludes that about 27 sec. after the takeoff roll commenced and 7 seconds after lift-off, engines Nos. 1, 2, and 4 ingested sufficient numbers of birds to cause losses of power on these engines and that Nos. 2 and 4 recovered in the manner described. More important, however, the Board believes that the key to the severity, and probably to the occurrence of the accident lies in the unique and critical sequence of a rapidly occurring chain of events.

First, the more complete loss of power on the left side than on the right started the aircraft turning to the left while its airspeed was decaying as a result of the over-all power loss. The fact that the No. 1 propeller rather than an inboard propeller autofeathered, while not critical in itself, was more undesirable in that it increased the degree of asymmetry of any power combinations on the right side.

The No. 2 engine flameout, coupled with only a partial loss of power on No. 4, placed the aircraft in a condition of having no power on the left side and substantial power on the right. This produced a severe yaw to the left which was further aggravated by No. 4 engine recovering full power prior to the relight and recovery of No. 2.

The high yaw angle, as earlier described, produced a drag of such magnitude that the subsequent recovery of No. 2 engine could not arrest the rapid decrease in speed before the aircraft stalled. The recovery of No. 2 engine, while it reduced the degree of asymmetry, could not compensate for the high-power condition on the right side. With some degree of asymmetric power still producing left yaw and roll, coupled with the effects of roll due to yaw, and with the aircraft rapidly entering a stall regime, roll control effectiveness degenerated and the aircraft rolled farther to the left, stalled, and entered a spin. The only recovery from such a situation prior to the spin would have been to reduce power and lower the nose to regain control and airspeed. Recovery in this case was impossible since the 100- to 150-ft. altitude was insufficient for the Electra's dimensions and speed requirements.

It is not unreasonable to assume that birds may have struck the windshield and may also have plugged one or both pitot heads. The startling effect of the noise generated by the bird strike and impairment of forward visibility, in conjunction with a possible loss of airspeed indication, would certainly be disturbing elements in an already critical situation. Neither the outer windshield panels nor the pitot heads were recovered; therefore, no proof can be offered.

The Board concludes that emergency conditions of great complexity were thrust upon the crew in an increasingly deleterious environment, and that human capabilities of perception, recognition, analysis, and reaction were insufficient in the time and space restrictions of this accident to accomplish restoration of positive performance control.

It has also been determined that there was no structural failure or mechanical malfunction of the aircraft, other than has already been discussed, which contributed to the cause of the accident.

As a result of this accident and pursuant

to section 701(a)(3) of the Federal Aviation Act of 1958, the Civil Aeronautics Board recommended on Dec. 5, 1960, to the Administrator of the Federal Aviation Agency that a basic research program be initiated by the FAA aimed at improving the tolerance of all turbine engines to bird ingestion. It was also recommended that a study be made of the means of precluding bird entry into turbine engines. A comprehensive program of research into turbine engine bird ingestion has since been initiated by the FAA.

Information obtained as a result of various tests which have been conducted thus far is being analyzed and should prove significant in preventing accidents of this type in the future.

The investigation disclosed the first failure points of the seat and seat belt attachments and also pinpointed injury-producing environment within the cabin. In view of these findings, recommendations were made by the Board soon after the accident with the objective of enhancing passenger safety aspects of the Electra L-188 aircraft. Based on these recommendations, considerable research was engendered which it is hoped will result in an over-all improvement in passenger safety.

Probable Cause

The Board determines that the probable cause of this accident was the unique and critical sequence of the loss and recovery of engine power following bird ingestion, resulting in loss of airspeed and control during takeoff.

By the Civil Aeronautics Board:

ALAN S. BOYD
Chairman
ROBERT T. MURPHY
Vice Chairman
CHAN GURNEY
Member
G. JOSEPH MINETTI
Member
WHITNEY GILLILLAND
Member

Investigation and Hearing

The Civil Aeronautics Board was notified of this accident at 6:15 p.m. on Oct. 4, 1960. CAB investigators were immediately dispatched to the scene and an investigation initiated and conducted in accordance with the provisions of Title VII of the Federal Aviation Act of 1958. A public hearing was ordered by the Board and held in the auditorium of the Air National Guard headquarters, Logan International Airport, Boston, Mass., on Jan. 11, 12, and 13, 1961.

Eastern Air Lines holds a current certificate of public convenience and necessity issued by the Civil Aeronautics Board to engage in the transportation of persons, property, and mail. It also possesses a valid air carrier operating certificate issued by the Federal Aviation Agency.

