THE AEROSPACE YEAR BOOK

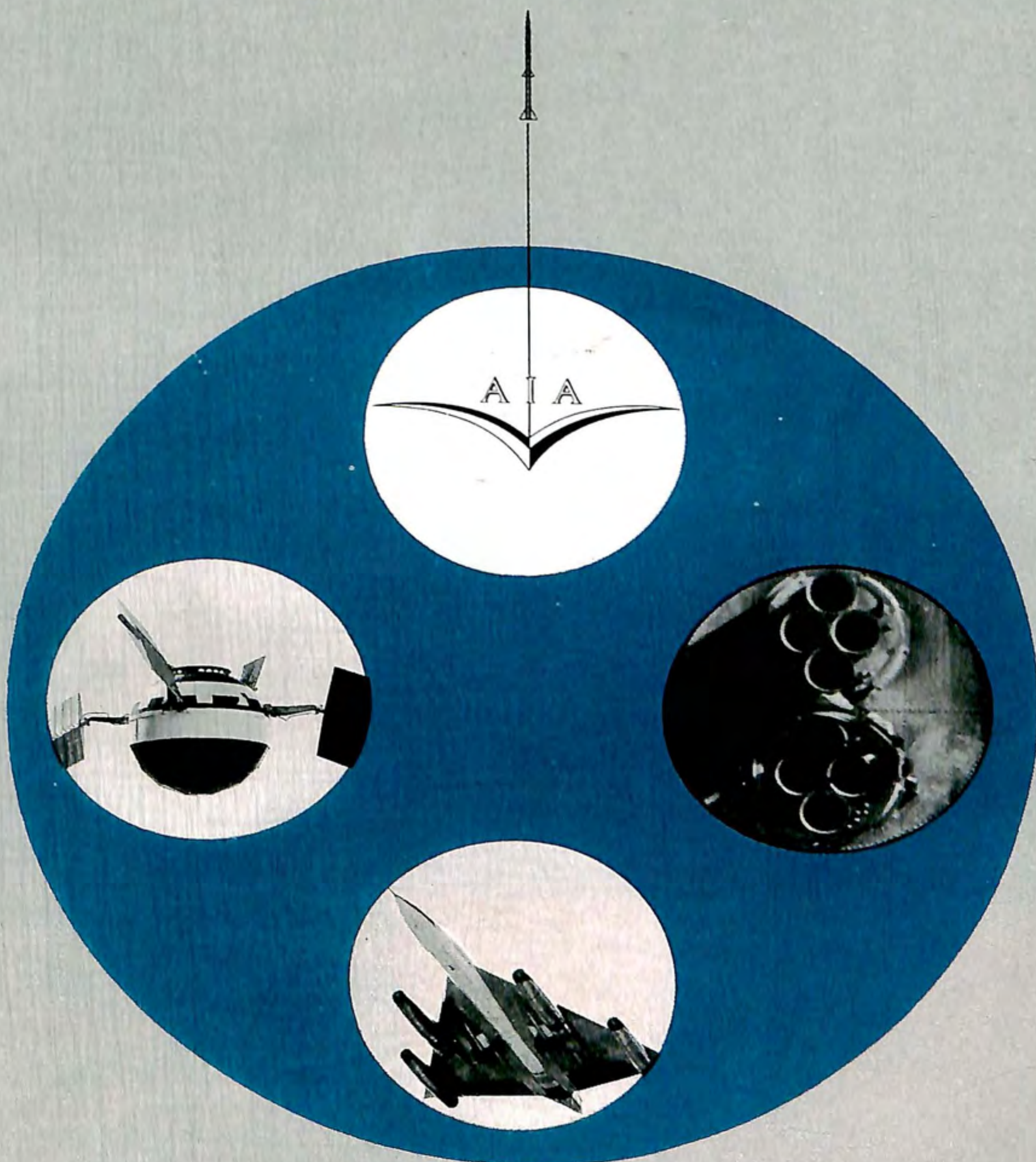
1962

AIA

FORTY-THIRD ANNUAL EDITION

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.

the 1962 aerospace year book



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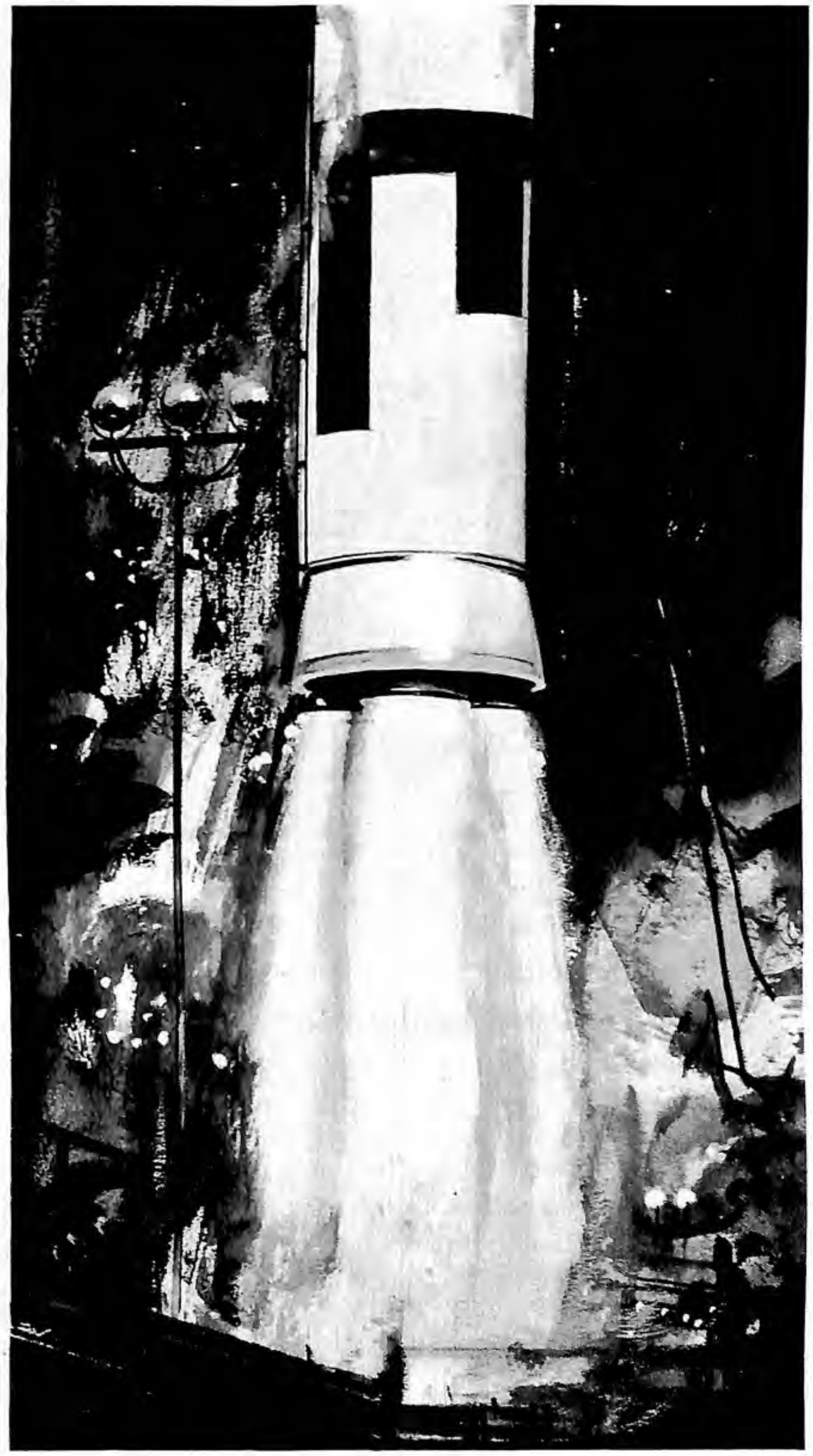

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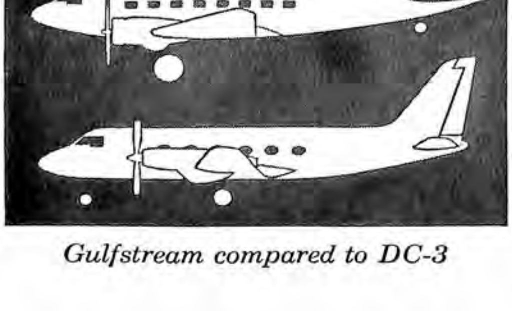

Gulfstream compared to DC-3

Here are the Gulfstream's capabilities: For military application, it will carry up to 24 passengers and has a transcontinental range against 50-knot head winds. It needs only 3,000 feet of runway, enabling personnel to use fields close to their destinations. It is completely independent of ground

Air evacuation

handling facilities. With its pressurization system (up to 30,000 feet), it flies above weather and traffic at a cruising speed of 350 mph and is powered by proven turboprop Rolls-Royce engines. An active develop-

Multipurpose Gulfstream cabin

ment program is in progress at Grumman for the installation of the General Electric T64 turboprop engine as an alternate source of power.

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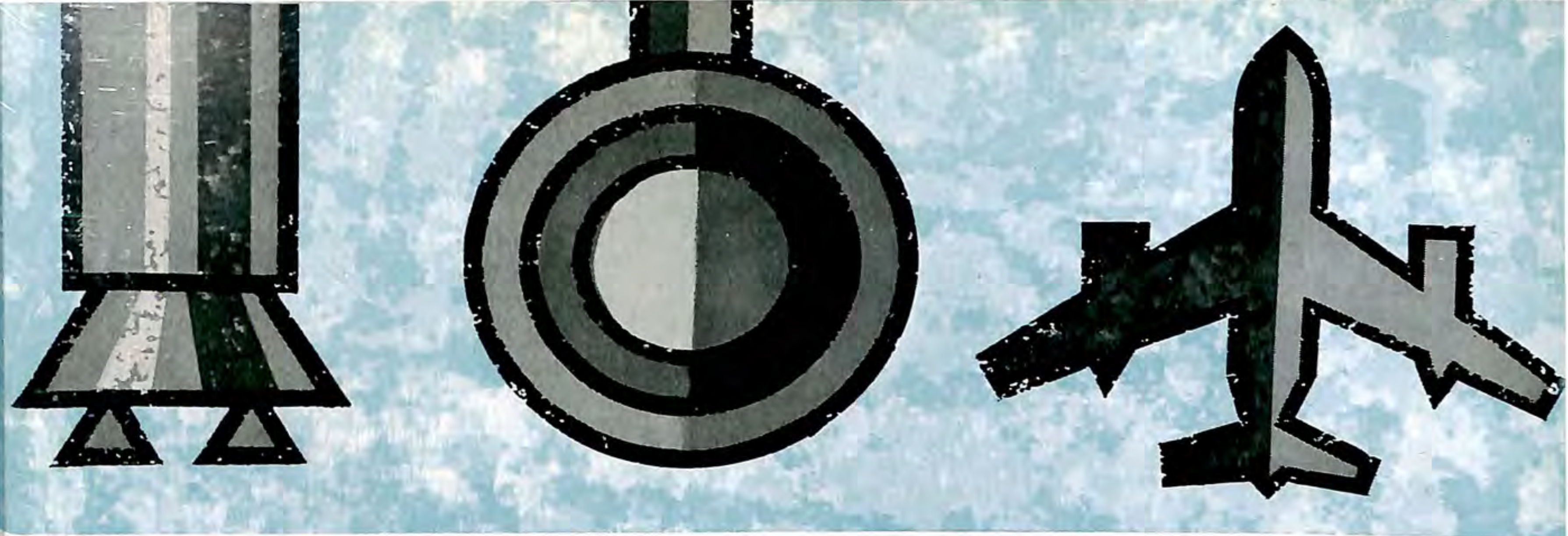

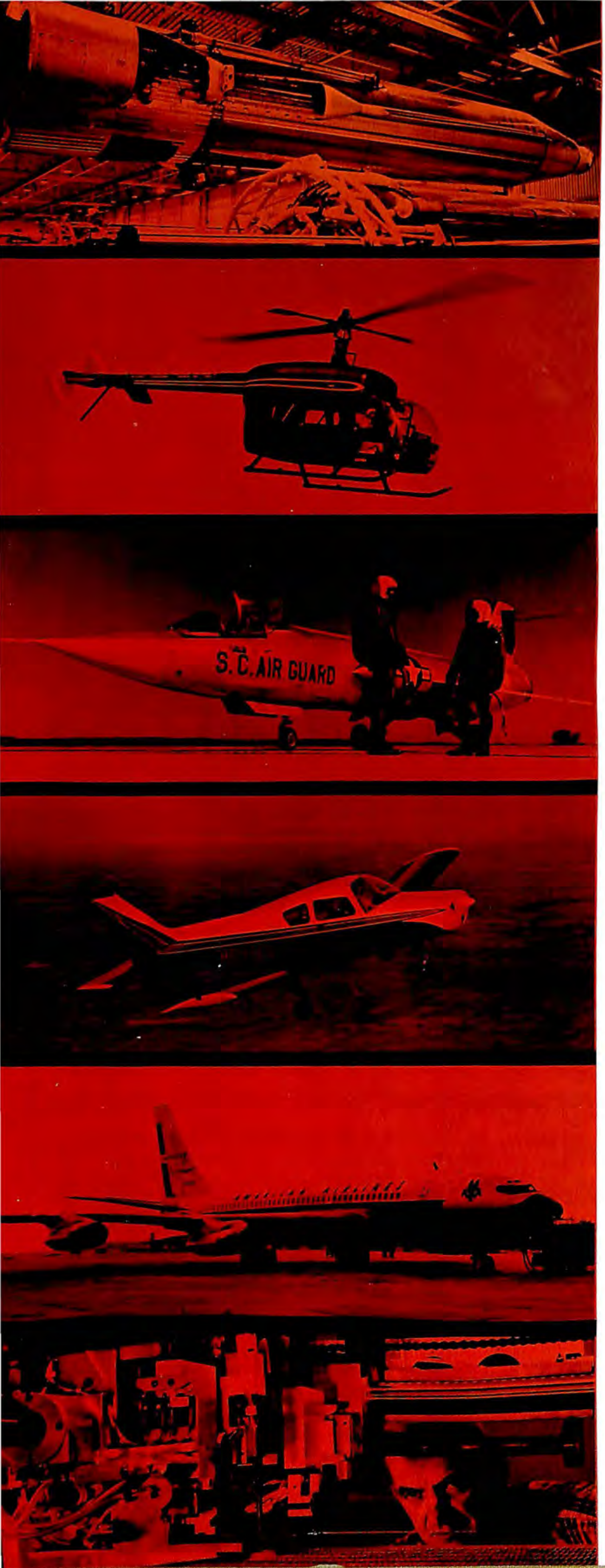

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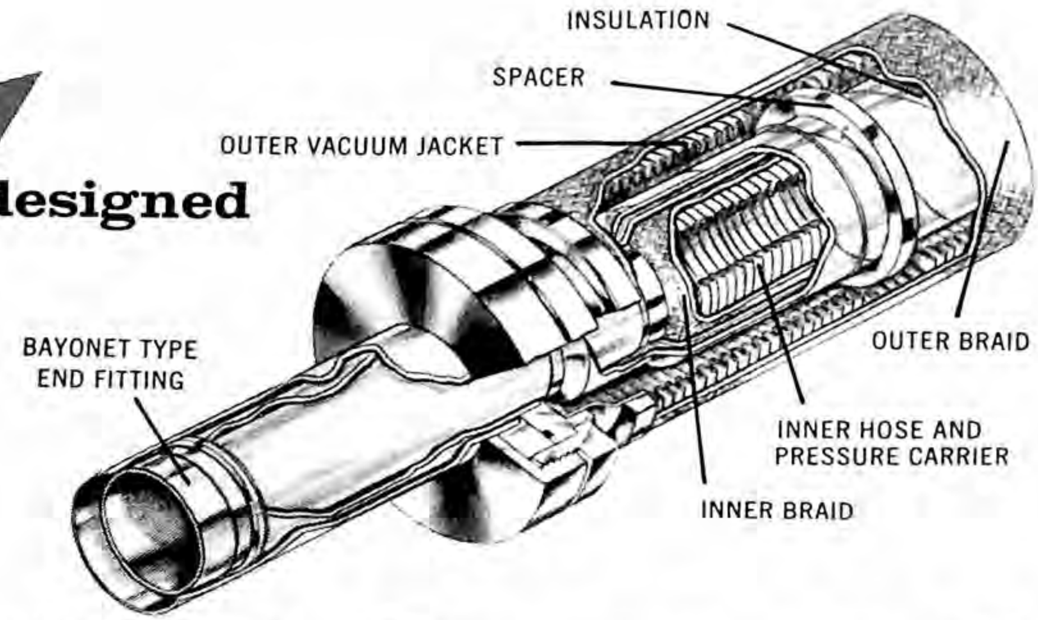

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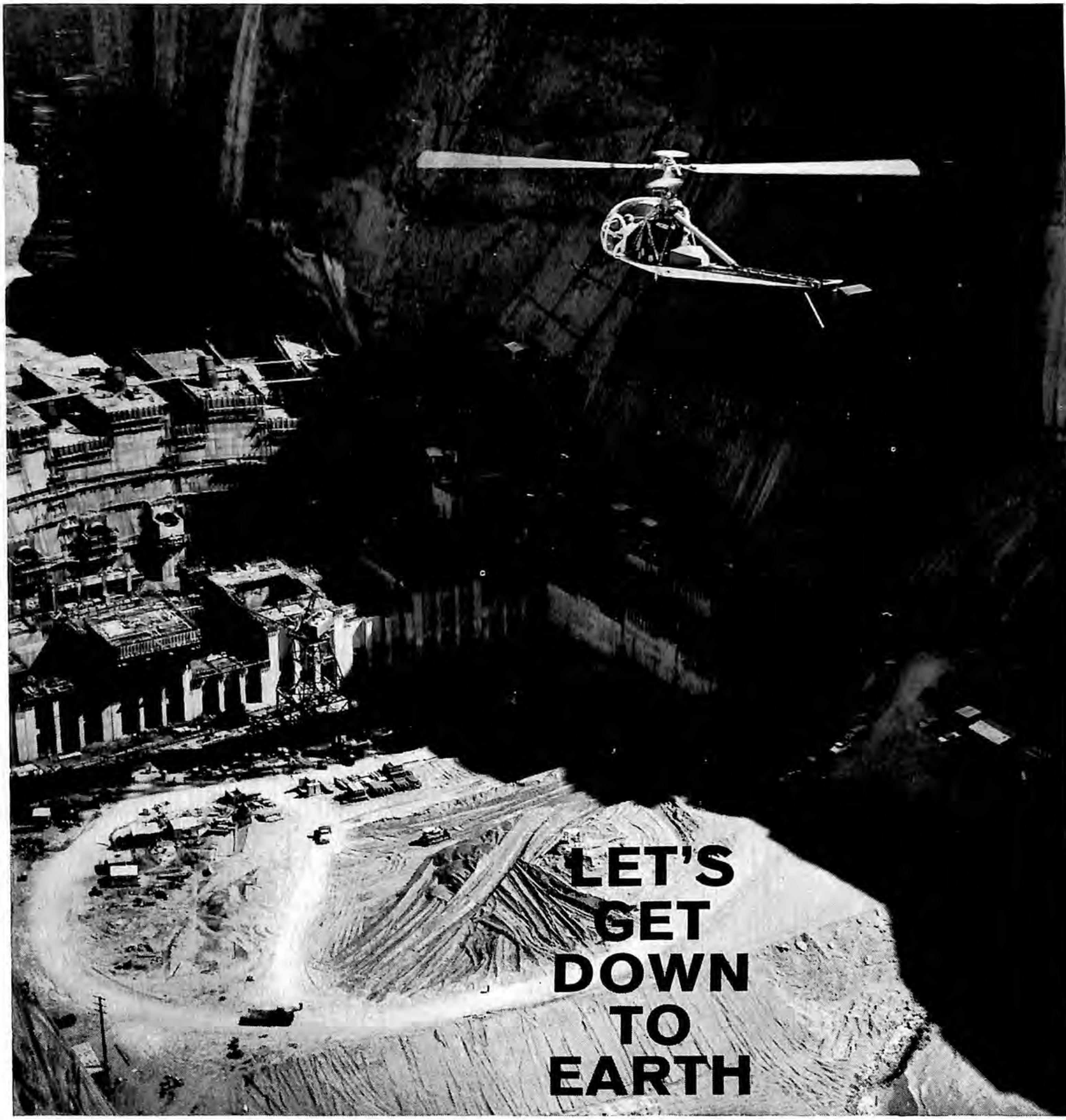
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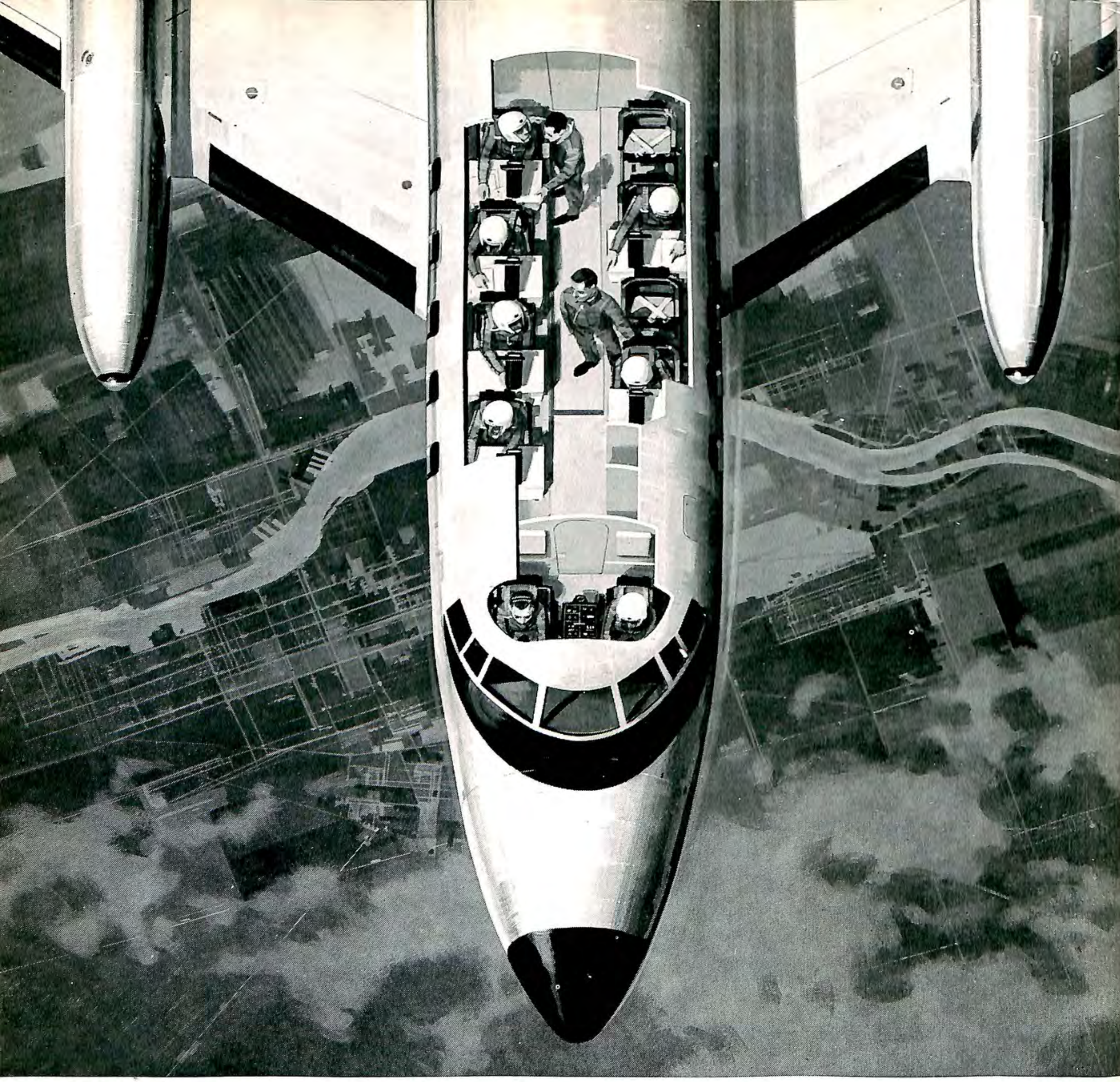

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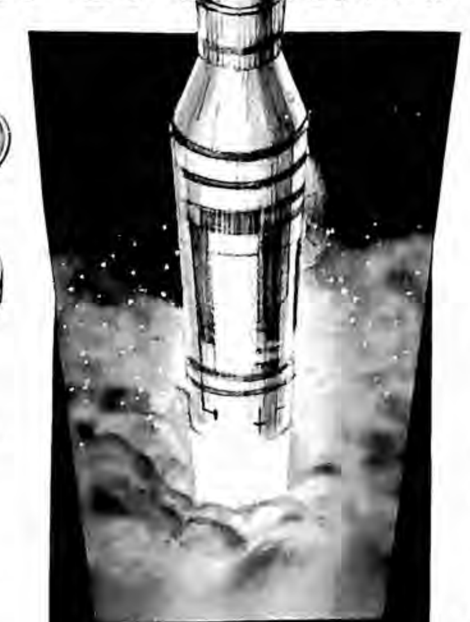
FORGING OUR SPEARHEADS IN SPACE



1 Titanium motor case parts totalling 2010 lbs.
2 ICBM heat sink cone; Copper, 1876 lbs.
3 Ported motor closure; 74 lbs., Aluminum.
4 Magnesium turbopump ring gear; 35 lbs.
5 Sustainer ring; 208 lbs., alloy steel.
6 Aluminum airframe ring splice; 53 lbs.
7 Missile blast cone; 237 lbs., carbon steel.
8 Stainless steel injector plate; 155 lbs.
9 Payload container; 10 lbs., Beryllium.
10 Super-strength steel head; 725 lbs.
11 Missile fin spar; 65 lbs., Aluminum.
12 Thrust cone; 613 lbs., alloy steel.
13 Power system part; 1300 lbs., Columbium.
14 Titanium igniter nozzle; 122 lbs.
15 Pressure bottle half; Titanium, 173 lbs.
16 Astroloy turbopump wheel; 170 lbs.
17 Heat shield backup; 134 lbs., Magnesium.
18 Airframe wind arm; 129 lbs., Aluminum.
19 Super-strength steel, 3100-lb. head.
20 Alloy-steel missile bulkhead; 130 lbs.
21 Tungsten nozzle throat insert; 115 lbs.
22 Aluminum sustainer thrust cone; 110 lbs.
23 Aft closure; 1600 lbs., super-strength steel.
24 Airframe rib spar; 95 lbs., Titanium.
25 Motor-case Titanium closure; 590 lbs.
26 Missile bulkhead; Aluminum, 89 lbs.
27 Beryllium guidance carrier ring; 23 lbs.
28 Booster turbowheel; Rene 41, 948 lbs.
29 Rocket spur gear; 18 lbs., Magnesium.
30 Magnesium satellite canister; 229 lbs.
31 IRBM Jetevator ring; 45 lbs., Molybdenum.
32 Missile motor Copper blast cone; 88 lbs.
33 IRBM spacer ring; 78 lbs., Tungsten.
34 Aluminum longeron for ICBM; 36 lbs.
35 Launching shoe; 26 lbs., alloy steel.
36 Columbium power system part; 1100 lbs.
37 Tungsten thrust-chamber throat; 32 lbs.
38 Glide vehicle component; Rene 41, 3 lbs.
39 Beryllium guidance main shaft; 9 lbs.
40 Launch vehicle domes; capability to 160".

To call the roll of America's space efforts—in missiles, satellites, launch vehicles and spacecraft—is virtually to name the projects which rely on Wyman-Gordon forgings.

Specialization has made it so. For this is the one source whose pioneering in the sophisticated metal-forming requirements of flight dates from the dawn of our air age.

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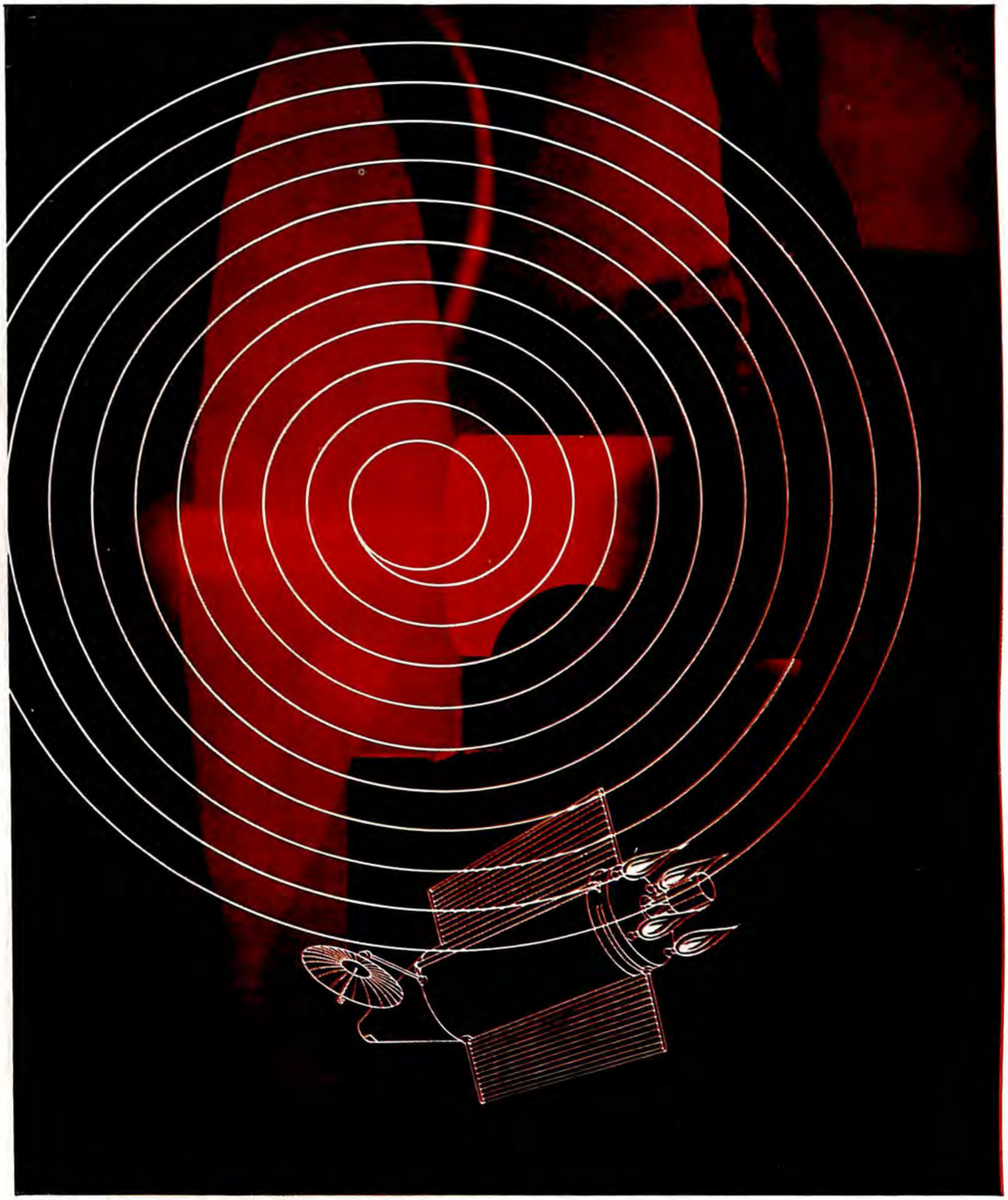

Propelling a satellite by electric power. Development of the electric arc jet as a propulsion engine for satellites in space moves ahead at Avco. Most recent advance: a radically new uncooled engine which dissipates 10,000° F. temperature by radiation alone. Performance in specific impulse and thrust is strikingly improved. Simplified design greatly increases reliability. Continuous operation for one hundred hours under simulated space conditions has been achieved at Avco's Research and Advanced Development Division.

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FOREWORD

THE 1961 aerospace year was highlighted by significant achievements on a broad front in space exploration and delivery of advanced, high-performance weapons systems to the military establishment.

While the most spectacular space accomplishment fell to the Soviet Union in the launching of two manned orbital flights, U. S. space efforts continued to score remarkable progress in all technological areas. U. S. astronauts were successfully launched in sub-orbital flights in May and June, and at the year's end a third American astronaut was poised for the nation's first manned orbital effort. Persistent space exploration in such areas as communications, meteorology, surveillance and detection paid unprecedented dividends. A start was made on the program which ultimately will send Americans to the moon and back; two missile detection satellites were successfully launched, and the dream of global weather prediction came closer to realization.

The U. S. successfully orbited 39 satellites during the year and the results promised more rapid advances in a sophisticated and comprehensive program of exploration than had previously been hoped. Meanwhile, the Soviet Union orbited six vehicles. At the year's end, there were 40 satellites in earth or interplanetary orbit and 37 of them were American.

Accomplishments of Government and industry in the intercontinental ballistic missiles field during the year were of signal importance to the national defense effort. ICBM weapons which eight years ago existed only on paper and only three years ago were labeled as "impossible" of achievement within assigned target dates were, during the year, placed in operational readiness at hardened sites. The depth and mobility provided the deterrent force by water-based ICBM's was expanded still further and more advanced, highly-reliable ground-based missiles were scheduled for early operational use.

The manned aircraft phase of the program moved forward swiftly with establishment of speed, payload and distance records.

Commercially, U. S. airlines increased their transition to turbine-powered transports, thus improving still further their international competitive situation and ultimate transport potential.

General aviation, that which is neither military nor airline, continued its remarkable expansion in usage and efficiency, as American business, industry and agriculture found new and rewarding uses for privately-operated utility and executive aircraft. General aviation continued to be the largest user of the nation's airspace, and of its air communication and air navigation facilities.

The year also marked the evolution of the turbine-powered helicopter from the experimental to the operational stage. While the major users of the rotary-wing aircraft continued to be the military services, the number of commercial users increased by more than one-third during the year, and the list of uses for the highly versatile machines continued to grow.

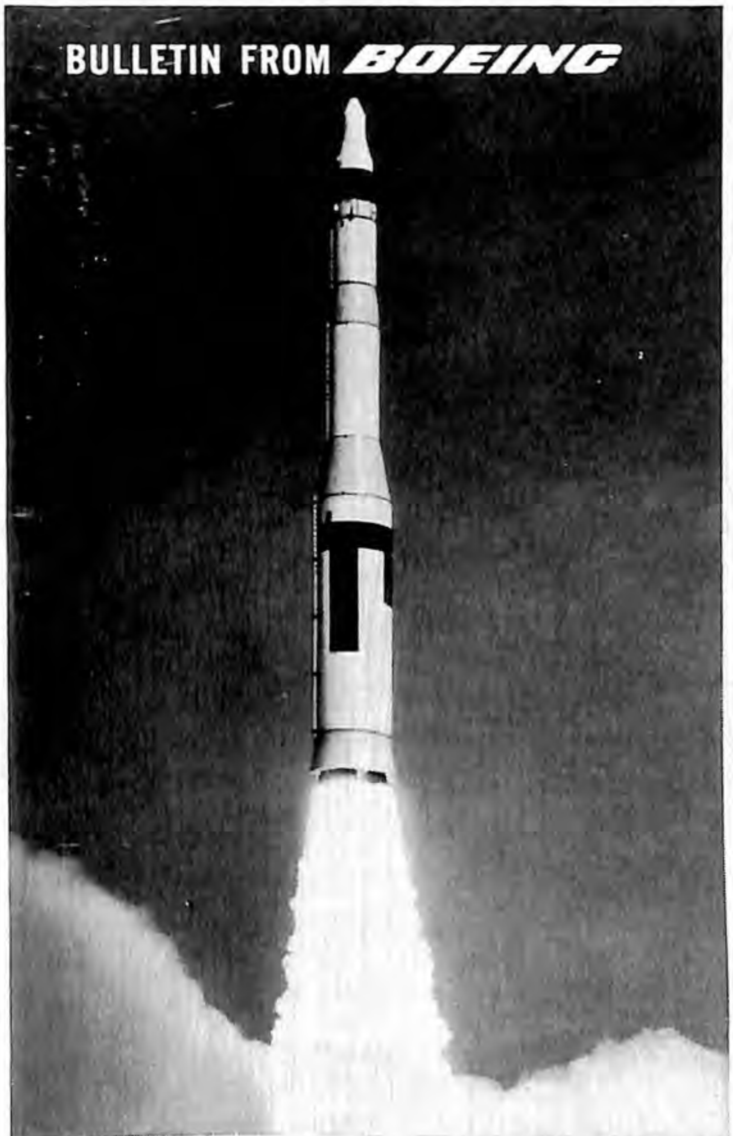
The Federal Aviation Agency fitted the nation's long-range aviation objectives into focus with a study which established a series of national goals for the remainder of the decade, and specific recommendations on how to achieve them. Formal approval was granted the FAA to inaugurate a five-year plan to improve dramatically the nation's air traffic control system.

The gratifying and broadly-based technical progress made in all aerospace areas during the past year is once again recorded in this 43rd annual edition of the Aerospace Year Book. ■

Orval R. Cook

President
Aerospace Industries Association

DEPTH MANAGEMENT FOR PROGRESS IN AEROSPACE ELECTRONICS COMMUNICATIONS AND CONSUMER PRODUCTS



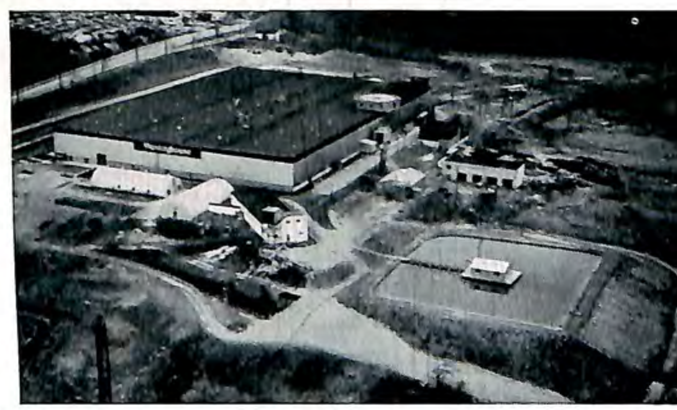
MINUTEMAN. The U. S. Air Force's first solid-fuel ICBM, shown above in flight, is one of Boeing's major programs in missile and space field, along with Supersonic Bomarc area-defense missile and the Saturn S-1B rocket booster. Boeing is weapon-system integrator on Minuteman. Saturn S-1B is the first stage of a giant three-stage launching vehicle that will be used for space probes. Boeing will develop, construct and test S-1B booster stage for National Aeronautics and Space Administration.

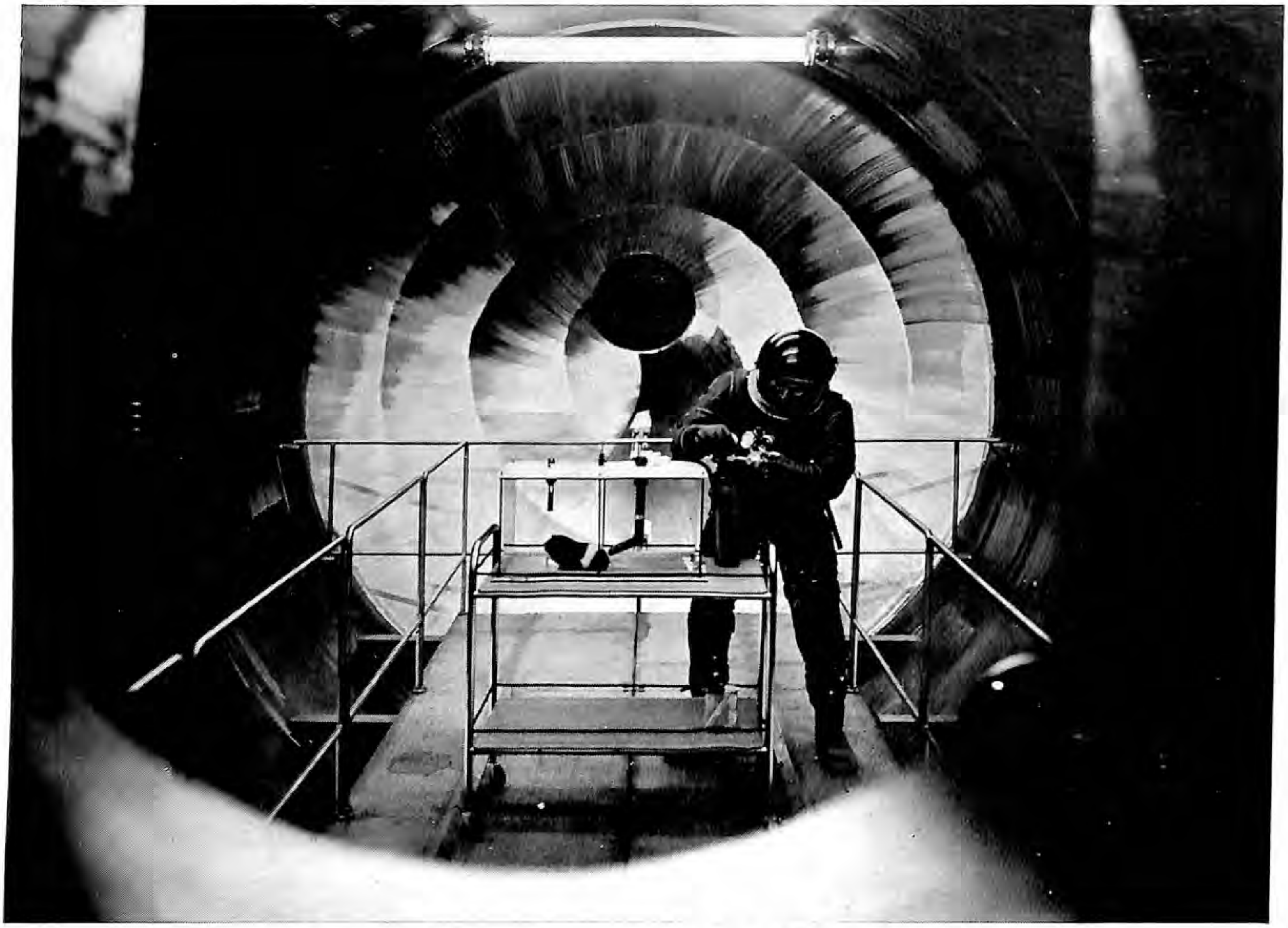
SPACE GLIDER. Drawing of Dyna-Soar space glider, which will combine extreme speed of a ballistic missile with controlled and accurate flight of a manned aircraft. Designed to be rocketed into space, where it could travel at speeds approaching 18,000 mph, Dyna-Soar will be able to re-enter earth's atmosphere and make conventional pilot-controlled landing. Boeing is system contractor for Dyna-Soar, now being developed by U. S. Air Force with cooperation of National Aeronautics and Space Administration.

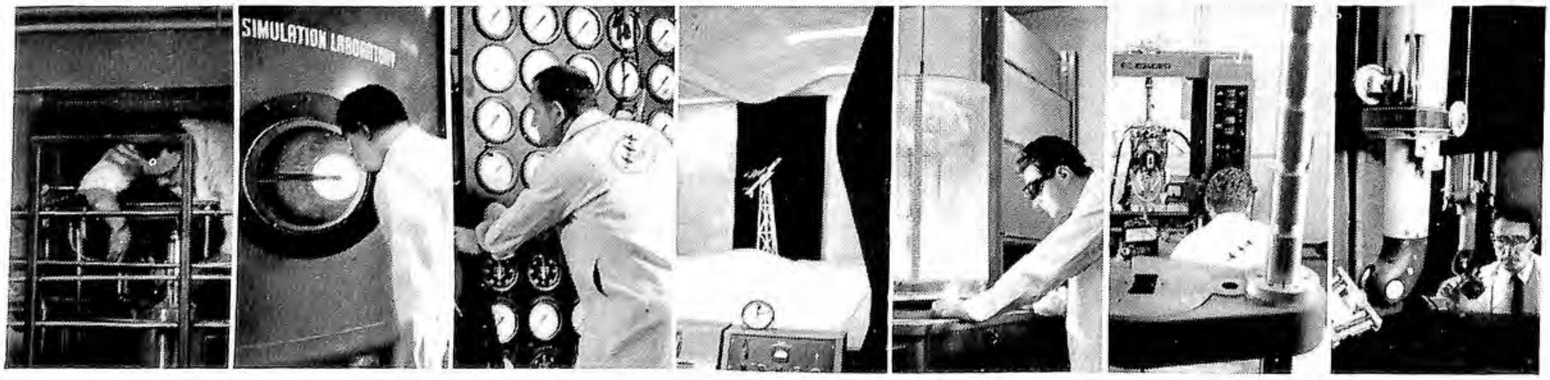
FLYING COUSINS. Boeing 707 and 720 jetliners fly long-range and intermediate-range air routes. This transportation network is completed by helicopters built by Boeing's Vertol Division, which link major terminals with local airports and center-city heliports. Vertol helicopters have been ordered for service in Japan, Canada and Sweden.

THREE-ENGINE JET. Scale model of America's first short-range jetliner, the Boeing 727. Already, 117 Boeing 727s have been ordered by American, Eastern, Lufthansa and United airlines for delivery beginning late in 1963.


Westinghouse







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AEROSPACE EVENTS

A pictorial display of the highlights of aerospace progress during the calendar year 1961, including new aircraft, missiles and engines, space achievements, awards, records and personalities in the news.

RECORDS

The major records of 1961 are detailed herein; for a complete listing of all 1961 records, see page 472.

X-15 MARKS

The North American X-15 special research plane continued to set new unofficial speed and altitude records in a highly successful test program. During the year, Major Robert M. White, USAF, (top) set a speed mark of 4,093 miles per hour and Joe Walker, civilian pilot with the National Aeronautics and Space Administration (bottom), climbed to a new altitude record of 217,000 feet.

HUSTLER SERIES

The Air Force's supersonic bomber, the B-58, built by General Dynamics/Fort Worth, set nine world speed and payload records during the year. The records consisted of 1,000 and 2,000 kilometer flights with varying payloads for a total of six records, a Washington-Paris record of three hours 39 minutes (average speed 1,048 mph) and a New York-Paris run in three hours 19 minutes (average speed 1,089 mph). The ninth record, which won the Bleriot Trophy, was a 1,073 kilometer flight in 30 minutes and 43 seconds at an average speed of 1,320 mph.

F4H WORLD SPEED RECORD

On November 22, Colonel Robert B. Robinson, USMC (right) flew a McDonnell F4H Phantom II at 1,606.342 miles per hour to claim a new official world speed record. The flight was made at an altitude of 45,000 feet over Edwards AFB, Calif., and was officially timed by the National Aeronautic Association. Later, another Phantom II, piloted by Commander George W. Ellis, USN, set a new world altitude record for sustained horizontal flight of 66,443 feet. The F4H set a number of class records during the year.

WOMEN'S RECORDS

Over a seven week span, August to October, noted aviatrix Jacqueline Cochran broke every established speed, altitude and distance world record for women. Flying a Northrop T-38 Talon jet trainer, Miss Cochran set speed marks for 15 kilometers (844.2 mph), 100 kilometers, closed course (784.3 mph), 500 kilometers, closed course (680.8 mph) and 1,000 kilometers, closed course (640.3 mph). In addition, she added distance records of 1,346.3 miles (closed course, jet) and 1,492.3 miles (straight line, jet). She wound up her record series with two altitude marks: peak altitude, 56,071.3 feet; sustained altitude, 55,253 feet.