Flight Personnel

Capt. Curtis W. Fitts, age 59, was employed by Eastern Air Lines Dec. 13, 1934. He held a valid FAA airline transport pilot certificate with ratings for the Martin 202, 404, Convair 240, 340, 440, DC-4, DC-6, DC-7, Lockheed Constellation, and L-188. Capt. Fitts had a total of 23,195 flying hours of which 1,053 were in the L-188. His last FAA Class I physical examination was given on July 20, 1960. He had received a line check on May 29, 1960, and an instrument check on Apr. 7, 1960.

Pilot Martin J. Calloway was employed as a pilot by Eastern Air Lines on October 5, 1953. He held a valid FAA airline transport pilot certificate with ratings for Martin 202, 404, Convair 240, 340, and 440. He had a total of 5,820 flying hours of which 201 were in the L-188. His last FAA Class I physical examination was given Mar. 17, 1960, and a line check June 7, 1960.

Flight Engineer Malcolm M. Hall was employed by Eastern Air Lines Dec. 7, 1953. He held a valid FAA flight engineer certificate and an airframe and powerplant mechanic certificate. He had a total of 7,796 flying hours of which 369 were in the L-188. Mr. Hall's latest FAA Class II physical examination was taken Dec. 14, 1959. His last line check was given May 20, 1960.

The aircraft was a Lockheed Electra, Model L-188, U. S. Registry N 5533, owned and operated by Eastern Air Lines. It was manufactured on June 8, 1959; serial No. 1062. The total time on the airframe was 3,526:29 hr.

The engines were Allison Model 501-D13 with Aeroproducts propeller model A644-IFN-606. No. 1 engine had a total time of 2,515:54 hr.; No. 2—2,707:46 hr.; No. 3—2,783:06 hr.; and No. 4—3,144:04 hr.

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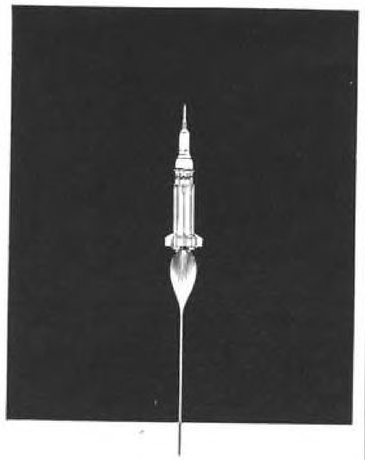

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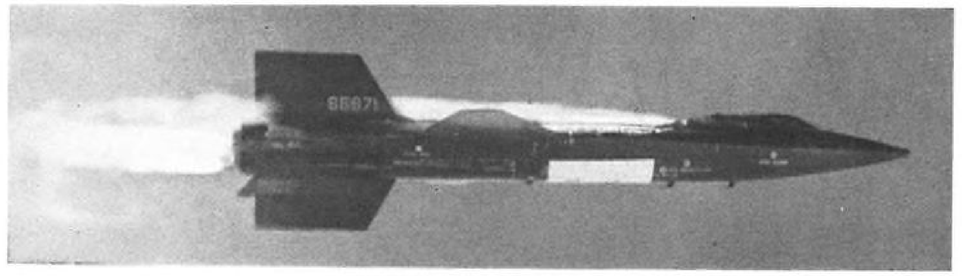

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A Message to the Engineer/Scientist Community At Large — and a Question: there's a dynamic technological race going on at the Atlantic Missile Range, a race between the fast-increasing capabilities of new missiles and space vehicles and the capacity of range instrumentation to test their performance. □ We wonder how much you have heard about this. . . . and about the challenge it offers engineers and scientists with PAN AM at Cape Canaveral? □ You may know a small segment of the work . . . many do. But only a handful are aware of its scope. In fact, we of PAN AM'S Guided Missiles Range Division sometimes think that only the ubiquitous seagulls know the full story of the new range instrumentation technology we've created in the 9 years we've been charged with development and management responsibilities for AMR by the U.S. Air Force. □ The measure of the distance we've come is the measure of the technological jump between MATADOR and MARINER. □ In the simplest terms, this has meant acquiring ever greater funds of data, of ever higher accuracy, at ever greater distances — and converting and transmitting it at ever increasing speeds. □ FIRST, the existing range instrumentation and communications techniques were pushed to the utmost bounds of their capacities — THEN they were replaced with new range systems built to new concepts, as specified by PAN AM engineers and scientists backed by research groups. □ *Today — a new phase of range technology development is under way — staff build-up is proceeding on schedule.* □ To meet the demanding requirements of both today and tomorrow, much of the work of the Range is divided into three time projections:

(A) designing and implementing range instrumentation for launches programmed for this year and next;

(B) developing range technology concepts required for launches in the near future (Dyna-Soar, Gemini, Apollo test vehicles, advanced Saturn boosters and Nova);

(C) advanced planning, looking forward as much as 15 years. Includes considering such problems as how to service, launch, track and recover information from multi-million pound thrust booster systems and anticipating the problems associated with the launching and support of nuclear propelled boosters and spacecraft.