NEW MARK FOR CONRAD

Perennial record smasher Max Conrad added a new mark to his long list of lightplane records in 1961, when he flew a twin-engine Piper Aztec around the world in eight days, 18 hours and 36 minutes, February 27-March 8. The flight, which started and ended at Miami, covered 25,946.3 miles. In photo at left, Conrad (right) is greeted on return by William T. Piper, president of Piper Aircraft Corp., while observer Dick Jennings looks on.

CLASS RECORDS FOR 47 SERIES

The Bell commercial 47 series helicopters set eight world records during 1961. Dr. Dora Dougherty set feminine records for altitude without payload for all rotorplanes (19,385.79 feet) and distance in straight line without payload (405.83) in a Bell 47G-3. Pilot Lou Hartwig set four class records for helicopters in the 1,102-2,204 pound category: 100, 500 and 1,000 kilometer speed records and distance in closed circuit. Hartwig flew the 47G on three flights and the 47J-2 on the fourth. Also flying the 47J-2, pilot Al Averill set a 100 kilometer speed record for heavier 'copters in the 2,204-3,858 pound bracket. At left, pilots Hartwig, Dougherty and Averill, all of Bell Helicopter Company.

TRIPLE RECORD FOR HSS-2

Captain Bruce K. Lloyd, USN (left) and Commander D. J. Roulstone pose with the Sikorsky HSS-2 helicopter in which they set three world helicopter speed records on December 1. The records, all closed course, were: 182.8 mph for 100 kilometers, 179.5 for 500 kilometers, 175.3 for 1,000 kilometers. Earlier in the year, the HSS-2 had set a three kilometer record of 192.9 mph.

AWARDS

Although space does not permit inclusion of all who were honored for their achievements in 1961, some of the major award winners are pictured on these pages.

COLLIER TROPHY

The Robert J. Collier Trophy was presented on June 15 to Vice Admiral William F. Raborn, Jr., for his direction of the highly successful Polaris fleet ballistic missile program. The trophy, presented in 1961 for the 50th time, was awarded for "the greatest achievement in aeronautics or astronautics in America, with respect to improving the performance, efficiency or safety of air or space vehicles, the value of which has been thoroughly demonstrated by actual use during the preceding year." The National Aeronautic Association is trophy custodian.

WRIGHT BROTHERS MEMORIAL TROPHY

Senator A. S. "Mike" Monroney (D., Okla.), long time champion of aviation, received the 1961 Wright Brothers Memorial Trophy for his significant contributions to aviation over a 22-year period. Monroney, author of the Federal Aviation Act, is chairman of the Senate Aviation Subcommittee. Presentation was made at the Aero Club of Washington's Wright Memorial Dinner on December 18. In photo above, Monroney (left) accepts the award from Jacqueline Cochran, president of the National Aeronautic Association, sponsor of the trophy, and Edward W. Virgin, president of the Aero Club.

AMERICAN ROCKET SOCIETY AWARDS

The American Rocket Society Research Award "to an engineer or scientist conducting outstanding individual research" went to Dr. James A. Van Allen of the State University of Iowa. Dr. Van Allen (left) is credited with the discovery of the radiation belts named in his honor.

The Society's Robert H. Goddard Memorial Award for contributions to rocketry and astronautics was presented to Dr. Wernher von Braun, director of the National Aeronautics and Space Administration's Space Flight Center.

FAIRCHILD TROPHY

The Arnold Air Society awarded the 1961 Fairchild Trophy to Northrop Corporation for its design, development and production of the T-38 Talon supersonic trainer and for other distinguished contributions to the national defense effort. Thomas V. Jones, Northrop president, accepted the trophy and plaque. Presentation was made at the Society's annual meeting at Detroit on March 24.

H. H. ARNOLD TROPHY

The Air Force Association's H. H. Arnold Trophy as air power's "Man of the Year" went to Lyle S. Garlock, former assistant secretary of the Air Force for financial management. Garlock had held a number of fiscal assignments in the Department of Defense since 1948.

HAWKS AWARD

Vice Admiral Robert M. Pirie, Deputy Chief of Naval Operations (Air), received the Frank M. Hawks Memorial Award on December 7 for his leadership in naval aviation. The award is sponsored by New York Air Service Post 501 of the American Legion.

ASTRONAUT CITATION

The first U.S. space man, astronaut Alan B. Shepard, Jr., received the Distinguished Service Medal for "an outstanding contribution to the advancement of human knowledge of space technology and a demonstration of man's capabilities in suborbital space flight." The citation was presented by NASA Administrator James E. Webb and Deputy Administrator Dr. Hugh L. Dryden.

CHANUTE-CABOT-HARMON AWARDS

The pilots of the North American X-15 research aircraft figured prominently in 1961 awards. Above, left to right, are Joseph A. Walker of the National Aeronautics and Space Administration, Major Robert M. White of the U. S. Air Force, and Scott Crossfield of North American Aviation. The three were jointly named as 1961 recipients of the Harmon International Aviator's Trophy for outstanding flying accomplishments. Walker was also presented the Octave Chanute Award of the Institute of the Aerospace Sciences for "experimental flight testing and engineering contributions to high speed flight research programs, including the X-1 through the X-15." Crossfield, first pilot of the X-15, received the Aero Club of New England's Godfrey Lowell Cabot Award for the outstanding contribution to aviation in 1960.

KOSSLER AWARD

Above, Ralph Alex, awards chairman of the American Helicopter Society, presents the Captain William J. Kossler Award to representatives of the Army's 56th Medical Platoon (Air Ambulance, Fort Bragg, N.C.) and 57th Medical Platoon (Air Ambulance, Fort Meade, Md.) "for participation in rescue operations in the earthquake stricken region of Southern Chile in May and June of 1960." Accepting the awards are Capt. John Temperilli (57th Platoon) at left and Capt. Donald T. M. Wall (56th Platoon).

KLEMIN AWARD

The Dr. Alexander Klemin Award of the American Helicopter Society went to Leon L. Douglas, vice president-engineering, Vertol Division of Boeing Airplane Co., "for numerous and important contributions to the development of the tandem rotor helicopter and other VTOL aircraft." In photo, Ralph Alex of AHS presents the award to Douglas.

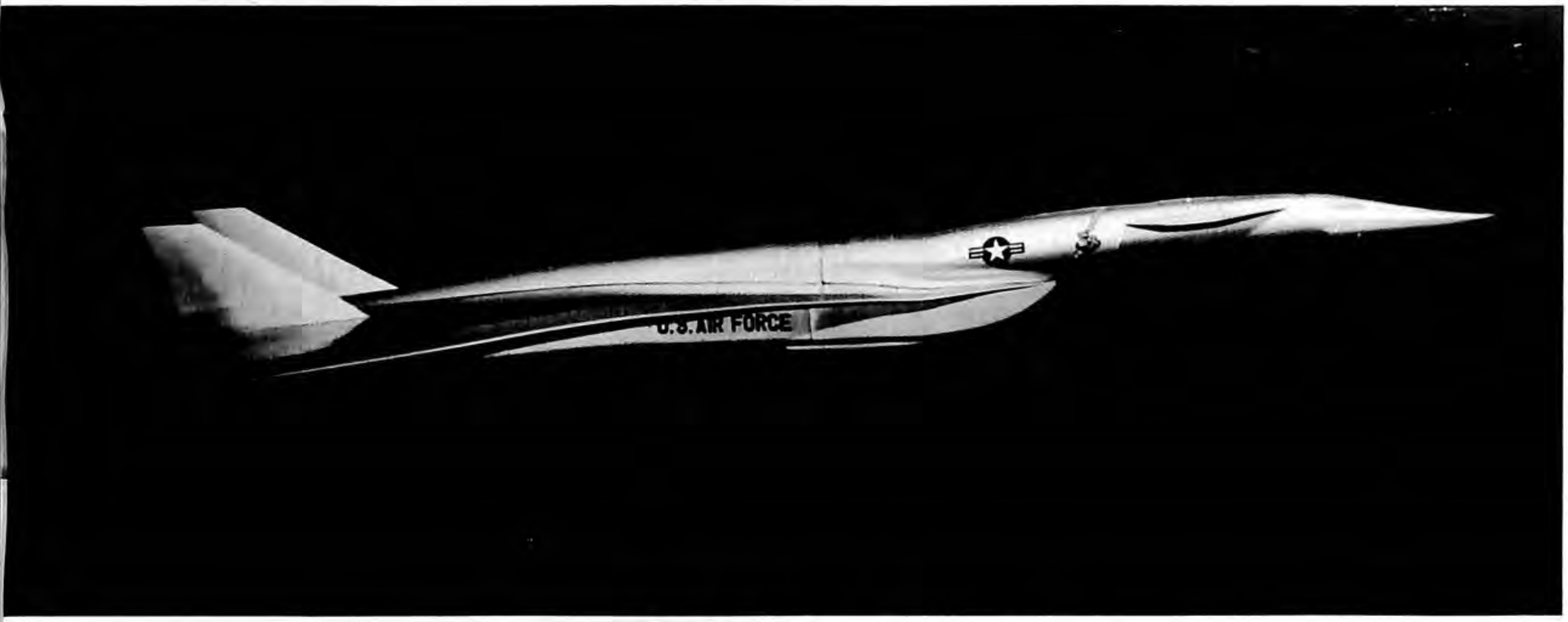
FREDERICK L. FEINBERG AWARD AND CARNEGIE MEDAL

For a series of six trips to the 18,000 foot level of Mt. McKinley, during which he rescued two mountain climbers with his Hiller 12E helicopter, Link Luckett received both the Frederick L. Feinberg Award and the Andrew Carnegie Silver Medal for heroism. The awards were presented at the American Helicopter Society Forum in May.

NEW PLANES

CONVAIR 990

The latest in the U.S. family of jet transports, the Convair 990 made its first flight in 1961. The 990, powered by General Electric aft-fan engines, was expected to go into service with American Airlines in the spring of 1962.

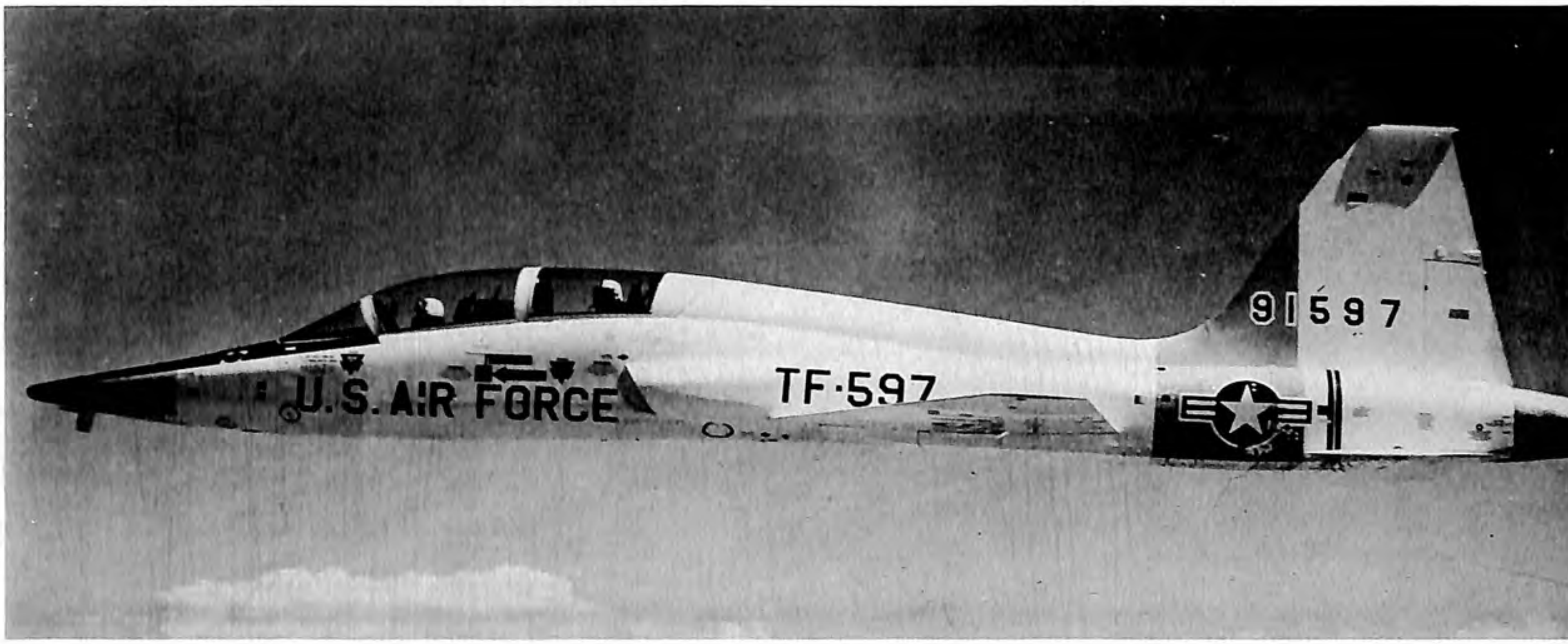


NORTH AMERICAN B-70 VALKYRIE

Work progressed during the year on the North American B-70, the Air Force's super bomber. Powered by six General Electric J93 engines, the B-70 will fly at 2,000 miles per hour-plus and will be capable of operating at altitudes up to 70,000 feet.

LOCKHEED C-141

Selected as tomorrow's logistic support aircraft for the U. S. Air Force was the Lockheed C-141, in early development status at year-end. Powered by four Pratt & Whitney TF33-P-7 turbofan engines, each developing 21,000 pounds thrust, the C-141 will gross 315,000 pounds and cruise at 550 miles per hour.



NORTHROP T-38 TALON

The first aircraft designed as a supersonic trainer, the Northrop T-38 Talon went into operational service with the Air Force in the spring of 1961. The T-38 is powered by two General Electric J85-5 afterburning turbojets.

BOEING 727

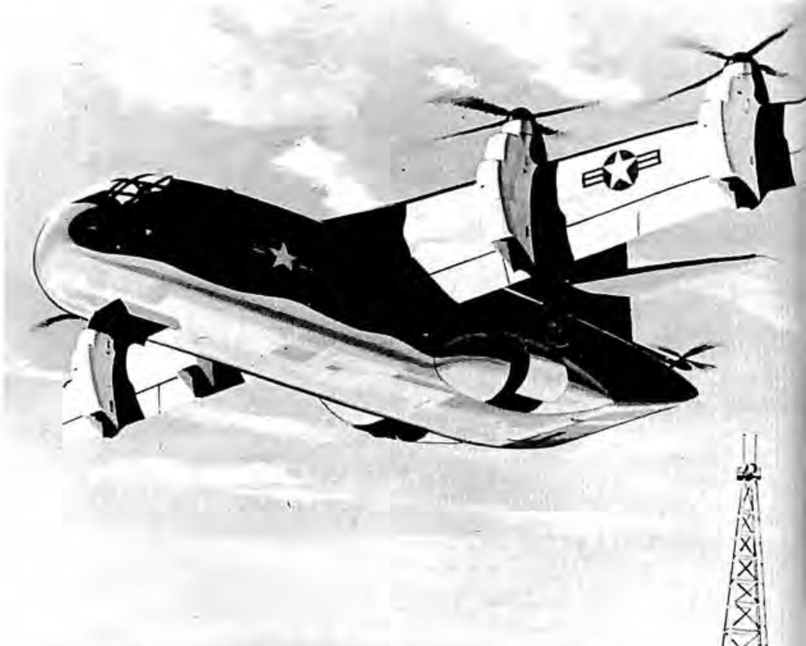
Development continued on the Boeing 727, 70-114 passenger short range airline transport. In 1961, American Airlines ordered 25 of the three-engine jets for delivery in 1964-65. Eastern and United Air Lines had previously placed orders.

BEECHCRAFT MODEL 23

A new addition to the Beechcraft line is the Model 23 Musketeer, a single-engine business plane. The four-place plane weighs 2,300 pounds gross. First production deliveries were scheduled for the fall of 1962.

LOCKHEED 330

Lockheed-Georgia Co. received a contract for a research aircraft to test the jet ejector augmentation principle for VTOL aircraft. Designated Model 330, it is a mid-wing monoplane powered by two turbojets of 3,000 pounds thrust each. It is 32 feet long, spans 25 feet, has VTOL capability and converts to forward flight speeds of more than 500 miles per hour.



VOUGHT-HILLER-RYAN VHR-447

Winner of a tri-service competition for a VTOL aircraft is the VHR-447 design, featuring a tilting wing and turbine power. Five prototypes will be built for USAF, Army and Navy evaluation.

AERO COMMANDER 1121

Aero Commander, Inc., came out with a new executive jet transport, the 1121. The six-place jet, powered by two rear-mounted General Electric CJ610 engines, cruises at more than 500 miles per hour at 35,000 feet. It has a maximum design weight of 14,000 pounds.

CESSNA 310G

Latest member of the Cessna family is the 310G, a light twin grossing 4,990 pounds. It cruises at 223 miles per hour and has a range of 780 miles. Power plants are six-cylinder Continental 10-470-D engines.

BOEING-VERTOL HC-1B CHINOOK

Boeing-Vertol completed first flights of the HC-1B Chinook, a twin-turbine helicopter to be used by the Army as a tactical transport vehicle. It can carry 33 troops at 150 miles per hour.

SIKORSKY HSS-2

The Navy's twin-turbine helicopter, the Sikorsky HSS-2, completed its sea trials and became operational in 1961. It is shown here on the deck of the aircraft carrier USS Lake Champlain.

BELL YHU-1D

The latest model in Bell Helicopter Company's Iroquois series, the YHU-1D, made its first flight on August 16. The 'copter can carry 12 fully-equipped battle troops.

HILLER TEN99

First flights of the Hiller Ten99 were made during the year. A six-place, all purpose helicopter aimed at both civilian and military markets, Ten99 features clamshell doors and payloads of more than 1,000 pounds.

SIKORSKY S-61L

First twin-turbine helicopter to be certificated for passenger service was Sikorsky's S-61L. Above, FAA Administrator Najeeb E. Halaby presents certification papers to Lee S. Johnson, Sikorsky general manager. In center is Fred W. Milam, vice president of Los Angeles Airways, which was to inaugurate passenger service with the S-61L in December.

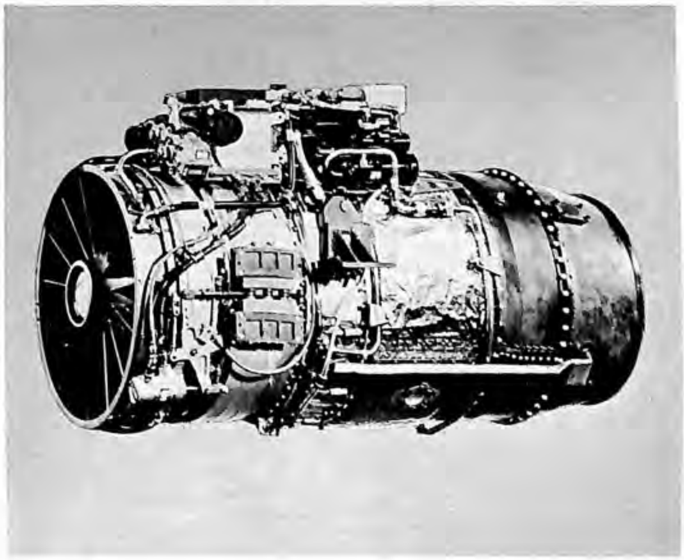
NEW ENGINES

PRATT & WHITNEY TURBOFAN

Above, technicians ready the Pratt & Whitney JT8D turbofan engine for its initial test stand runs in June. Later in the year, the engine was tested in a flying test bed. The JT8D, which will power Boeing's three-engine 727, weighs 2,994 pounds and develops 14,000 pounds thrust.

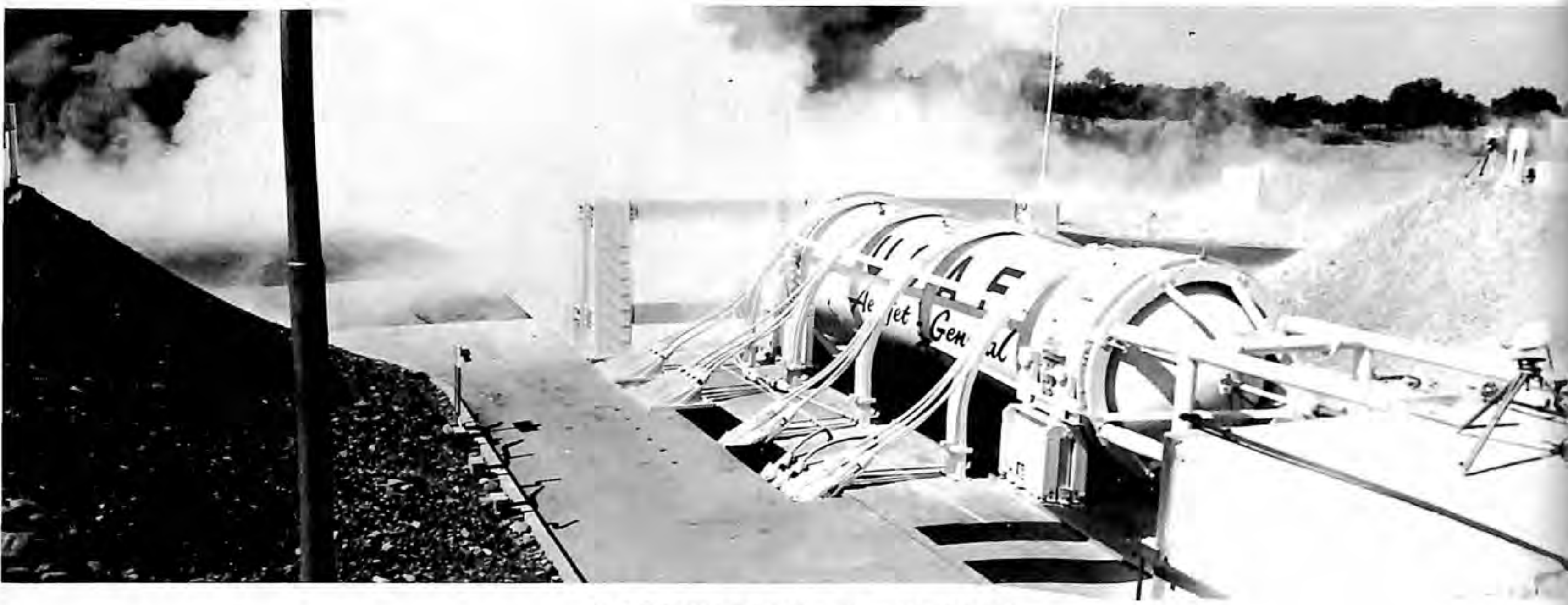
REPUBLIC PINCH PLASMA ENGINE

Republic Aviation Corp. successfully tested a new pinch plasma engine designed for satellite control and guidance and for interplanetary propulsion. The fuel (readily available inert gases) becomes ionized after injection into the engine and the resultant plasma is electromagnetically accelerated and exhausted out the nozzle at extremely high velocities. Above, a Republic technician makes final instrumentation adjustment prior to a test run.



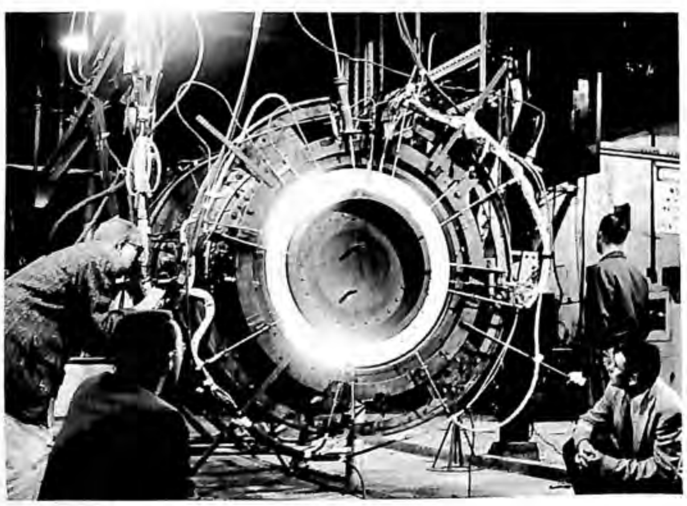
GE VERTICAL LIFT ENGINE

General Electric a new version of the J85 turbojet, the SJ132, designed for VTOL applications. With a 10.3 to 1 thrust to weight ratio, the SJ132 produces 3,050 pounds thrust. An advanced version, SJ133, was under development.



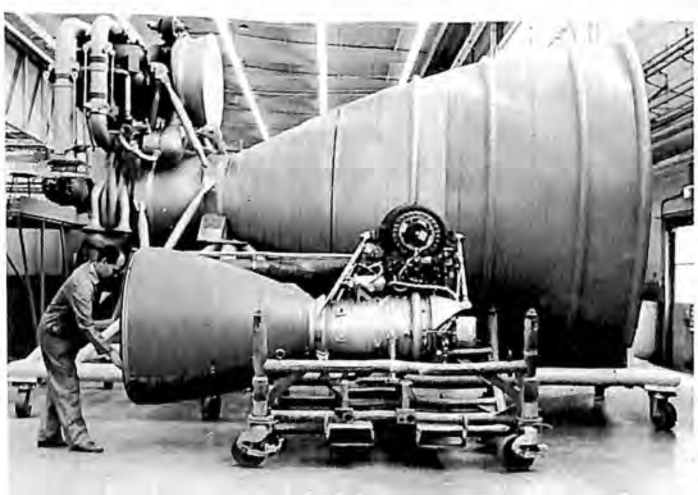
AEROJET-GENERAL SOLID ROCKET

On August 26, Aerojet-General successfully tested its huge solid fuel rocket motor, a milestone in an Air Force program designed to demonstrate that solid rockets can provide thrust in the multi-million pound category. The units operated for 87 seconds and developed 500,000 pounds thrust. The 100-inch diameter, composed of four segments, is 45 feet long and weighs about 80 tons. Aerojet-General at year-end was readying a still larger solid rocket for test.



GENERAL ELECTRIC J93

General Electric's super-powerful (thrust classified) J93 passed its preliminary flight rating test late in the year. Six of the big J93's will power the Air Force's B-70 Mach 3 bomber. In photo above, technicians check out the J93's combustor.

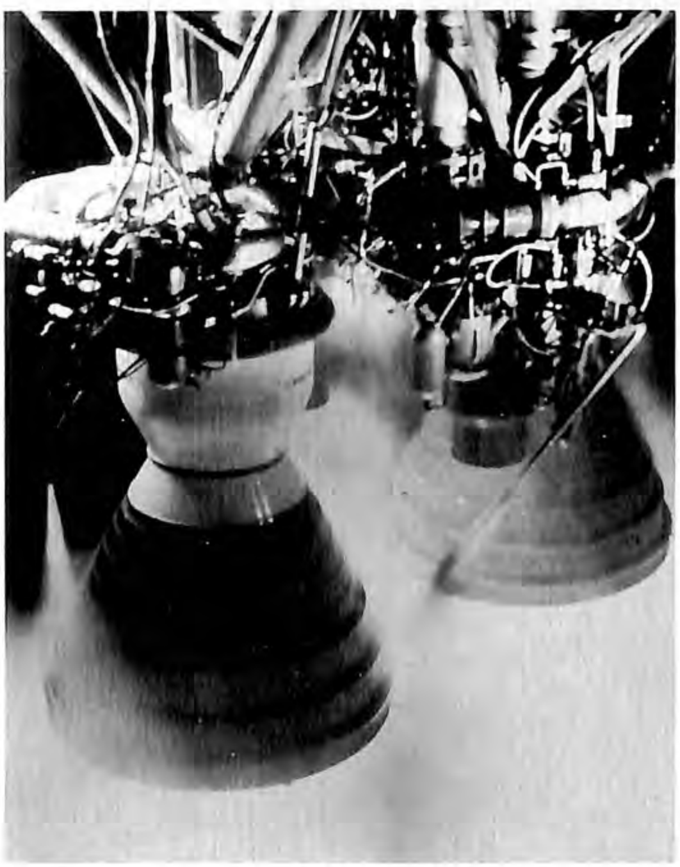


ROCKETDYNE F-1

Rocketdyne's super-booster, the liquid-propellant F-1, underwent a series of test firings in 1961. Designed for 1,500,000 pounds thrust, the F-1 exceeded 1,000,000 pounds output more than 140 times in static firings, and on one test reached 1,640,000 pounds. The F-1, in combinations of two or more, will power the lower stage of advanced Saturn launch vehicles. Photo shows size comparison of F-1 with the Rocketdyne H-1 being developed for the initial version of the Saturn launch vehicle.

UNITED TECHNOLOGY SOLID ROCKET

A huge, four-segmented solid propellant rocket motor, designed and built by United Technology Corp., was successfully test fired late in the year. Being developed for the Air Force, the motor burned for an extended period and produced almost 500,000 pounds thrust. A smaller version of the engine, developing 220,000 pounds of thrust, was tested earlier in the year. UTC was aiming at development of single solid propellant rockets in the multi-million pound thrust class.



AEROJET TITAN II ENGINE

Tested during the year was Aerojet-General's twin-barrel first stage engine for the Titan II missile. The first stage unit, which delivers 430,000 pounds thrust, uses storable propellants, a new combination of Aerozine-50 (fuel) and nitrogen tetroxide. Aerojet was also developing a smaller engine, similar in design, for the Titan II second stage. The latter develops 100,000 pounds thrust.

NEW SYSTEMS

Space limitations preclude pictorial presentation of all the important developments in the field of systems and components. Those reviewed here are representative of developments throughout the industry.

MARTIN BIRDiE

At right, an artist's conception of the BIRDiE Army air defense coordinating system in action. The BIRDiE, developed and produced by Orlando Division, Martin-Marietta, coordinates the firing of guided missile batteries around cities and strategic military installations by processing locally-generated data from its own radar or correlating inputs from external sources, such as SAGE, with such data. The information, displayed on a single console, is relayed to battery commanders to give the missiles maximum effectiveness against air attack.

NORTHROP LAMINAR FLOW CONTROL

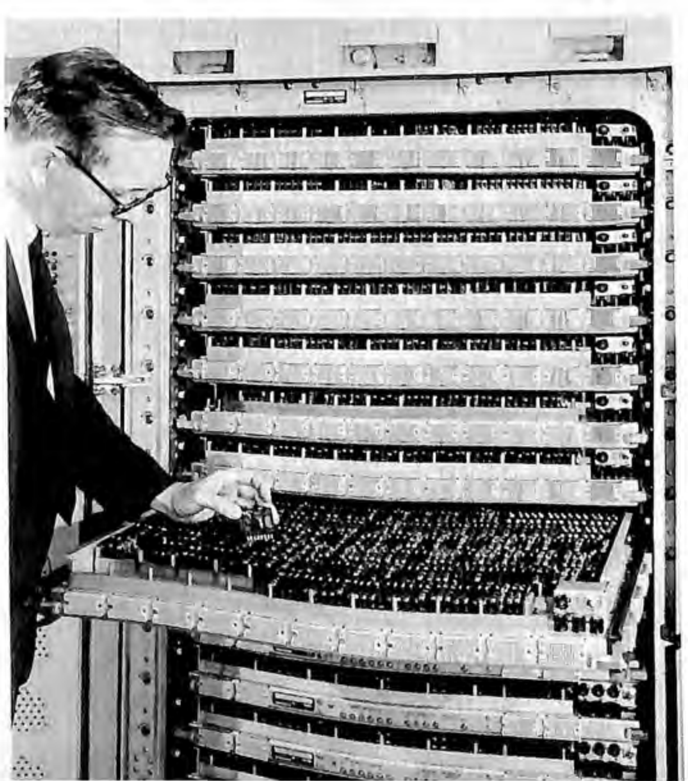
Northrop Corp. developed a Laminar Flow Control system to improve aircraft performance. Photo shows slots in wing and tail surface of a typical subsonic transport. Structures aft of the trailing edge of the wing are suction compressors which suck air from the turbulent boundary layer into very thin slots and exhaust it rearward, smoothing airflow and improving performance.

AVCO SATELLITE RECEPTION SYSTEM

These "black boxes" comprise a new radio receiving system for picking up signals from a space satellite. Developed by the Electronics and Ordnance Division of Avco Corp., the equipment is extremely sensitive and capable of locking exactly in phase with the radio frequencies transmitted by the satellite. The two cabinets house three receivers each. The system will be used in conjunction with NASA's S-45 satellite, which will study the propagation of radio frequencies from the ionosphere.

MARTIN RACEP

An important development in the field of wide band communications systems was RACEP — Random Access and Correlation for Extended Performance — developed by Orlando Division, Martin-Marietta. The equipment is the equivalent of a private radio telephone system which has all the operating characteristics of an ordinary telephone system without the use of wires or switchboard. With RACEP, a subscriber can "dial any other subscriber and talk privately with no interference." RACEP has wide application in air traffic control, commercial communications, emergency disaster communications, commercial or military ship-to-shore communications, or private telephone-type communications via orbital satellite relay.



SPERRY NTDS

Sperry Rand Corp.'s Remington Rand Univac division completed development of NTDS (Naval Technical Data System). The system utilizes a Univac computer and is composed of a series of consoles which display schematic pictures showing targets, their type and movements and offensive postures of friendly ships and aircraft. This permits deployment of a whole task force as easily as a single vessel from the control center in the command ship. Remington Rand Univac received a production contract in 1961.

PEOPLE

JOINT CHIEFS OF STAFF

Changes in the top military command brought about this 1961 composition of the Joint Chiefs of Staff: left to right, Admiral George W. Anderson, Jr., Chief of Naval Operations; General George H. Decker, Chief of Staff, U. S. Army; General Lyman L. Lemnitzer, Chairman, Joint Chiefs of Staff; General Curtis E. LeMay, Chief of Staff, U. S. Air Force; General David M. Shoup, Commandant, U. S. Marine Corps.

AIA CHANGE

At year-end, General Orval R. Cook (left), retired as president of Aerospace Industries Association. He was succeeded by August C. Esenwein (center), formerly executive vice president of General Dynamics/Convair.

NEW NAVY SECRETARY

In December, Fred Korth (right), former president of the Continental National Bank, was appointed Secretary of the Navy. He succeeded John B. Connally, who resigned.

GE PRESIDENT

Gerald L. Phillippe became president of General Electric Company on August 2. Phillippe had been comptroller and principal financial officer of the company since 1953. Cramer W. LaPierre (not shown) was elected executive vice president on the same date.

FAIRCHILD PRESIDENT

E. G. Uhl, former engineering executive with Ryan Aeronautical Co. and The Martin Co., was named president of Fairchild Stratos Corp.

RYAN PRESIDENT

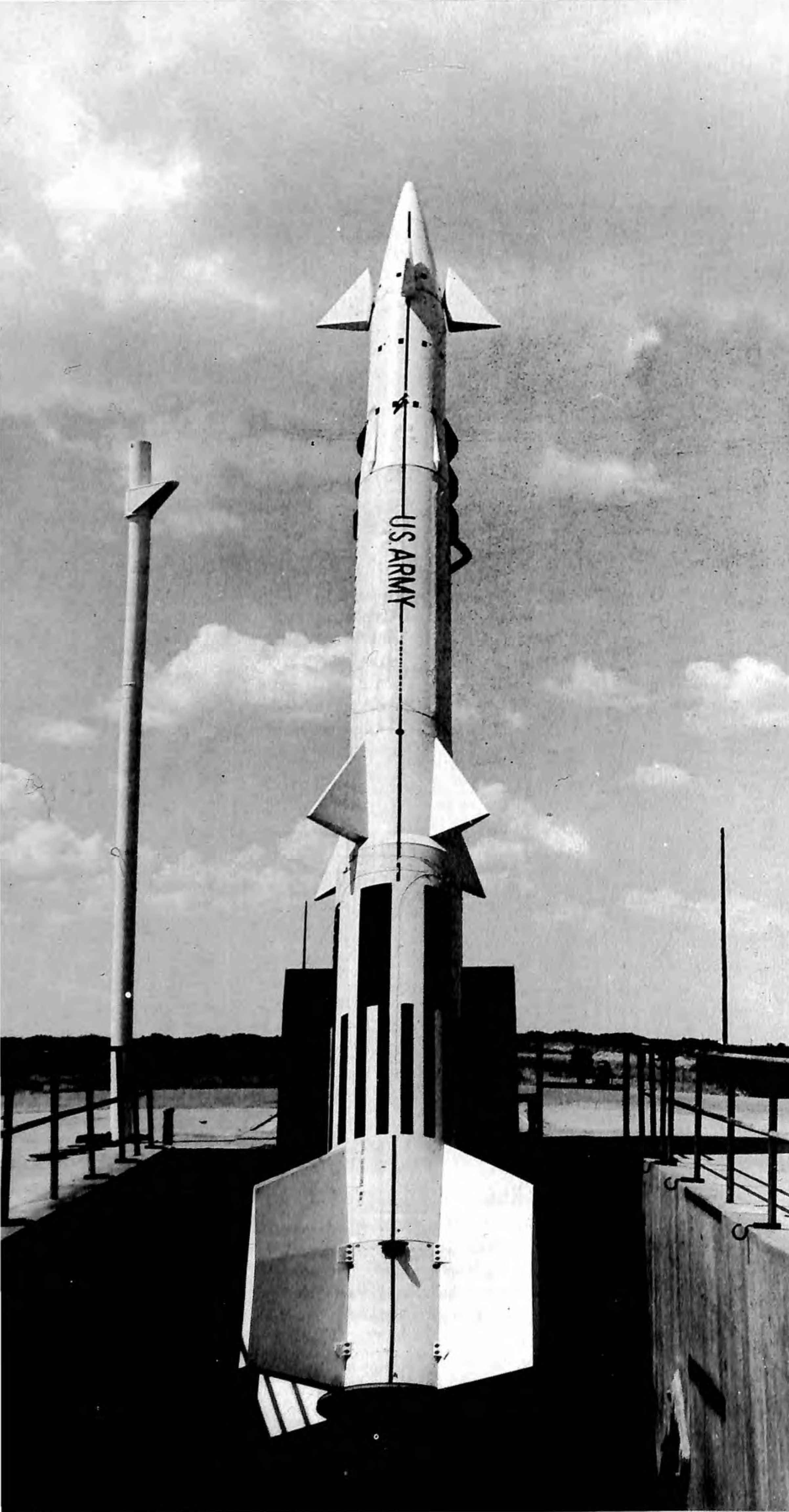
Robert C. Jackson, formerly executive vice president, was elected president of Ryan Aeronautical Co. T. Claude Ryan, who had been president as well as board chairman, continued as chairman and chief executive officer.

IN MEMORIAM

Robert E. Gross, chairman of the board and chairman of the executive committee of Lockheed Aircraft Corp., died on September 3.

LOCKHEED EXECUTIVES

Upon the death of his brother, Courtlandt S. Gross (center), became chairman of the board and chairman of the executive committee of Lockheed. Daniel J. Haughton (right), former executive vice president, was elected president of the company.



MISSILES

NIKE-ZEUS

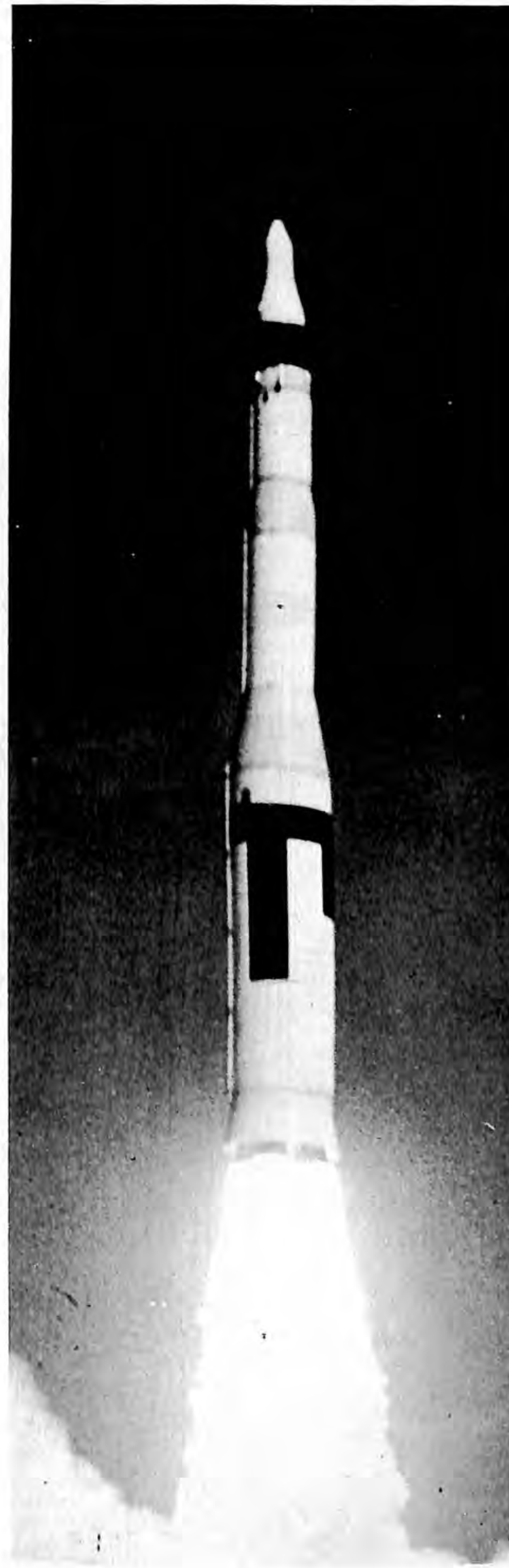
The Army's Nike Zeus anti-missile missile underwent a highly successful series of tests during 1961 at White Sands Missile Range, N.M., where its complementary radar systems were also being tested. Facilities were under construction at Kwajalein Island in the South Pacific for Nike Zeus' advanced test series, in which it will be launched at Atlas ICBM's fired from Vandenberg AFB, Calif.

MINUTEMAN

The Air Force's second generation intercontinental ballistic missile, the Boeing Minuteman, moved into flight test status after a series of "tethered" launches in which the missile was restrained from free flight by nylon ropes. First free flight took place on February 1, 1961, with all three engines operating perfectly. The Minuteman mobility concept, in which the missile would have been launched from freight cars, was canceled during the year.

POLARIS

Lockheed Missiles and Space Company completed production of the 1,200 mile range Polaris A-1 in December and moved into production of the 1,500 mile range A-2 version. Work also proceeded on development of the A-3, a 2,500 mile range Polaris.



QUAIL

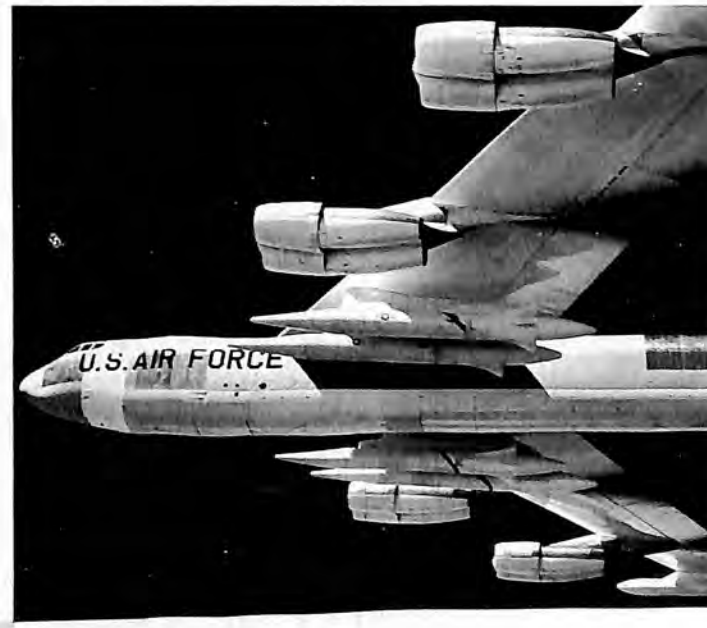
The McDonnell GAM-72 Quail decoy missile, which is powered by a General Electric J85-7 turbojet engine, became operational with Strategic Air Command in the spring of 1961. When launched from a B-52 bomber, the Quail confuses enemy defense systems by producing a "blip" on the radar screen identical to that of the B-52.

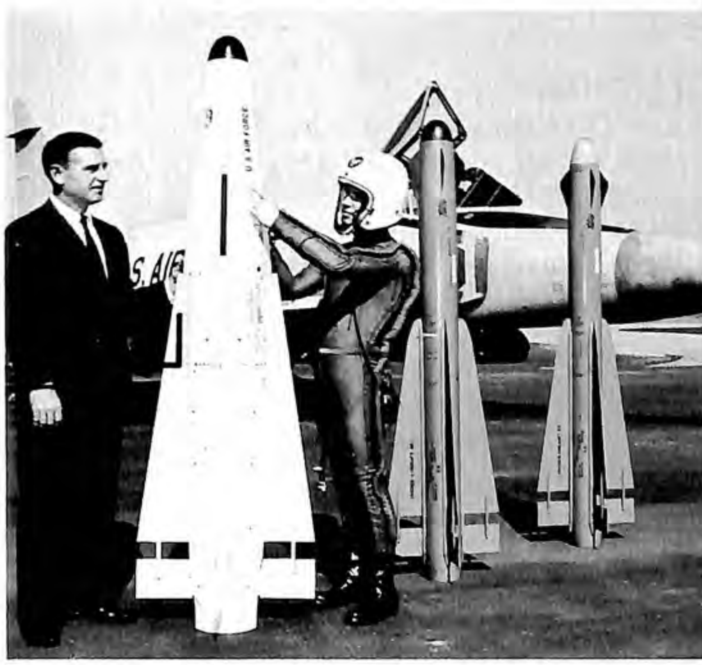
SUBROC

The Department of Defense released this artist's conception, showing for the first time the configuration of Subroc, an underwater-to-air-to-underwater antisubmarine weapon being developed by Goodyear Aircraft Corp. Subroc "provides ranges greatly in excess of present antisubmarine warfare torpedo ranges."

SKYBOLT

A B-52H missile bomber carried four inert Skybolt missiles on a test run. Skybolt, still under development, is a nuclear, long range, hypersonic ballistic missile. Four of the weapons can be carried by a single B-52H. Douglas Aircraft Co. is prime contractor for Skybolt.





FALCON

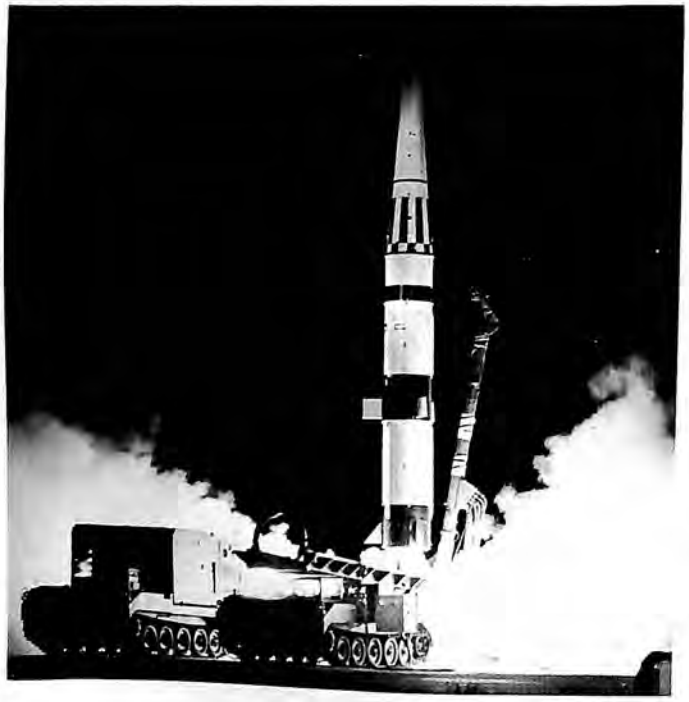
An Air Force pilot inspects the latest member of the Hughes Falcon family, the GAR-11, which has a nuclear Falcon. The GAR-11, which went into production in 1961, is seven feet tall and weighs 200 pounds. It is radar guided.