OPPORTUNITIES are open right now to join Pan Am in developing range test systems of hemispheric, global and celestial scope. □ □ **SYSTEMS ENGINEERS** EE, Physicist — capable of accepting project responsibility for design of range instrumentation systems, monitoring systems development, installation and acceptance. (Must also be adept at liaison.) Background in one of the following areas is essential: Pulse radar, CW techniques, telemetry, infrared, data handling, communications, closed circuit TV, frequency analysis, command control, command guidance, underwater sound, timing □ **INSTRUMENTATION PLANNING ENGINEERS** EE, Physicist — with managerial capacities, to accept responsibility for specific global range instrumentation concepts. Must be able to comprehend overall range instrumentation concepts and have extensive experience in one of the following areas: radar, telemetry, infrared, optics, data handling, communications, underwater sound, shipboard instrumentation □ **SENIOR ENGINEERS & SCIENTISTS / FORWARD PLANNING** PhD's, Math., Physics, Applied Mechanics, Astronomy, Electronics — to evaluate and project the state-of-the-art in all applications to range instrumentation. Help establish both theoretical and practical limitations of existing relevant technologies. □ **In addition to** all the uncommon professional values, you get Florida, too! Those who enjoy casual, year-round, outdoor living are in their element at the Cape, where a majority of engineers and scientists live and play near the water. Consider too that PAN AM gives you a 90% world-wide air travel discount.

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LETTERS

Challenge in Space

You are to be commended for your editorial in your Aug. 20 issue, although I do not believe the recent Soviet shot was a full docking experiment but rather an ascent guidance experiment. Nevertheless, as you note, the message is clear and we must free our programs from the bulldog grip of a number of Presidential and DOD scientific advisors, or else we may jeopardize our very existence.

It appears that in the U. S. the scientists are calling the shots. A reputation in polymers or a prize in genetics qualifies many to pass judgment on operational, political, or strategic factors for which they have neither the background nor the inclination. The dark picture by some on radiation dangers reminds us of the pessimists who howled about the sonic barrier and the thermal thicket, which we now call old hat. The engineers and strategists are hamstrung. Reports from the USSR and discussions with Soviet scientists indicate that engineers and strategists there have literally dragged their scientists screaming into the space age. The external shell of Soviet space effort is peaceful scientific use for propaganda consumption. The core and direction of the effort is military—engineering oriented—winged vehicles—big boosters—all with serious implications for us.

We also hear much today concerning public criticism of our space effort and its cost. The main difficulty here is that our NASA space program is being sold to the American public on a peaceful uses, scientific basis. Historically, this approach has never met with much success. What is really vital is to redirect our space effort along the lines of military need which is the area in which the true danger from the Soviet achievements exists. The recent Russian success is frightening in its military implications when placed in contrast to our deliberate but plodding approach along so-called scientific lines. It should be noted we tried the same separation of scientific approach in Vanguard which was an abysmal failure, and only when we diverted military developments did we crack the orbital barrier. The contention of some that it's easy in Washington to get money for military machines is erroneous, at least in regard to military space machines.

Evidently we have learned very little from history. Practically all of the significant technology advances in areas such as aircraft, electronics, and other similar fields have been made under the pressure of military and national survival needs. The fallout to science and engineering and consumer welfare has been tremendous: the 707 jetliner, the radar traffic control, the computer, the printed circuit in our TV sets, the transistor radio every teenager carries are cases in point. Now we are wagging the dog, running a space program under the suicidal guise of peaceful uses and hoping we'll get fallouts for military use.

In essence, we are really faced with a situation where it seems that only the appearance of a Billy Mitchell-type of space proponent willing to sacrifice a significant career can jar some of the fuzzy thinking now being pursued at our highest administration levels. When the aircraft controversy was raging in the thirties, we had time to correct our mistakes; now we do not. With a country that can spend $7 billion per year on liquor, $4 billion on horse racing and $4 billion on tobacco, should we really be concerned over the bleeding hearts who bemoan our supposed strained resources needed to support a military space program when our national survival may depend upon it? Thus a military space program has a three-fold benefit, national strength, public support and technological progress.