MAULER

An artist's conception depicts battlefield use of the Mauler weapon system, under development by General Dynamics/Pomona. Each Mauler unit is contained on a self-propelled chassis and is capable of firing missiles while stationary or on the move. The compact weapon system will use solid-fuel, radar-guided missiles to destroy short-range tactical missiles and aircraft in forward battle areas.

BULLPUP B

In advanced development at year-end was the Bullpup B, shown here under the wings of a Navy A4D. Bullpup is a larger, longer-ranging version of the Bullpup missile which has been operational with the Navy since 1959. It is being developed by Martin-Orlando. Also under development is the GAM-83B, an Air Force nuclear-warhead version of Bullpup. It was test fired during the year, using dummy warheads, and a contract for its production was awarded late in the year.



PERSHING

The latest version of the Army's Pershing ballistic missile was flight tested for the first time on April 21. In this photo, elements of the Pershing ground support system are shown being integrated into the flight test program. At left is the tracked prime mover. The two-stage, inertially-guided missile is being fired from its transporter-erector-launcher mounted on another tracked vehicle. Pershing is being developed by Martin-Orlando.

SERGEANT

The Sergeant, an Army battlefield missile produced by Sperry Rand Corp., became operational in 1961. The mobile tactical missile, shown here being readied for a test firing, is capable of hurling a nuclear warhead 85 miles.

ASTRONAUTICS

PROJECT MERCURY

The National Aeronautics and Space Administration's man-in-space program, Project Mercury, scored notable successes in 1961. On May 5, Alan Shepard, Jr., became the first American to enter space. In a Mercury capsule built by McDonnell Aircraft Corp., launched by a Redstone booster, he made a sub-orbital flight which lasted 15 minutes and 22 seconds. He reached a peak altitude of 116.5 miles and the flight took him 303 miles downrange from the Atlantic Missile Range launch site at Cape Canaveral. On July 21, astronaut Virgil Grissom made a similar Redstone-boosted flight, reaching an altitude of 118 miles. Later in the year, NASA made two unmanned Mercury flights using the larger Atlas booster, which will be used for orbital Mercury missions, the second of these carrying a 37½ pound chimpanzee around the earth on a single orbit. At year-end, NASA was readying the Mercury system for the first U.S. manned orbital flight, expected early in 1962. Photos: At left, the historic first U.S. manned launch from Cape Canaveral; right, astronaut Shepard and Mercury capsule aboard USS Lake Champlain after flight.

DISCOVERER

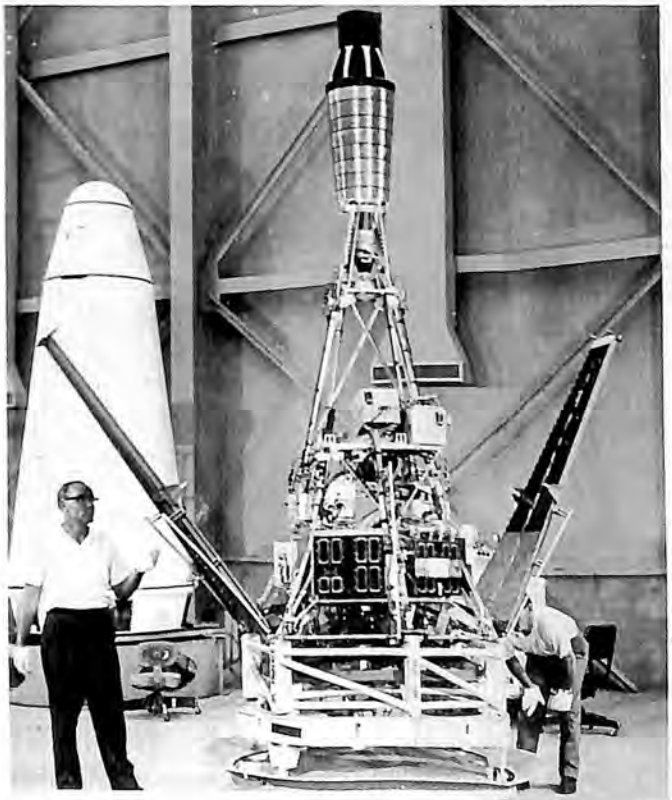
The Air Force's Discoverer program, established to test designs and techniques applicable to future military spacecraft, enjoyed another highly successful year. In 1961, the USAF launched 12 Discoverers (for a total of 36 since the program started in 1959) and on six occasions recovered an instrumented capsule from space, one of the prime objectives of the program. Launch vehicle for the 1961 Discoverers was a Thor-Agena, with the Thor serving as first stage and the Agena B, with 15,000 pounds thrust, serving as both second stage and satellite. The recovery capsule is contained in the nose of Agena. In photo, the Douglas Thor, Lockheed-Bell Agena combination lifts off the launch pad on Discoverer XXIX.

TIROS

During the year, the National Aeronautics and Space Administration launched another of the Tiros series of meteorological satellites, Tiros III, which went into orbit on July 12 and relayed back to earth thousands of excellent cloud cover photographs. Tiros III was more advanced than its predecessors in that it carried two wide-angle TV cameras and an additional infrared experiment. Radio Corp. of America is prime contractor for Tiros, which stands for Television and Infra-Red Observation Satellite. In photo, an RCA engineer inspects the components of Tiros III.

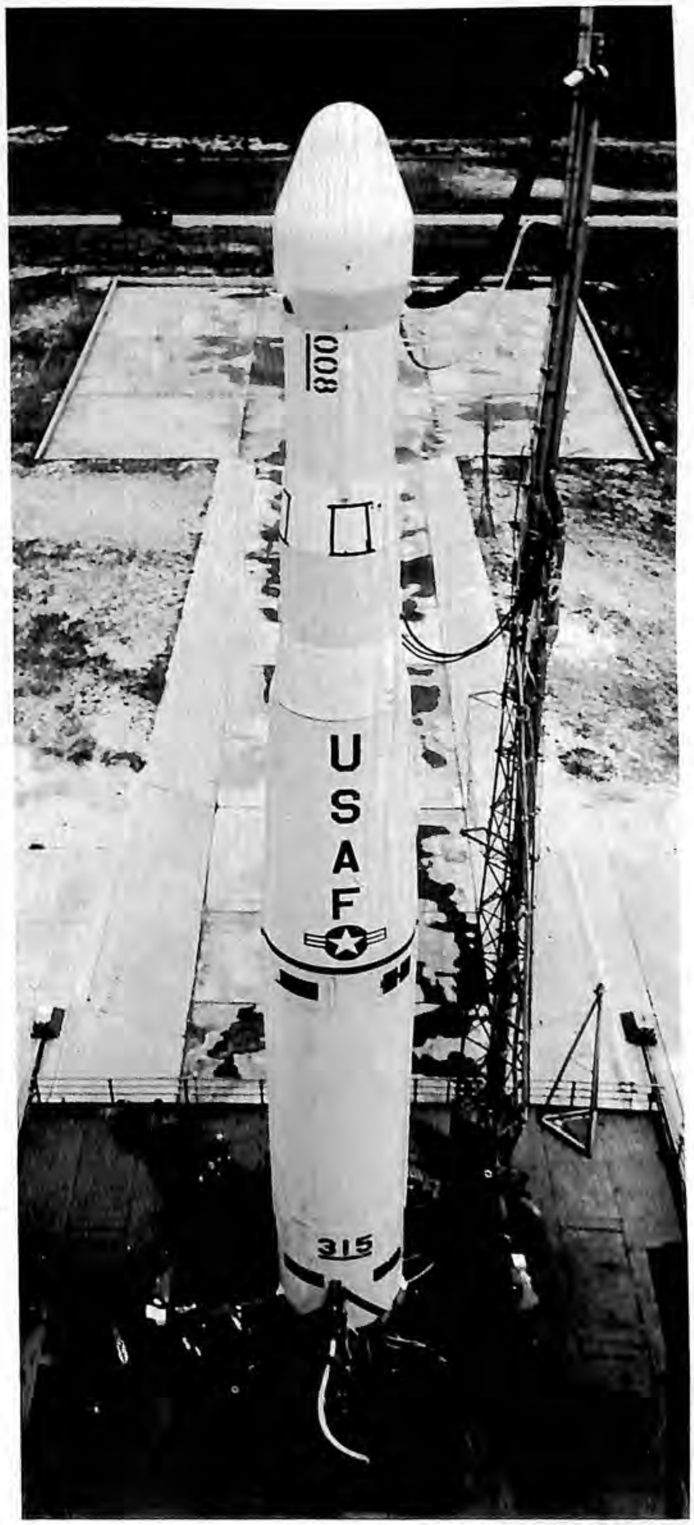
TRANSIT

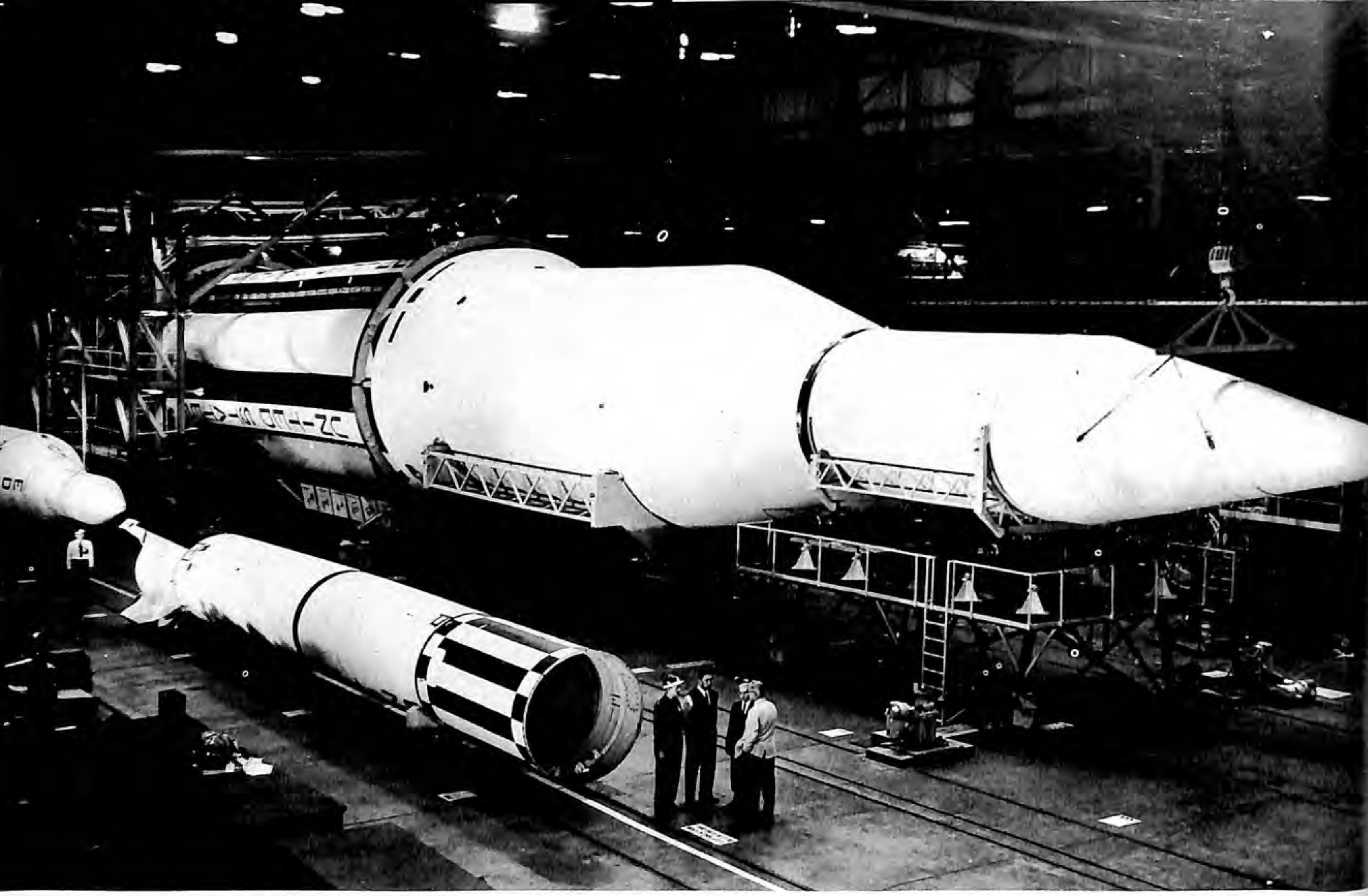
The Navy-directed Transit program, designed to produce an operational navigation satellite for use by submarines, ships and aircraft, scored successes in 1961. Three satellites—Transit IIIB, IVA and IVB—were placed in orbit during the year, each carrying a secondary or tertiary "passenger" satellite. Transit IIIB carried Lofti, a 20-inch sphere designed to measure the intensity of very low frequency signals through the ionosphere. Transit IVA carried two passengers, Injun, a cosmic radiation experiment, and Greb III, an experiment in solar X-ray radiation measurement. Transit IVB's passenger was TRAAC, designed to test the feasibility of spacecraft stabilization utilizing the earth's gravitational field. The Johns Hopkins University serves as prime contractor for the Transit program. Photo shows Transit IVA just prior to launch.



RANGER

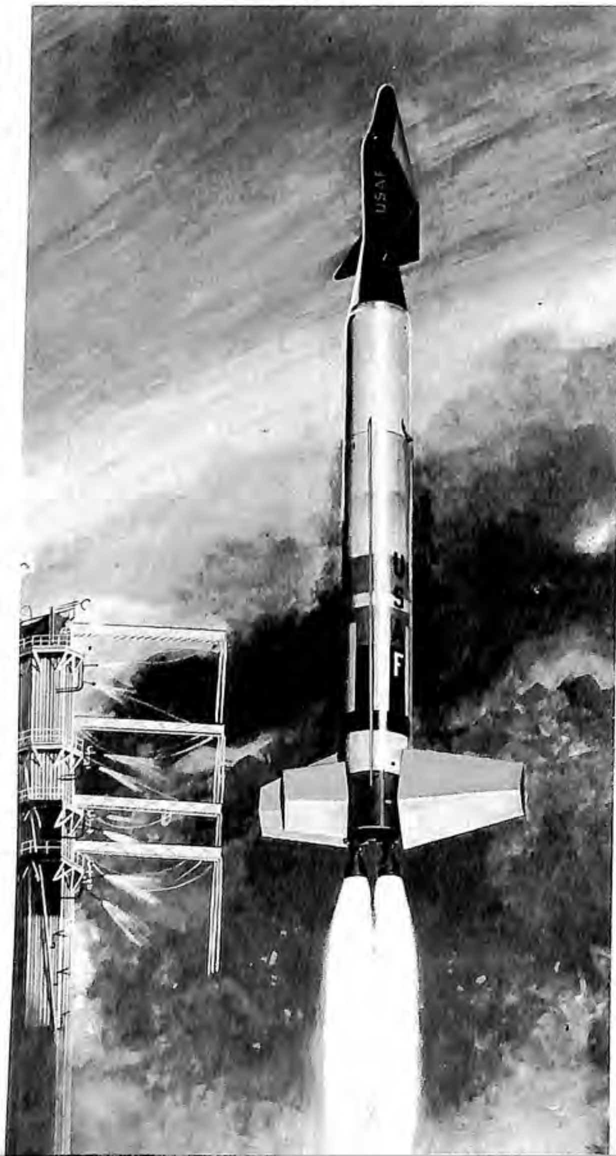
The first of a series of lunar exploration vehicles, Ranger I was launched by an Atlas-Agena vehicle on August 23. Intended only as a test of the spacecraft and not a lunar mission, Ranger and Agena went into a low earth orbit rather than the programmed orbit, but NASA pronounced the test successful. Later versions of Ranger, designed for a "hard" or crash landing on the moon, will contain instrumentation and TV cameras to transmit lunar data prior to the crash. They will also contain a lunar seismometer, designed to survive the impact and transmit data on "moonquakes." Jet Propulsion Laboratory builds the spacecraft, Ford's Aeronutronic Division the lunar capsule. In photo, NASA engineers inspect Ranger I prior to launch.





SATURN

The launch vehicle which will figure prominently in future U.S. space exploration passed its first test on October 27, when the first stage booster of the Saturn C-1 vehicle was successfully test flown. The first stage, 82 feet tall and 22 feet wide, consisted of eight Rocketdyne H-1 engines, each developing 165,000 pounds thrust for a total of 1,300,000 pounds (later versions will produce 1,500,000 pounds). It will be topped by a Douglas S-IV stage 40 feet tall with 70,000 pounds of thrust. Several versions of Saturn, with greater thrusts and payload, figure in NASA's plans.



DYNA-SOAR

In September, the full-scale mock-up of the Dyna-Soar, Air Force boost-glide spacecraft, passed its inspection. Earlier, prime contractor Boeing Airplane Co. had signed contracts with the eight major subcontractors for the glider portion of the spacecraft. Through fiscal 1961, $110,000,000 had been appropriated for development of Dyna-Soar, prototype of future military spacecraft. Scheduled for test in 1964, Dyna-Soar will be boosted by a Titan III launch vehicle utilizing both liquid and solid rocket engines.

MIDAS

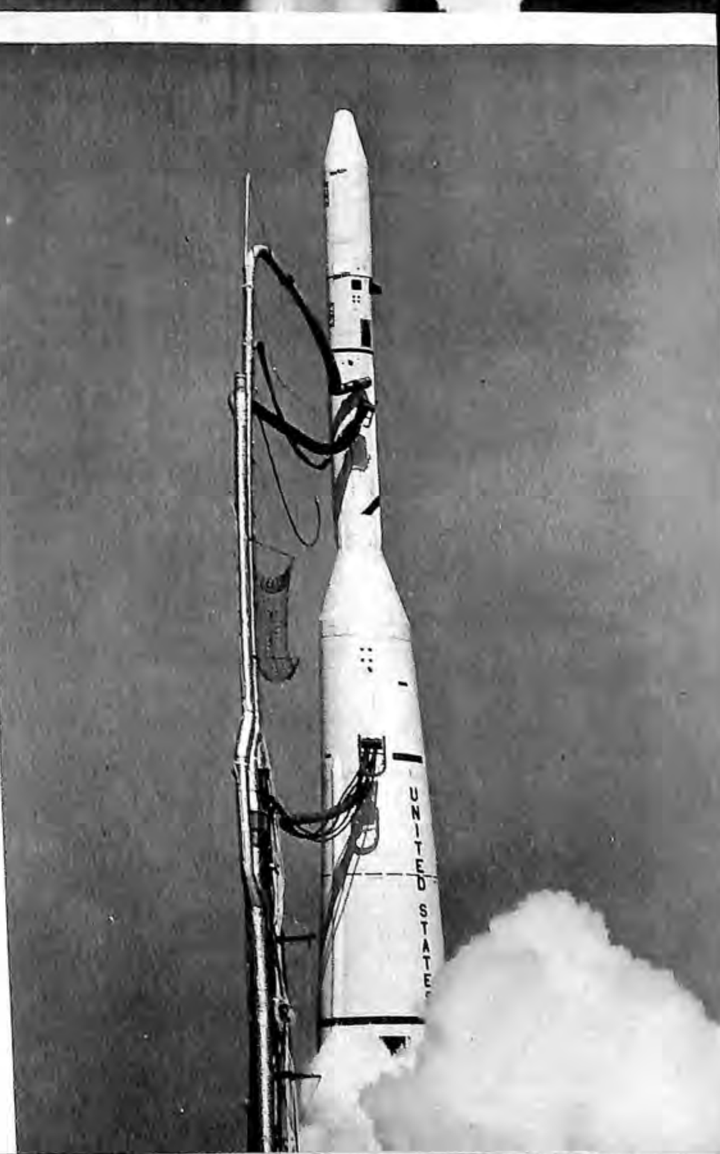
In photo, the Air Force's Midas early warning satellite (Missile Defense Alarm System) soars into space atop the Atlas-Agena launch vehicle. Striped portion, which includes the Agena second stage, is the 22-foot satellite section. The Midas program, for which Lockheed Missiles and Space Co. is prime contractor, calls for orbiting of satellites carrying infrared devices to detect exhaust heat of an intercontinental ballistic missile shortly after launch, providing early warning of attack. In 1961, the USAF launched Midas III (July 12) and Midas IV (October 21) into polar orbits from Point Arguello, Calif. Both were successful; Midas IV detected a Titan missile launch from Cape Canaveral 90 seconds after lift-off on October 26.

SAMOS *(No photo)*

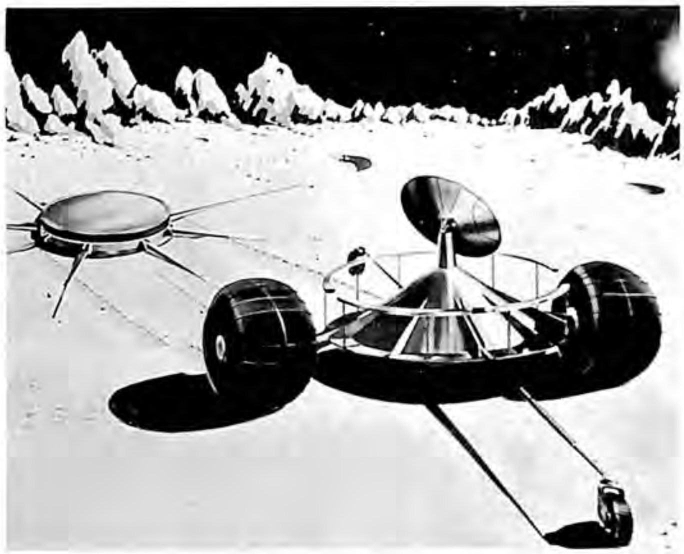
Few details and no photos have been released on Samos, the USAF's Satellite and Missile Observation System, aimed at development of an operational system of observing the earth from an orbiting satellite. On January 31, 1961, Samos II was successfully launched from Point Arguello and placed in a polar orbit. Lockheed Missiles and Space Co. is prime contractor. Launch vehicle was a first stage Atlas and an Agena A second stage/satellite 22 feet long weighing 4,100 pounds.

EXPLORER

The NASA Explorer series, originally developed by the Army, was notably successful in 1961, with launches of five satellites, Explorers IX through XIII. Explorer IX, launched by a four-stage Scout vehicle, was designed to determine the density of earth's atmosphere by measuring the air drag on a 12-foot inflatable sphere, and also to evaluate the Scout vehicle. The balloon inflated but the data transmitter broke down after one orbit. Explorer X, successful, sent back valuable data on solar winds, hydromagnetic shock waves and the effect of solar flares on earth's magnetic field. Explorer XI, also successful, contained a telescope to detect and map high energy gamma rays in the first attempt at space astronomy from a satellite. Explorer X was launched by a Thor-Delta vehicle, Explorer XI by a Juno II. Explorer XII transmitted a mass of data on solar winds, magnetic fields and energetic particles in space. It was launched by a Thor-Delta. Explorer XIII, Scout-launched, investigated micrometeoroid impact and penetration. In photo, Thor-Delta launches Explorer X.



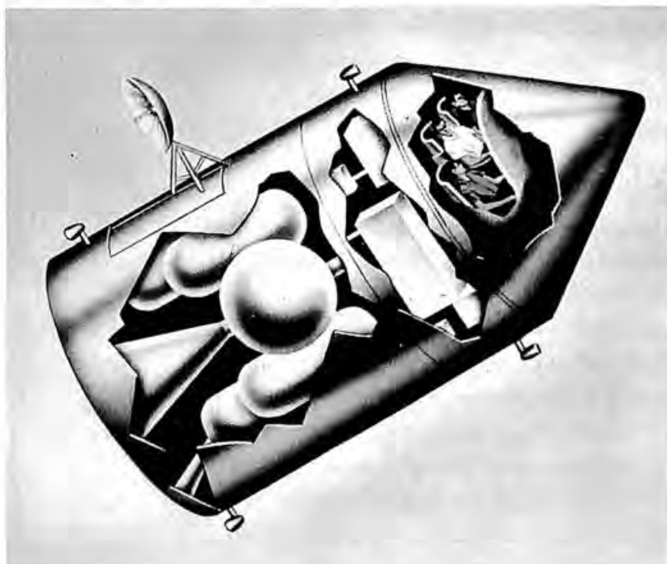
The National Lunar Program



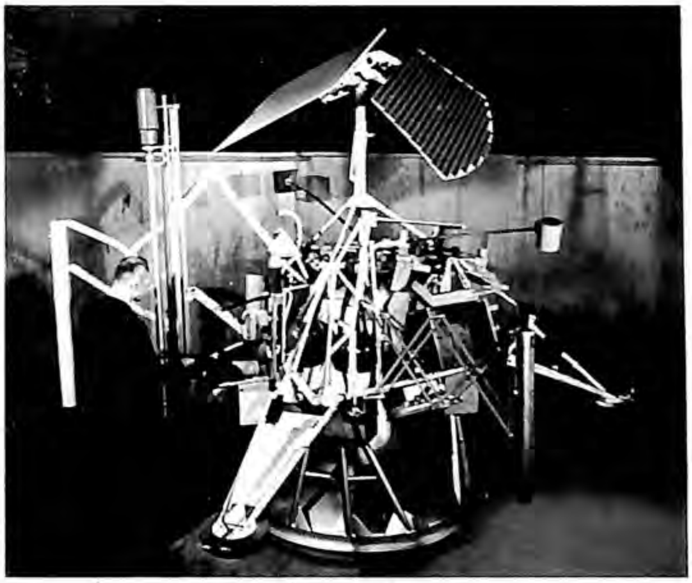
Prospector

After Administration approval and initial Congressional funding in 1961, the National Aeronautics and Space Administration set up a National Lunar Program aimed at both manned and unmanned exploration of the moon and the space between the orbits of earth and its moon, to be accomplished in the decade of the sixties. The highlights of the program, as planned in 1961 but subject to continual change, include:

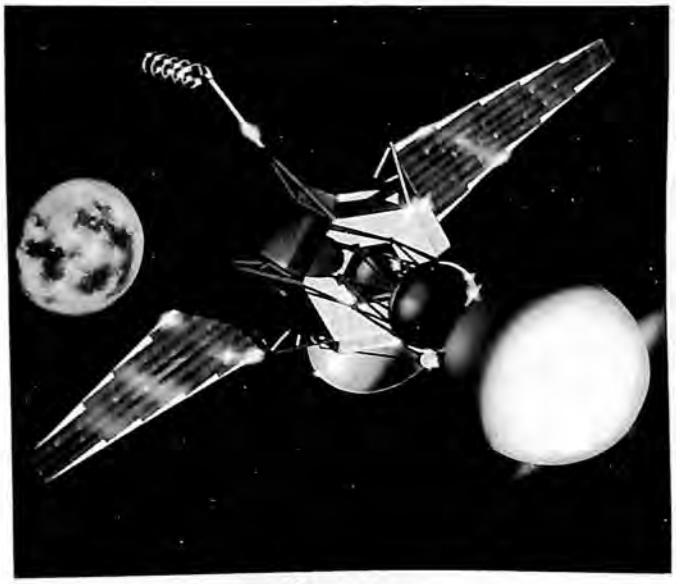
RANGER, a series of spacecraft designed to investigate cislunar space and the moon itself via the hard landing technique. Ranger will be equipped with instruments and cameras which will operate until the spacecraft crashes on the lunar surface, and with a small spherical capsule containing a lunar seismometer, which will make



Apollo I



Surveyor



Ranger

a semi-hard land and operate for 30 days after impact.

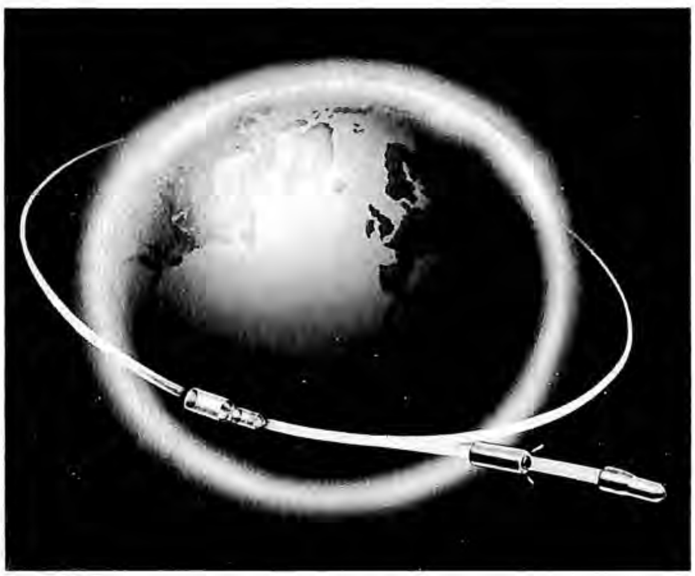
SURVEYOR, a larger, more sophisticated aircraft, designed for "soft," or cushioned landings on the moon. The spacecraft will "back down" to the lunar surface on a column of rocket thrust and its sensitive, "intelligent" instruments will transmit data on a variety of subjects back to earth.

PROSPECTOR, a soft landing spacecraft with instrumentation similar to that of Surveyor, but with the capability of moving about the lunar surface on track treads or balloon wheels, permitting observations from a number of different areas. Prospector is still under consideration.

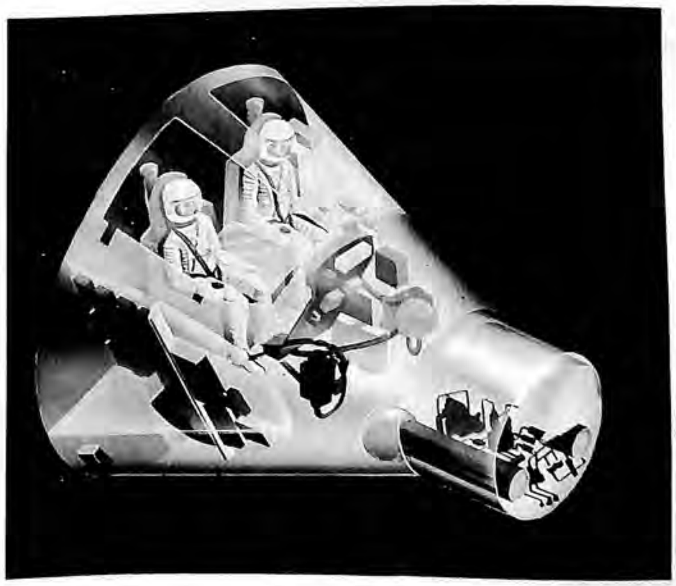
MERCURY, the initial man-in-space program, which will continue for approximately two years after the initial Mercury orbital flight. NASA will make a series of one-man flights at orbital distances increasingly distant from earth and at durations up to 26 hours.

GEMINI, a follow-on to the Mercury program, with a two-man capsule designed for longer durations. To be launched in 1963-64, it will also investigate space rendezvous techniques.

APOLLO, the spacecraft for manned lunar exploration, with a duration capability of about two weeks. In the initial phase, the three-man capsule will make a series of earth orbital missions. Later, it will be launched on a circumlunar mission and finally, at a date still unspecified, it will land three astronauts on the moon. ■

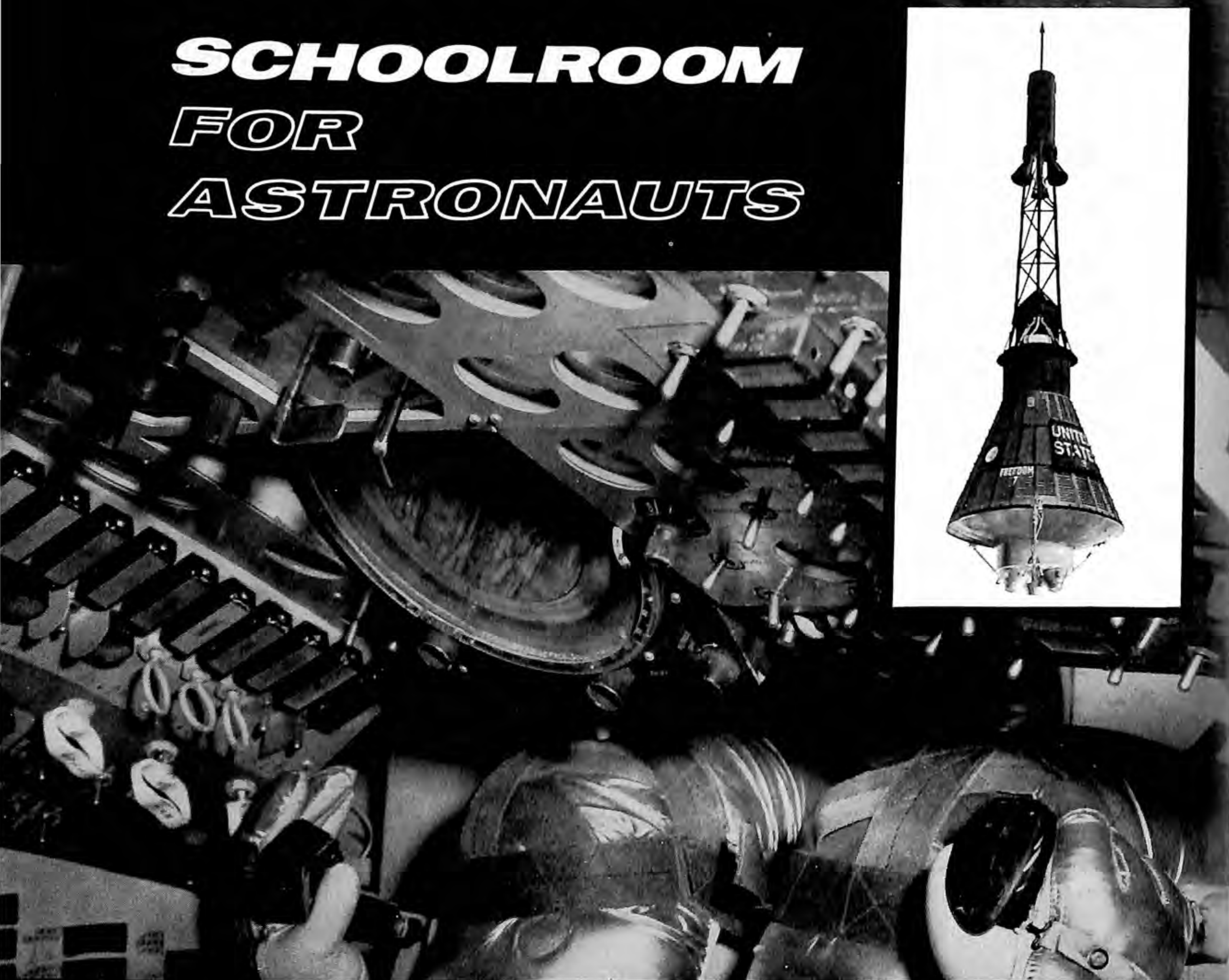


Apollo II



Gemini

SCHOOLROOM FOR ASTRONAUTS



On America's drawing boards and in the laboratories are two, three and five-man spacecraft, space platforms and manned lunar craft. The goal is interplanetary flight. Eventually, lifetimes may be devoted to a single space adventure.

But man must conquer near space before he goes afar.

Ready to serve as the trainer for future astronauts is NASA's Project Mercury spacecraft. This compact, one-man vehicle now carrying the first Americans into space is an astromedical laboratory to test man's reactions to this new environment. But the Mercury spacecraft can easily serve as a readily available and efficient schoolroom for future astronautics students making their first leaps into space.

Months of ground training will be necessary for coming space explorers. Then will come trajectory flights to experience weightlessness and spacecraft control. Earth-orbital flights will acquaint the future astronauts with spacecraft control, celestial and ground observation, re-entry techniques, artificial atmosphere and other environment concepts.

Only after he has mastered the "one-room schoolhouse of the space age" will the astronaut be ready to man a deep space vehicle.

Employment opportunities exist for engineers and scientists. All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.
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MCDONNELL

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FAST SWITCHING
HUGHES
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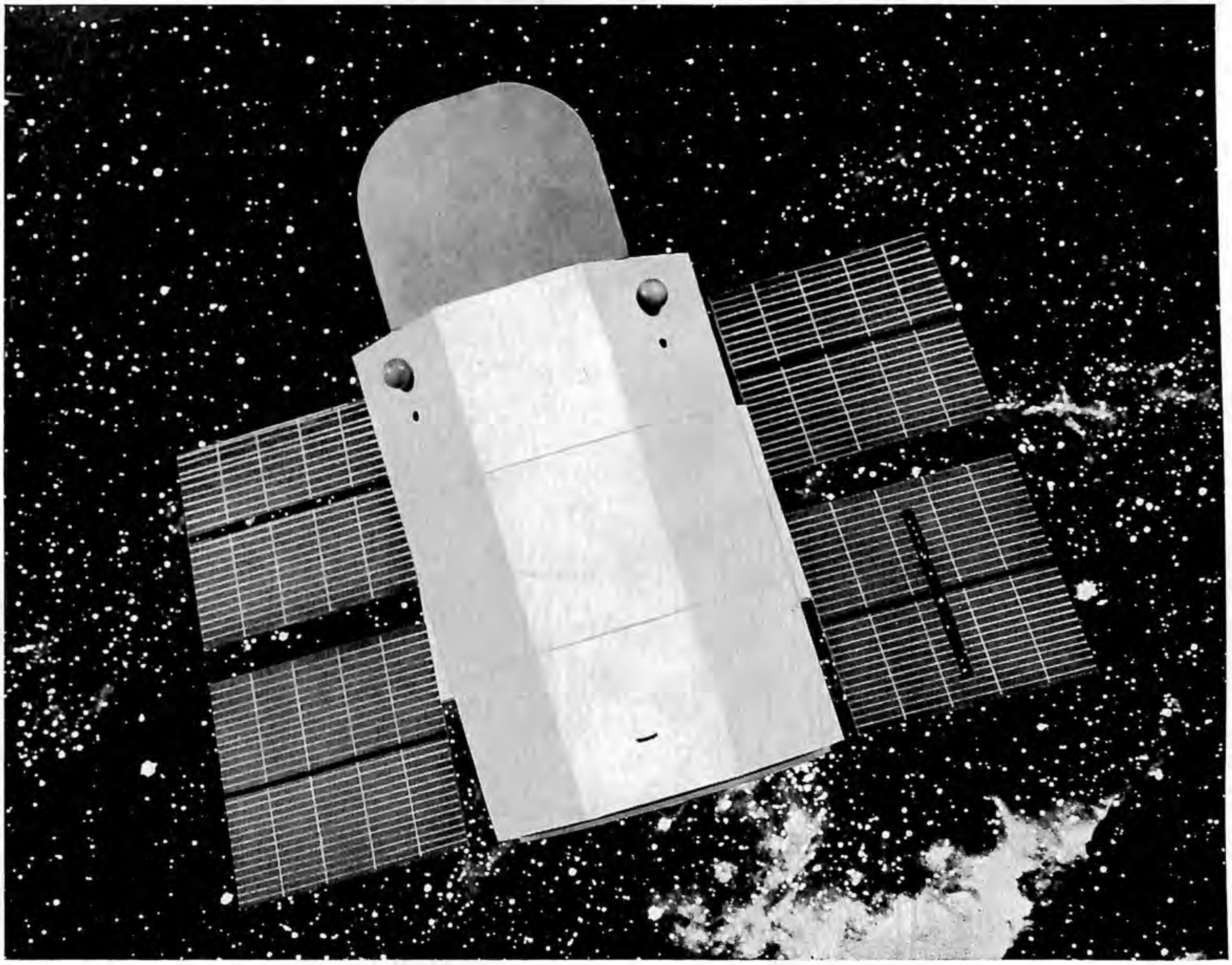



Emphasis: Technical Capability
At Aerospace Division we demonstrate the depth and breadth of our disciplines and talents in a multitude of ways, in many programs . . . Nucleonics. Electronics. Basic and applied research. Major defense systems: Titan I and II, Pershing, Bullpup, Lacrosse, Missile Master, Birdie, and the Dyna-Soar and Gemini boosters. In such programs, there can be no substitute for technical capability.
AEROSPACE DIVISION
MARTIN MARIETTA

A look at what's ahead in the realities of space exploration

Some predictions from Douglas — builders of Thor which has lifted more satellites toward orbit than all other space-boosters combined

Our mastery of space has advanced so rapidly that only diehard pessimists doubt the moon and planets will know our footsteps within a few decades.

Already a vehicle capable of orbiting a 19,000-pound payload, or driving 5,000 pounds to escape velocity, or lofting 2,500 pounds to Mars or Venus is being built in the U.S. This is Saturn, taller than a 14-story building, with an initial thrust of 1.5 million pounds. Its second stage, under construction for NASA by Douglas, will use a cluster of liquid hydrogen-oxygen engines of unique design.

The world knows a man can rocket into space and return. Can he survive for long periods? Douglas studies give a strong affirmative. Zero gravity and artificial G require further study. Radiation is a problem, but reports from Discoverer XVII, one of more than 50 space projects launched by the Douglas Thor rocket, show the threat less serious than was first thought.

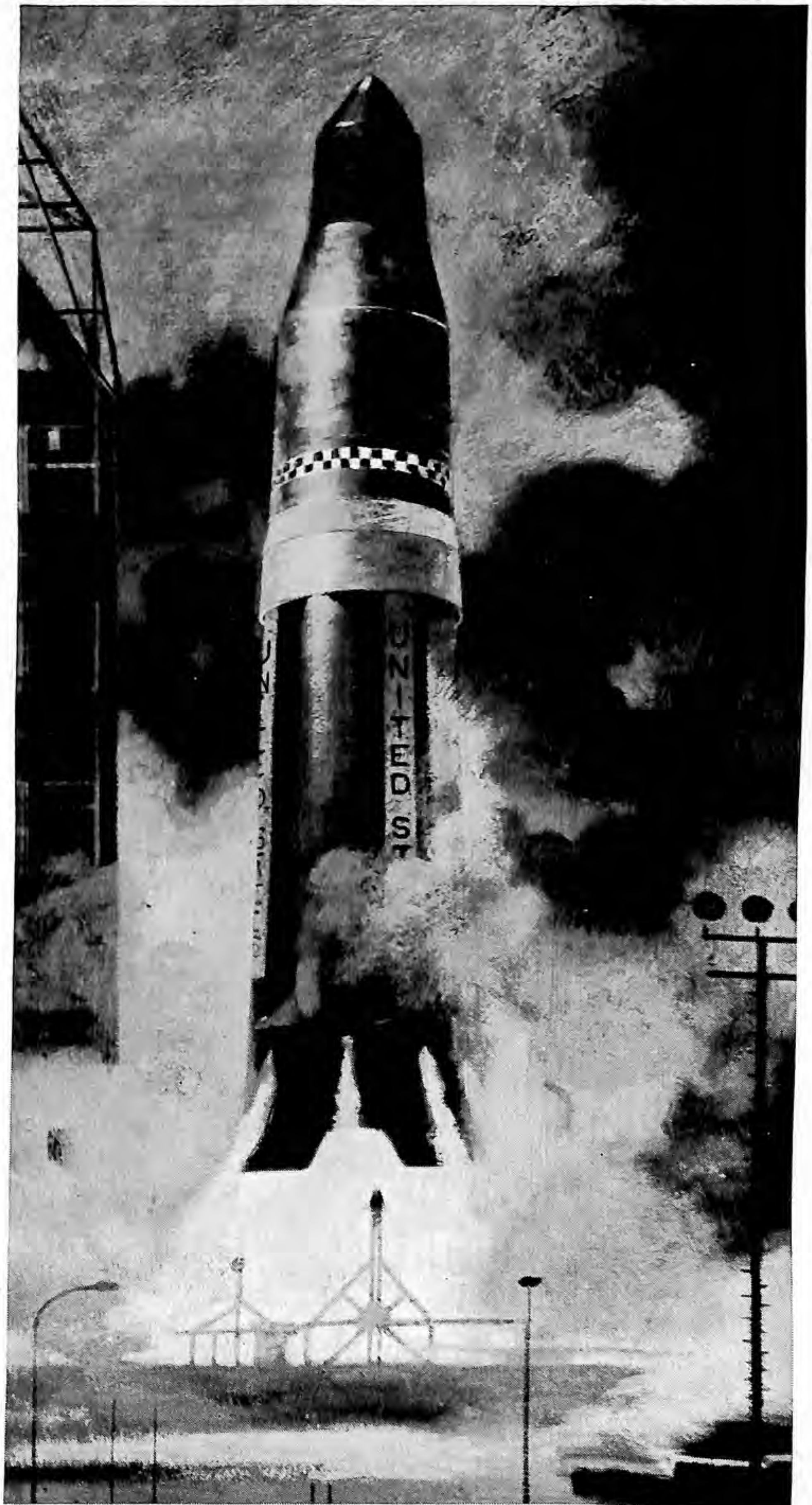
The cost of space travel? A breakthrough in nuclear power, which Douglas engineers confidently predict, should cut the operational cost of a trip to the moon to about $900 per passenger. Other power sources, already under study, may even open such stars as Sirius and Alpha Centauri to travel.

The DC-8 Jetliner, an example of Douglas aero-space leadership

Few of us will ever be lunar commuters, but growing millions are learning about a new kind of travel through the DC-8 jet.

Here is an airplane that slices through time at 10 miles a minute, opens the world to all who have an urge to get up and go places.

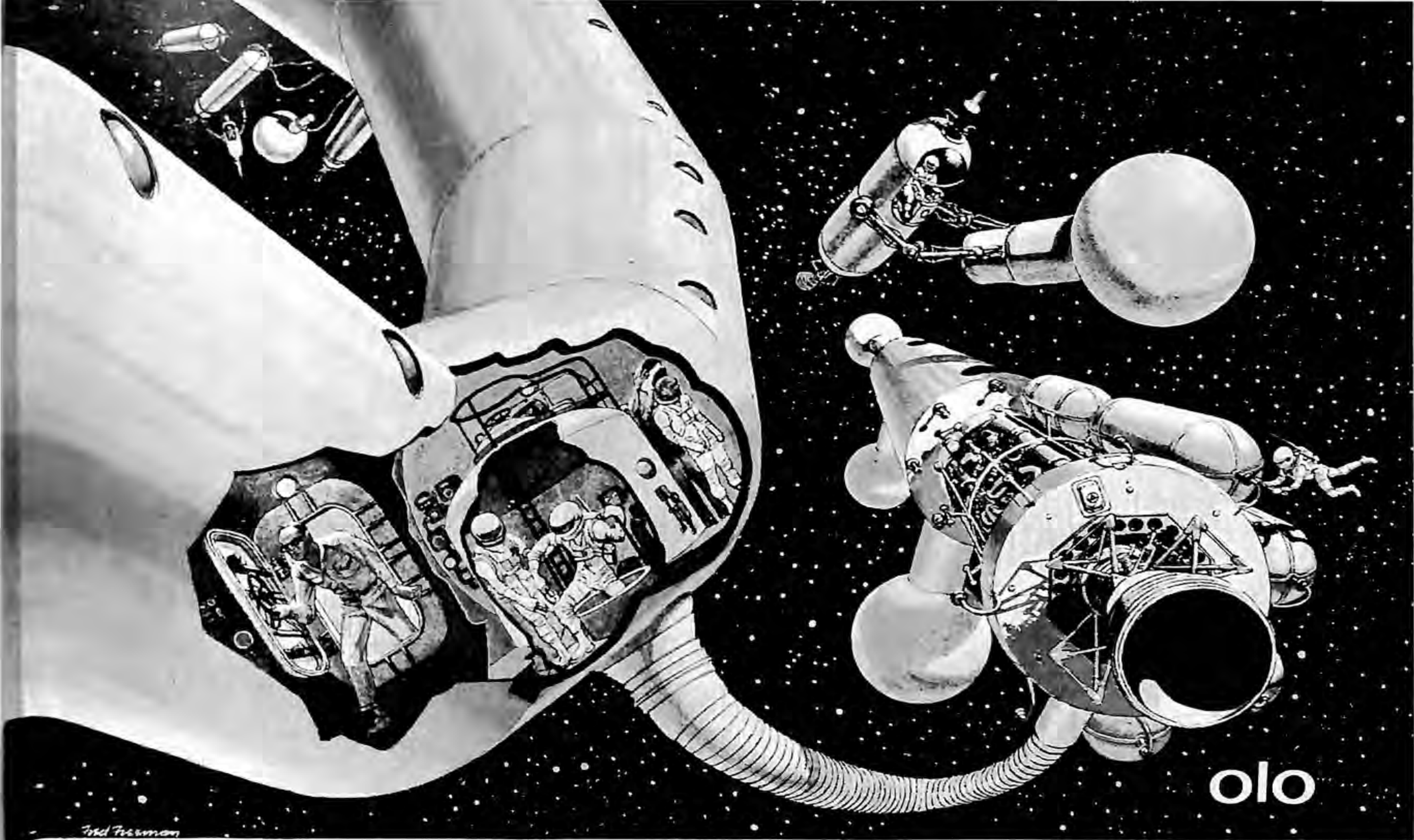
Next trip, fly a DC-8 jet, newest of which is the DC-8 Series 50, which already has set new records for speed and range.