The public must know we have no significant military space program now despite the euphoric pronouncements of DOD. We **must** have one. It may cost more than we are now spending. The fact remains that in our lifetime we are seeing a challenge to the final full measure of democracy. The question is simple. Can a free people sustain an intensive, competitive, technical effort without the patriotic stimulus of a hot war? This in essence is the challenge to the Kennedy leadership.

GEORGE R. ARTHUR, PH.D.
Levittown, Pa.

I read with considerable interest your articles concerning the recent "group flight" of Vostoks 3 and 4, piloted by Cosmonauts Nikolayev and Popovich (AW Aug. 20, p. 26, Aug. 27, p. 36). I am especially referring to your "undisclosed source" claim of rendezvous, the official NASA statement of "never closer than 75 mi.," the Sohio Research Center tracking efforts, and DOD's silence. I feel now that I must add my "two cents" to what seems to be an already confused state of affairs.

During the paired flight, I was able to radio track and obtain time fixes on the two Vostoks for a total of 27 orbital passes and could have easily tracked them for 31 separate circuits, if I had tried. On the majority of these passes the signals were very strong and clearly resolvable, including several voice communications which I recorded on tape. (Apparently my geographical location, i.e., flat terrain for 300 mi. in all directions, strongly favors tracking the Soviet satellite flights of 49° to 65° orbital inclination, since I have monitored most of them up to 11 passes out of every 24 hr. period.)

On Aug. 12 at 7:47:48 a.m. CST, I first acquired the beacon signals of Vostok 3, (19,996 mc.) followed shortly by Vostok 4 (19,990 mc). At that time, based upon signal peak data and "closest approach" times, I was able to ascertain that a separation distance of 110 stat. mi. already existed between the two vehicles. This was one full orbital period before the Sohio Research Center acquisition at 10:22 a.m. EST, and does conflict somewhat with their claim of 75 mi. separation for the next two orbits. Except for these first few passes, my data is in very good agreement with their published data, showing the same progressive increase in distance with time. Using the data at hand and extrapolating backward (as the others have done), I cannot support the "rendezvous" claim. However, it does appear that the two were very close, say of the order of five to 10 mi., shortly after the orbital injection of Vostok 4. This would tend to support Soviet claims in this regard.

GERALD F. SCHMIDT
Wichita, Kan.

Air Traffic Control

The description in the Aug. 27 AVIATION WEEK (p. 71) of FAA's plans to automate air traffic control is extremely encouraging to anyone who flies either as a pilot or passenger. It is an ambitious program, but its realism is reinforced by the planned sequence of implementation of data processing and display capabilities. There seems little question that the functions proposed are within the state of the art of today's computers and displays. But, are they compatible with the ability of the human controller who will remain an essential part of the overall air traffic control system?

The final system requires displays presenting many kinds of data including aircraft position, alphanumeric identity and altitude, video maps (not mentioned in the AVIATION WEEK article, but of great value to the controllers at present), flight plan data, computer predicted aircraft position, computer recommended solutions to conflicts, handoff symbols, cursors, weather and other types of data, either permanently displayed or to be called up on demand. Certainly the final system should eliminate the necessity of the controller having to transfer attention back and forth from one type of display to another in order to obtain all the data he wishes. It is equally unsatisfactory for these many kinds of information to be presented on the same cathode ray tube of limited area unless there is an immediate and obvious method of segregating the different types of data at first glances. Such a capability exists through the use of color. A multicolor display has been discussed by the Air Traffic Controllers Assn. as far back as 1959, to my knowledge. Only recently, however, has the state of the art in color cathode ray tubes arrived at a point which makes them suitable with respect to resolution, color contrast, and other desirable features.

One possible application of color would require the use of only the three primary colors of red, green, and blue together with white. The complexities of color mixing are thus minimized. Different kinds of data (radar blip, video map, alphanumerics, emergency situations) could be presented in different colors and no interpretation would be required by the controller as to what it is that appears on his scope.

The advantages of color over monochrome for a busy display seem so obvious that its tremendous potentials should be carefully investigated before the FAA proceeds irrevocably down a road which cannot attain the most desirable ultimate goal.

CHARLES FANWICK
Radio Corp. of America
Van Nuys, Calif.

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