Douglas is building Saturn's 2nd stage.

DOUGLAS

DOUGLAS AIRCRAFT CO., SANTA MONICA, CALIFORNIA • MAKERS OF MISSILE AND SPACE SYSTEMS • MILITARY AIRCRAFT • DC-8 JETLINERS • AIRCOMB® • RESEARCH AND DEVELOPMENT PROJECTS • GROUND SUPPORT EQUIPMENT • ASW DEVICES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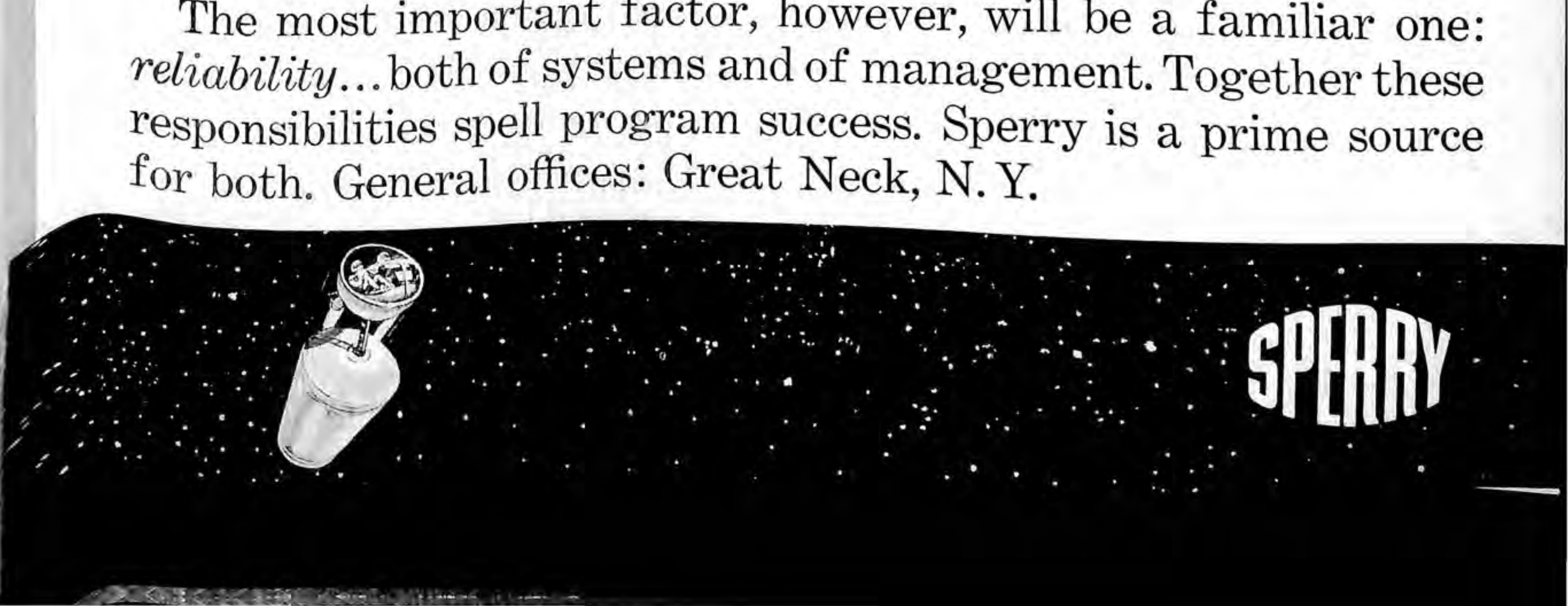
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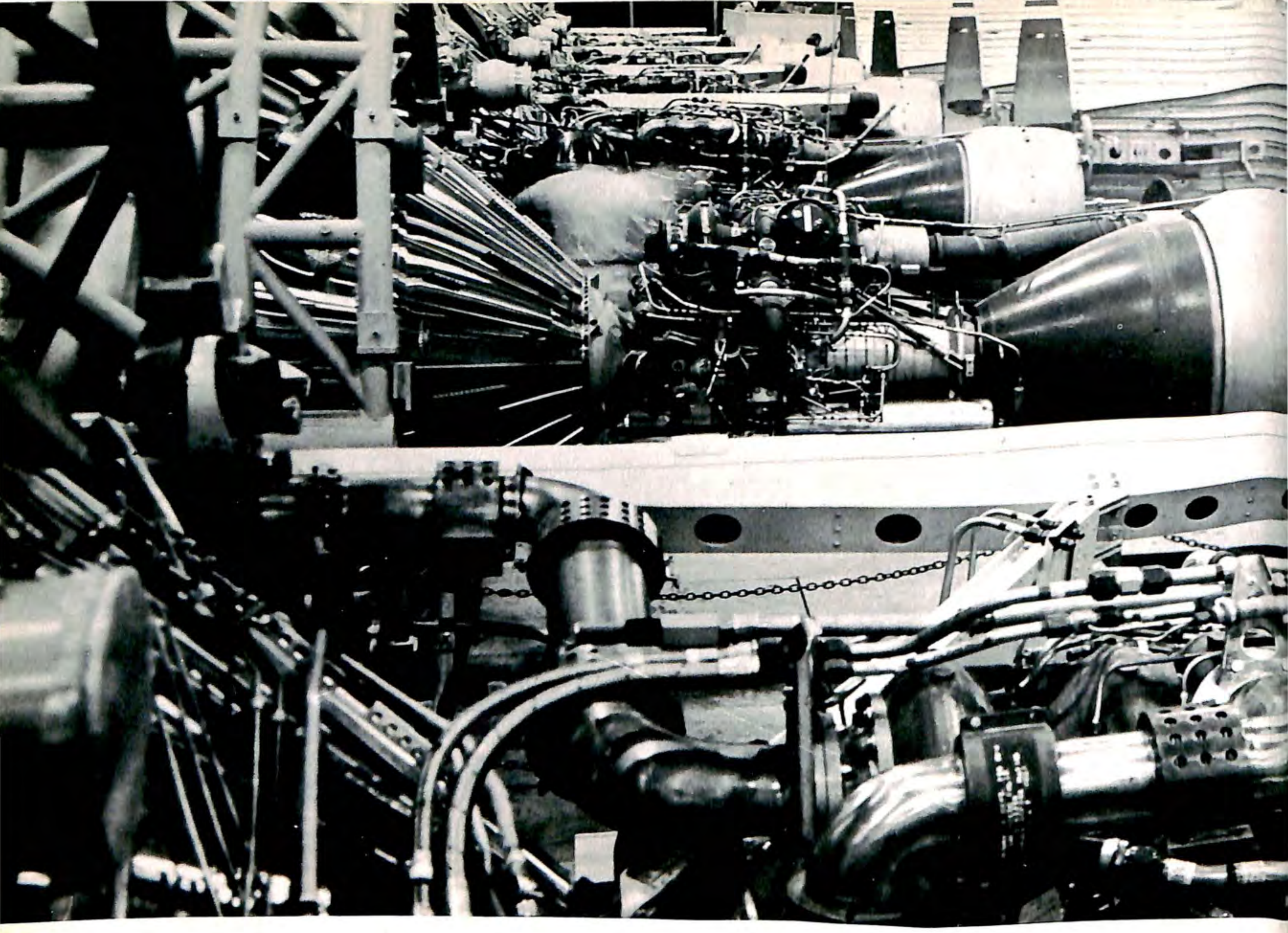
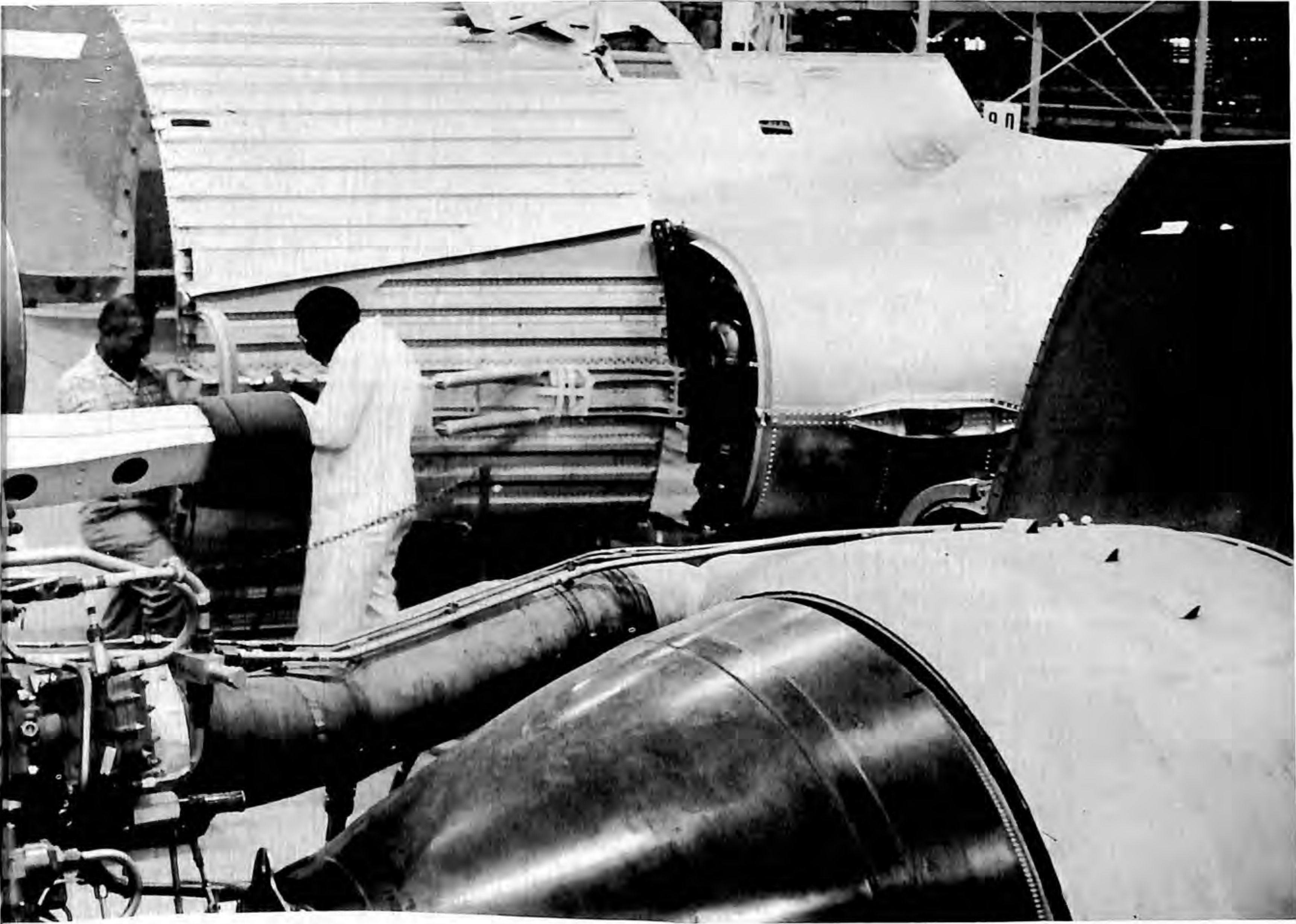


THE INDUSTRY



THE YEAR 1961 was an extremely active one in all areas of aerospace equipment manufacture, although once again, following the trend of the past several years, there was further decline in volume production and a corresponding increase in short production runs of highly complex equipment. The year was marked by further adjustment to technological change and by a continuation of the program of product diversification in the industry, as longtime manufacturers of aircraft expanded their operations or entered into such fields as rocket propulsion, electronics, nuclear and marine equipment, and non-aerospace products.

The national space program enjoyed a highly successful year as the first American astronauts entered space, and the aerospace industry contributed the hardware to this effort. New missiles joined the arsenals of the armed services, and, most significantly, long range ballistic missiles moved into operational silo sites. Advanced aircraft types of higher performance were added to the military fleets, new turbine-powered equipment was delivered to the commercial airlines and production of smaller aircraft continued at a high level.

Although missile expenditures climbed once again, the production of manned aircraft and associated equipment continued to constitute the major portion of the industry workload, estimated at about 55% in terms of dollar volume. Despite a marked step-up in space programs, production of space exploration equipment during 1961 was still a negligible factor in overall workload. However, Administration approval of a decade-long national lunar program requiring large expenditures promised a heavy increase in production of space equipment. In 1961, manufacturers were already embarked on the initial steps of the long-range program.

As it had in the immediately preceding years, emphasis on research and development continued to grow, to the point where it reached approximately one-third of the total industry effort in terms of contract dollar volume. The trend toward ever more complex equipment, coupled with the programmed increase in space projects, indicated an ever greater emphasis on research and development in the immediate future.

Although final figures had not been compiled at year-end, it was estimated that total sales would approach $13 billion and that the earnings rate would be about 1.4% of sales.

Employment climbed from 643,300 at the start of the year to approximately 675,000 at year-end. Average hourly wages increased from the 1960 average of $2.70 to $2.80 in September, 1961.

The contributions of the individual companies to aerospace progress in 1961 are detailed on the pages that follow.

AIRFRAME, ENGINE AND MISSILE MANUFACTURERS

AERO COMMANDER, INC.

The major highlight of Aero Commander's 1961 year was the announcement of plans for production of a twin engine jet aircraft for the corporate market. With the Model 1121, as it was designated, priced at $475,000 without electronics, Aero Commander hoped to capture the market between the existing line of piston aircraft and the larger jet transports costing $1,000,000 or more.

The Model 1121 is a four to six passenger jet featuring engines mounted at the rear of the fuselage. With a wing span of 43 feet and an overall length of 48 feet, the plane will cruise at more than 500 miles per hour. Price for the 1121 completely equipped with dual navigation and communication systems, autopilot, radar, etc., will be $555,000.

Prototype flight was tentatively scheduled for early summer of 1962, and FAA certification was expected by the end of 1962. The company estimated the start of production deliveries by the third quarter of 1963.

Aero Commander also announced production of a pressurized version of the 680F Commander. The pressurization package was being offered at $45,000 when installed at the factory as an item of optional equipment.

The differential pressure on the 680F-Pressurized was raised from two to three psi. The new system includes a Stratos-Sundstrand expansion type air conditioning unit which provides cooling both on the ground and in the air. Production deliveries of the pressurized 680F were scheduled for November, 1961.

AEROJET-GENERAL CORPORATION

Aerojet-General Corporation moved forward at a fast pace during 1961, entering the space field competition with a new subsidiary, Space-General Corporation, extending its operations into oceanics by purchasing a 45 per cent interest in the Global Marine Exploration Company of Los Angeles and expanding its international operations in the field of optics and technical assistance to the NATO Hawk production program.

The company's sales for fiscal 1961, ending November 30, were estimated to total $480 million compared to $412 million the previous year. The company estimated 1962 total sales should be between $550 million and $600 million.

During the year the company obtained a study contract on the NERVA program and in October announced it had obtained options on 80,000 acres of land in Florida as a proposed site for a new large rocket plant. Subsequently, 25,000 acres were leased with option to buy in Dade County, Fla., and President Dan A. Kimball announced that the company's plans for use of this property would be made known early in 1962.

Major programs accounting for the company's sales volume were the Polaris and Minuteman solid-rocket programs and the Titan I and Titan II liquid-fueled missiles. Aerojet provides both propulsion stages for Polaris and the second-stage for Minuteman. Its liquid fuel engines propel both stages of Titan I and both stages of the advanced storable-fuel Titan II.

As these programs move into later stages of production and eventually taper off, Aerojet is prepared to go into the field of large, segmented solid rocket boosters for space satellites, accommodating improved Titan propulsion systems to similar purposes and to move on into complete space systems with nuclear or electric propulsion devices.

Aerojet in 1961 was off to a good start in this new direction. In August 1961, it successfully test-fired at its Sacramento Plant, the largest flight-weight, segmented solid rocket ever fired, a motor of 500,000 lbs. thrust. In the nuclear field, it was working on an AEC-NASA study contract for NERVA (Nuclear

Engine for Rocket Vehicle Application). With Westinghouse as subcontractor, this contract put Aerojet in a favorable position for follow-on contracts which may total several hundred millions.

Aerojet's Solid Rocket Plant sales increased from $197 million in 1959 to approximately $250 million in 1961. This resulted from increased development programs in Polaris, Minuteman, Skybolt, the Hybrid Motor and The Large Space Booster Vehicle Motors. Noteworthy developments at the Solid Rocket Plant included the continuous mixing of propellants, nitro-plasticized propellant, new polyurethane-based insulator-liners, light weight titanium, and spiral wrapped plastic chambers, and improved nozzles made of advanced materials. The Solid Rocket Plant led in the development and testing of large flight-weight segmented rockets.

These developments were expected to lead to extensive use of large solid rocket motors for major NASA and Air Force space missions.

Because of the greater ease of handling the storable Titan II, Aerojet expected that these engines will have wide use in space application. The Titan II was selected for the first phase of the Air Force's Dyna-Soar, manned recoverable space vehicle and may be applicable to advanced versions of this mission or to diversified uses in connection with other space or military missions of the future.

In October Aerojet successfully launched a full-scale Aerobee rocket from the ocean off Pt. Mugu, Calif., presaging ultimate launching of large liquid rockets by this means.

The Liquid Rocket Plant expected to play a significant role in the development of non-nuclear components for nuclear rocket engines. It is expected that a significant portion of the NERVA program would be conducted at the Liquid Rocket Plant.

To provide corporate resources and ready facilities to handle the growing tide of currently planned governmental and commercial projects, Aerojet organized a new subsidiary, Space-General Corporation, and was negotiating for a site of between 25,000 and 80,000 acres for a new Solid Rocket Booster plant. The choice for the latter lay between sites under consideration in Florida, Texas and Northern Calif. A determining factor is accessibility to sea transportation to enable these large rockets to be shipped to land-based launching areas, or perhaps eventually to be launched from an ocean site.

Space-General, a combination of Space Electronics Corporation, previously an Aerojet subsidiary, and Aerojet's own Spacecraft Division, previously a unit of its Azusa Plant, was organized for the purpose of developing complete space systems and putting Aerojet-General squarely in competition for prime contracting on major space programs still to come. Construction started in September, 1961, on a 200,000 square foot building for the new corporation at Rosemead, Calif., close to corporate headquarters at Azusa. Sales in 1961 of Space-General were expected to be about $15 million, with projected growth to $25 million in 1962 and more than $100 million by 1966.

Principal contracts on which Space-General was working included electronic support for the Ablestar program, Ablestar upper-stage vehicle, sounding rocket programs, rocket sleds and the Saint target program. Space-General also has contracts for terminal guidance for AVCO and data processing for Autonetics.

Aerojet's major plants at Sacramento, the Solid and the Liquid Rocket Plants expected to better their 1960 records of $240 million and $110 million, respectively, in 1961. The Solid Rocket Plant esti-

Aerojet's rocket sled tested Navy guidance systems.

mated sales of $400 million by the mid-Sixties and the Liquid Rocket Plant looked for better than $130 million in 1962.

The Azusa Plant, a complex of multiple research and production divisions, among them Avionics, Chemicals, Power Equipment and Structural Materials—varied fields all associated with the Space Age —looked to an increase of 15 per cent in sales for 1962.

Among major projects at Aerojet's Astrionics Division in Azusa was the Midas satellite payload. An orbiting missile alarm, Midas uses an infrared detection system that resembles a miniature observatory. The Astrionics Division assembles the complete infrared system of the satellite and fabricates the precision lenses and electronics which are the heart of the system. Many environmental test chambers make possible a simulated orbit in the laboratory to prove the reliability of components before the satellite ever leaves the ground. Other important Azusa projects were the Snap 8 program for NASA and an advanced type torpedo project for the Navy. Aerojet's Azusa plant was also involved in the development and production of filament wound pressure vessels and rocket chambers for major missiles.

Aerojet's Oceanics Division, an outgrowth of its former Underwater and Anti-Submarine Warfare Divisions, projected the company into the growing field of deep sea exploration. In conjunction with the formation of the new division, Aerojet acquired a 45 per cent interest in the Global Marine Exploration Company, engaged in Project Mohole for the National Science Foundation, and expected to pursue oceanic research which gives promise of substantial commercial potential for the future. Areas of interest range from submarine communications to advanced underwater weapons and deep-running vehicles.

Both the Chemical and Structural Materials Divisions at Azusa were introducing new products based on advanced technology in support of the company's rocket and other programs.

AETRON, another division of Aerojet, was engaged in important design and architectural management contracts for the Saturn program and the design, fabrication and installation of ground support facilities for government agencies and private industry. AETRON's 1961 sales were placed at $40 million and it looked forward to doubling that figure by 1965. Diversification of AETRON's activities to include greater proportions of commercial business were expected to step up AETRON's operations.

Aerojet's Downey, Calif., plant, acquired from the Rheem Manufacturing Company in 1959, was producing ordnance and SD-2 drone aircraft for the Army. It developed new explosives of considerable commercial potential and its manufacturing division, which supports Aerojet rocket engine programs, was operating at peak. New facilities will have to be designed and built to handle anticipated gains in production contracts by this plant.

The company's Atlantic Division at Frederick, Md., was concentrating on automation devices for railroads, warehouses and post offices. It had a backlog of more than $2.5 million and its projects included installation of an automated freight handling system at the St. Louis railroad terminal and automated parcel handling system for the new Biscayne area post office in Miami. The division was organized strictly for competition in the commercial market.

Aerojet's Nucleonics subsidiary, Aerojet-General Nucleonics at San Ramon, Calif., was actively working on nuclear and electric propulsion devices for rockets of the future. More than $1 million was committed to an advanced plasma physics laboratory, and AGN was developing the fissio-chemical process for transforming cheap liquid ammonia to expensive hydrazine in a nuclear reactor. Prospects for large scale production and commercialization of this product were bright.

Aerojet's foreign operations centered on technical assistance to two European agencies which will produce the HAWK anti-aircraft missile for NATO under license from Aerojet. Other licensing projects were being discussed with additional NATO powers.

Aerojet entered into an agreement with Optische Industrie "de Cude Delft", Delft, The Netherlands, to establish a new American company to produce and market advanced commercial x-ray and other special optical equipment developed by the Dutch company. The x-ray equipment employs principles of light intensification that will make possible television and motion picture projections of x-ray images without intensifying exposure of the patient in diagnostic examinations. Certain optical devices of military potential were in production in Holland and being employed by military units of NATO, and a new U. S. plant was contemplated by Aerojet on Long Island.

Besides the major missile programs already mentioned, Aerojet was involved in volume production of Hawk, Tartar, Genie and Sparrow motors and Aerojet Senior and JATO units. The Able and Ablestar second stage units developed in the past by its Spacecraft Division have been used to launch many spectacular American satellites still in orbit, many of them in conjunction with Thor boosters.

Aerospace Corp's engineers discuss Mercury-Atlas program.

Skybolt propulsion was another Aerojet development of its Solid Rocket Plant, while the Liquid Rocket Plant's Titan II was selected for the first phase of the Air Force's Dyna-Soar, a manned, recoverable, space vehicle.

Feasibility studies and component development were also underway on advanced concepts for future application to such programs as Apollo, Nova, Saturn S-1 and other space probing propulsion requirements.

Aerojet continued the production of JATO (take-off assist and in-flight thrust augmentation) rockets. Sales in this area increased materially as broader applications were made by manufacturers of commercial and private aircraft.

AEROSPACE CORPORATION

Completing its first full year, Aerospace Corporation was fully organized and operational. Formed in June, 1960, as a non-profit corporation, by November, 1961, Aerospace employed approximately 3,000, including over 850 scientists and engineers.

The mission of Aerospace Corporation, working in the interest of the U.S. Government, is to accelerate the advancement of space science and technology. Its immediate purpose is to provide an objective organization of high technical competence to serve the U.S. Air Force in the scientific-engineering planning and direction of ballistic missile and space programs.

Early in 1961, Roswell Gilpatric resigned as Chairman of the Board of Trustees when he was appointed Deputy Secretary of Defense. William C. Foster was elected to fill the post.

A number of field offices were formed during the year in addition to one established earlier at Cape Canaveral, Florida. These offices are located in Washington, D.C.; Palo Alto, California; and Boston, Massachusetts.

Aerospace Corporation, during the year, continued in its assigned role as a planning and technical management organization working in the public interest—in partnership with the government-science-industry team—to advance space and missile programs. The company did not—nor does it plan to—engage in the production or manufacture of hardware.

The Corporation was engaged in forward planning of such systems as ballistic missiles; defense systems against ballistic missiles and satellites; space launching systems; surveillance, early warning, weather surveillance, and communications satellites; systems for developing reentry, rendezvous, and man-in-space capabilities.

The projects for which Aerospace provided general systems engineering during the year include: Saint, the satellite rendezvous and inspection system; the booster for Dyna-Soar, the manner hypersonic space glider; the Atlas booster used in the Mercury man-in-space project; the launching and final stage vehicles for Advent, a communications satellite system; the Thor-AbleStar booster used in the Transit navigational satellite program; targets to be used in the Nike-Zeus weapon system test program; the booster and final stage vehicles for Vela Hotel, a research program for detecting high altitude nuclear explosions; Bambi, program of research on systems concepts for destroying a ballistic missile during powered flight; and a penetrations program for developing concepts to insure that our missiles have the capability of penetrating possible enemy defenses.

As a part of its mission, the Corporation conducted both basic and applied research in areas which because of their long-range nature are not ideally suited to industry or because of the elaborate technical support necessary are not suited to the university. In addition, the company assisted the Air Force in the technical management of its large program of applied research in the missile-space field. Laboratory research projects included: propulsion—chemical, nuclear, and electric; aeromechanics—reentry and hypersonic flight conditions; materials research—physical and chemical effects created by the space and reentry environments; electronics—space communications and quantum electronics; and space physics—with particular emphasis on effects of radiation.

Headquarters for Aerospace Corporation is a modern research and development center located in El Segundo, California, adjacent to the Los Angeles International Airport.

ALLISON DIVISION

GENERAL MOTORS CORPORATION

Contracts for development and production of Air Force Minuteman rocket engine cases plus significant advances in the development of a variety of aerospace power and propulsion systems were among the high points of 1961 for the Allison Division of General Motors.

Rocket engine cases produced by Allison for Minuteman have, since the inception of the program, maintained a 100 per cent reliability record in repeated static and flight tests.

Allison in October received a $1,467,200 contract from Aerojet-General Corporation for development and production of titanium second-stage rocket engine cases for Minuteman. Steel second-stage rocket engine cases already being built for Aerojet also established a perfect reliability record.

This accomplishment in both first- and second-stage cases emphasized a new break-through in metallurgical achievement and processing control that assures predictability and uniformity of quality previously unattainable.

At the same time, substantial progress and numerous successful test firings were made on Allison-developed thrust vector control nozzles for Minuteman.

Attention during 1961 continued to focus on the new lightweight T63 gas turbine engine with the announcement that Bell Helicopter Company, Hiller Aircraft Corporation and Hughes Tool Company's Aircraft Division will use the 250-horsepower engine in light observation helicopters, one of which will be selected as the U.S. Army's LOH aircraft.

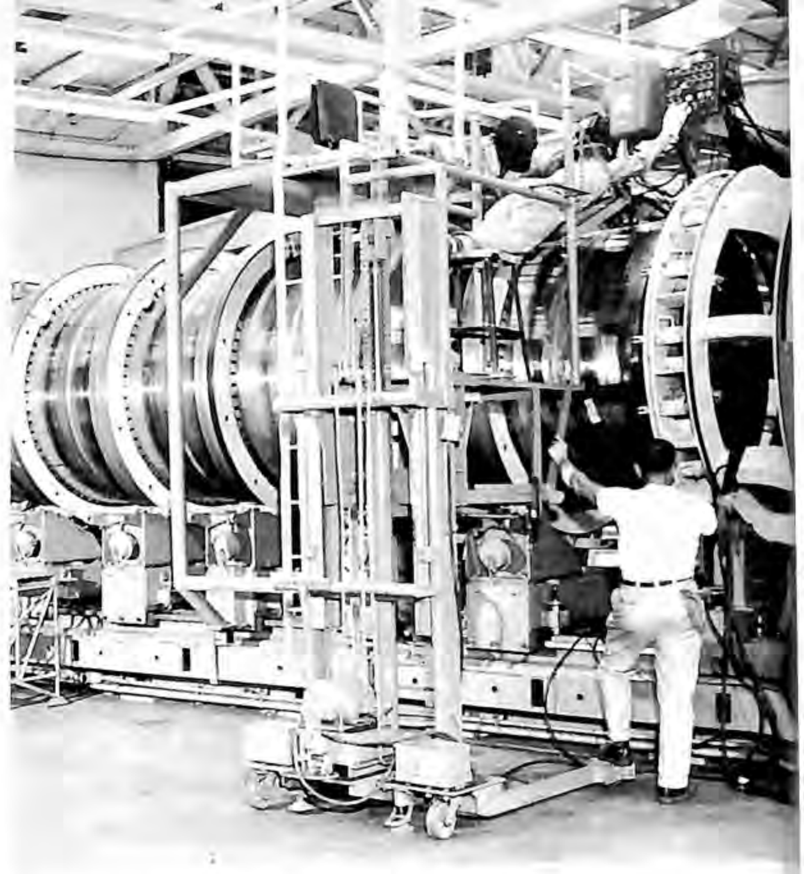
Research effort during the year was concentrated principally in four general areas—open- and closed-cycle gas turbines, Stirling-cycle engines, direct energy conversion devices, and rockets. Development work continued on a compact nuclear powerplant for military applications. Being designed is an extremely mobile, lightweight powerplant with a rating of 2,000 to 3,000 kilowatts. Nuclear units of this type would find application in the field as versatile powerplants capable of operating over extended periods in areas isolated from other power sources.

In another area, Allison began studies associated with the problems of energy storage depots.

Allison in 1961 began placing increased emphasis on development of an attitude and velocity control system designed to keep missiles and space vehicles on their programmed course. This versatile control system, which compiled an excellent reliability record in repeated test firings, is designed to operate independently of the main booster rocket.

The system's four pivotal rockets, which provide thrust for directional stablization, can control pitch, roll and yaw. In orbital space vehicles, this compact system can be mounted to control a single stage or a series of stages. For ballistic rocket applications, the unit can be fitted in any position consistent with the designs of the main rocket body. Electronic signals from the missile's guidance package activate the Allison control system.

Another high priority project in the 1961 research program was the regenerative liquid metal cell that may in the not-too-distant future provide primary power for submarines, locomotives, sea-floor vehicles, orbital space stations, compact generating



Minuteman engine cases are welded with Allison's automatic welding equipment.

stations, and large military supply and construction vehicles. A 500-1000 watt laboratory unit was expected to be in operation by June, 1962, at the Allison Research and Development Center. In charge of the program is the Allison electrochemist whose invention of a regenerative liquid metal cell made possible for the first time continuous operation of a thermally regenerative cell.

Regenerative fuel cells will play an important role in the electro-jet propulsion systems of the future. Three such systems—ion, electro-magnetic and electro-static—are under investigation at Allison.

Prop-jet engines continued to be a major production item during 1961. Sizeable contracts were received for T56 Series engines to power the Navy's new Lockheed P3V-1 Orion ASW plane and the Grumman W2F-1 Hawkeye AEW plane.

With the build-up in the defense effort, the military services broadened the use of the versatile Lockheed C-130 Hercules combat-cargo transport powered by Allison T56 Series engines. C-130s by the end of 1961 were in operational service with the U.S. Air Force, Coast Guard, Marine Corps, Military Air Transport Service and the Navy. Australian, Canadian and Indonesian air force units also are operating Allison-powered C-130s.

Continued emphasis was placed on sales of prop-jet engines to the nation's airline and corporate operators of Convair 340/440 airliners as conversion units to replace outdated piston engines. These same model 501-D13 engines which now power Lockheed Electras for 14 of the world's largest airlines have been approved by the Federal Aviation Agency for 2000 hours flight time before overhaul in Electras operated by Eastern Air Lines and Pacific Southwest Airlines.

In its aircraft engine program Allison also was at work during 1961 on gas turbines of appreciably higher rating with lower specific fuel consumption—factors that can be translated into increased operating range or time on station for "next generation" aircraft. Examples are the regenerative turboprop engine and the by-pass turbo-jet.

Development also continued on the "Whirlfire" vehicular type gas turbine engine, 15 of which were undergoing extensive field evaluation testing with commercial and military agencies.

First Aero 45 Reel-Launcher supersonic target tow system was delivered to the Navy for flight testing. This unique ram-air-driven unit which can stow, launch, tow and retrieve a 12-foot target for gunnery practice can release or retrieve cable at the rate of 5,000 feet a minute.

Allison during 1961 completed phasing of the Aeroproducts engineering, manufacturing and sales organizations into the "home" operation at Indianapolis.

Employment stood at 11,000 at year's end.

AVCO CORPORATION

AVCO-EVERETT RESEARCH LABORATORY

Avco-Everett Research Laboratory in 1961 continued to conduct theoretical and experimental research in high-temperature gas dynamics.

Experience and knowledge gained during the Laboratory's early work in helping to solve the ICBM re-entry problem opened many new avenues of research effort, among them: magnetohydrodynamics (MHD), space vehicle design and satellite recovery, MHD power generation, electrical propulsion for space vehicles and re-entry monitoring.

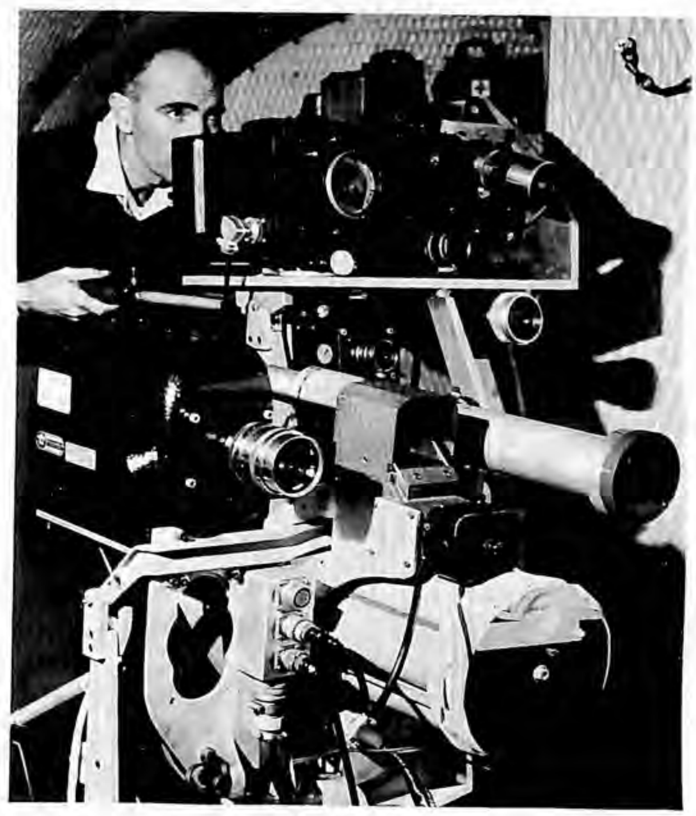
In 1961, the Laboratory was engaged in work under contract with the Office of Naval Research, the Department of the Army, the National Aeronautics and Space Administration, and several Air Force agencies including the Air Force Office of Scientific Research. The Laboratory also was engaged in projects with the Bell Telephone Laboratories and with a group of electrical power companies.

ELECTRONICS AND ORDNANCE DIVISION

Avco's Electronics and Ordnance Division, with its electronics operation centered in Cincinnati and its ordnance operation in Richmond, Indiana, in 1961 continued production of FPS-26 height finder radars for the U.S. Air Force and began production of the AN/VRC-12 series of radio communications units for the U.S. Army Signal Supply Agency. The division's principal ordnance contracts included a variety of special ammunition and shells as well as arming and fuzing kits for the Polaris missile.

During the year, the division's Air Traffic Control Central system, or AN/GSN-11, built for the Air Force, was sent to Atlantic City for testing by the Federal Aviation Agency and the Air Force. The system automatically directs 120 aircraft to and from landing and takeoff and generally controls traffic in air terminal areas. The division also demonstrated its infrared tracking-scanning device that can be used to spot incoming missile nose cones or jet aircraft while they are many miles away.

A family of missile and space communications equipment, designed and produced by the division, won greater acceptance during the year. A satellite



Avco-Everett used pedestal mounted cameras to obtain data on ICBM re-entry vehicles.

receiver used in NASA's Explorer XI, which has been orbiting the earth since April 27, 1961, handles commands sent from the ground to the various equipment aboard the space vehicle. Coders, decoders, decommutators, ground-based signal recording equipment, command and destruct receivers, were all in production at the division for missile and space use.

During 1961, the division also developed data processing and handling equipment of its own, as well as production recording equipment, and did work in advanced radio communications.

LYCOMING DIVISION

Increases in virtually all the company's major areas of activity, including gas turbine engines, reciprocating engines, constant speed drives, missile systems and amphibious vehicles, were recorded by Avco Corporation's Lycoming Division during calendar 1961.

In the aircraft reciprocating line, seven new models or variations thereof were certificated by the Federal Aviation Agency while major emphasis was placed on improvements in existing models, including fuel injection systems and turbo-charging. In addition, two gas turbine models successfully completed their 150 hour qualification tests and were placed in volume production.

First announcement was also made during the year of a new family of air cooled, lightweight, multifuel automotive-type piston engines being developed by Lycoming's Williamsport, Pa., plant for the Army Ordnance Corps. These new engines feature cold starting capabilities down to temperatures as low as 25 degrees below zero.

In the amphibious vehicle field, Lycoming was selected to design and develop for the Navy a new advanced hydrofoil amphibious vehicle capable of transporting five tons of cargo through rough seas at speeds in excess of 35 knots. The vehicle will be powered by a new Lycoming marine gas turbine engine as will another amphibious vehicle for the Navy now being built by Borg-Warner.

Qualification of a second constant speed drive model and subsequent production of the unit for use in the Douglas A4D-5 aircraft was accomplished during the latter part of 1961. Production of another model for Lockheed was also started during the year.

In the missile field, Lycoming's Stratford, Conn., plant successfully produced and hydrotested the first titanium second stage rocket chamber for the Air Force's Minuteman missile. This unit, which was later fired with complete success, is believed to be the largest single chamber in the world ever fabricated of titanium. A production order for a quantity of titanium chambers as well as follow on production for conventional steel chambers was received from Aerojet-General Corporation.

Also in the missile field, Lycoming continued production of re-entry vehicles for all three United States intercontinental ballistic missiles; the Mark 4 for the Titan and Atlas and the Mark 5 for Minuteman. New processes and techniques were incorporated into the program throughout the year.

Other missile programs currently underway included center skins for Bullpup, components for the Saturn, acceleration rocket chambers for Dyna-Soar and major assemblies for first stage Minuteman rocket chambers.

At Williamsport, the company received type certificate number 1E-10 for the IO-360 engine rated at 180 horsepower. This fuel injection model was being used in the Beechcraft Travel Air. Certificate number 1E-11 was awarded the fuel injection, geared IGO-540 engine rated at 350 horsepower and now being used in the Aero Commander 560F.

The company also received certification for down draft models of all three of the "540" series of fuel injection engines, the ungeared, geared and geared and supercharged.

Certification of the company's first turbocharged model, the TVO-435, was also achieved during 1961. This new helicopter power plant, used in the Bell 47G-3B, increases altitude capability to 15,000 feet with maximum continuous rating of 260 horsepower and to 20,000 feet at a rating of 220 horsepower.

The gas turbine program advanced in both the aircraft and marine areas. The 2200 shaft horsepower T55-L-5 completed its qualification test last year and entered volume production in early 1961. It made its first flight in October, powering the Army's new twin turbine Boeing Vertol HC-1B Chinook helicopter. A turboprop version of the engine, featuring a Lycoming developed split-power gear, was also tested for the first time. The new turboprop, designated LTC4G-3, is rated at 2535 eshp and has the highest power-to-weight ratio of any turboprop engine in the free world.

Lycoming's T53-L-9 helicopter engine, rated at 1100 shp, was also qualified during the year and entered production for use in the advanced Bell HU-1D helicopter. In late October the company received a $21 million contract, its largest single production order ever for engines, for this new power plant.

Other turbine advances were scored in the marine field with the selection of the TF-2036 for the Navy's LVW amphibious vehicle being developed by Borg-Warner, and the TF-1430 for the LVH hydrofoil vehicle being developed by Lycoming.

Total number of operating hours on all Lycoming gas turbine engines exceeded 125,000.

The Landing Force Amphibious Vehicle, Hydrofoil, or LVH, for which Lycoming received a prime development contract, will be capable of "flying" through rough water, boating through the surf zone, traversing difficult beaches or sand dunes and then traveling overland at speeds of more than 25 miles per hour. It will incorporate two fully submerged foils which will be retractable for land operations. The tires will contain a self inflation-deflation system and will allow the vehicle to "kneel" for loading and unloading operations.

The new family of multifuel engines included a four cylinder, six cylinder and eight cylinder model, each with a high degree of parts interchangeability. It is light and compact as a conventional gasoline engine but uses only about 60 percent as much fuel. There are only three principal moving parts per cylinder. The engine will operate on compression ignition fuel, combat gasoline, JP-4 jet engine fuel or diesel fuel. Horsepower range is from 160 to 325 brake horsepower.

Lycoming's two production constant speed transmission models are the LD6-2 for the A4D-5 and the LG3-1 for the Lockheed EC-121 aircraft. The latter unit is a complete transmission and gear box rated at 40 KVA. The LD6-2 is a compact unit rated at 17 horsepower and driving a 10 KVA generator which provides 400 cps electrical power for the aircraft.

NASHVILLE DIVISION

Avco's Nashville Division carried on its aircraft structures production program in 1961 much as it has in the past. Empennage and wing structural parts of aluminum for the Air Force's Lockheed C-130 turboprop transport and of aluminum honeycomb for the Convair 880 and 990 commercial jet transports were delivered during the year.

The division also produced the first upper aft fuselage sections for the B-70 *Valkyrie* bomber. These large sections of stainless steel honeycomb, manufactured under sub-contract to North American Aviation, Inc., were made by using the new Avcoramic tooling process developed by Avco.

This process makes possible the production of stainless steel honeycomb in almost any size or shape, to exacting specifications and tolerances, without a brazing furnace. Avcoramic tools can be heated in open plant areas and the entire brazing cycle—heating, cooling and aging—can be carried on without removing the stainless steel honeycomb from the tools. Nashville Division was adapting the process to specific applications for Saturn and a number of other possible space projects.

RESEARCH AND ADVANCED DEVELOPMENT DIVISION

At Avco/RAD work continued during 1961 under Air Force prime contracts for the development of re-entry vehicles for the Titan and Minuteman intercontinental ballistic missiles. Similar work was also in progreess to provide re-entry vehicles for advanced Atlas squadrons.

On February 1, an Avco Mark 5 vehicle soared downrange from Cape Canaveral aboard the Minuteman on the solid-fuel ICBM's completely successful maiden flight.

In October, Avco's Mark 4 R/V made a 9,000 mile test flight boosted from Canaveral by the Atlas ICBM. The Mark 4 impacted in the Indian Ocean, and the Avco/RAD cassette containing vital flight data was recovered.

For a special NASA study of re-entry materials, Avco RAD materials specialists and design engineers delivered three re-entry payload nose caps for flight test aboard the Scout research vehicle.

Meanwhile, the division's Florida Missile Test Station at Patrick AFB continued to meet 'round-the-clock schedules for the check-out and delivery of Avco re-entry vehicles to Cape Canaveral launching pads, with the pace of RAD's involvement in ICBM test flights gaining increasing momentum through the summer and fall of 1961.

At Wilmington, construction began on a million-dollar building to expand facilities for the development of space systems. Also, existent capabilities for test operations were increased when a 91-foot, 12-foot-diameter wind tunnel was installed for hyper-thermal studies.

In the arc jet sciences the division produced the first practical electrodeless plasma torch, making it possible to heat-test ablation materials in an uncontaminated jet stream. A new ½-to-one pound thrust arc jet engine which dissipates heat up to 1,000° F. by radiation was developed, thus eliminating the need for a closed-cycle cooling system. Continuous runs of up to 100 hours were achieved with this arc jet engine.

A new lightweight plasma gun was designed and packaged as a complete system for industrial spray-coating operations. Previously unattainable component tolerances were also obtained in using the plasma gun system for the application of brazing materials. The tolerance reduction was made possible by spraying brazing powders in a non-oxidizing plasma.

A preliminary design study for the three-man Apollo lunar spacecraft was completed by the division's scientific and technological staff.

Rocket nozzle design and testing programs were being conducted to develop nozzles for engines with a thrust capability of a million pounds and more.

In Undersea Technology, in-house projects included: advanced programs to develop high-speed hydrofoil systems, antisubmarine weapon systems, and submarine detection and classification systems.

Studies were being made of deep water corrosion, acoustic damping, underwater sound propagation, and long-life underwater power sources. During 1961, an Avco-developed command communications system was in service with the Navy's Polaris-armed submarine fleet.

In Human Factors Engineering, Avco/RAD scientists worked on problems associated with man's survival in outer space. Specifically, their mission is the integration of Factor "H"—the human equation—into systems concepts designed for outer space or underseas.

Devices under development in the division's Medical Science Technology department included: a cardiac probe to remove obstructions in the human heart by means of sound waves, and a TV-catheter system which would make it possible to view the interior of a pulsing heart.

BEECH AIRCRAFT CORPORATION

First flights of new products, expanding aerospace projects and important changes in marketing concepts highlighted Beech Aircraft Corporation's research, development and production activities in 1961.

For the fiscal year ending September 30, 1961, the company's total commercial and military sales exceeded $72 million, well in line with original projections. Of this volume, business airplane sales of more than $43 million gave Beech its second highest commercial sales year in history. While factory deliveries of all Beechcraft models compared favorably with 1960 unit totals, 1961 retail sales were up due to the fact field inventories at the beginning of the '61 sales year were somewhat higher than existing levels 12 months earlier.

Military sales of some $29 million in 1961 topped by several million Beech predictions a year earlier. The company had forecast a substantial reduction in military volume as the result of a scheduled phase-out of major subcontract jet fighter assembly production programs and the cancellation of its B-70 alert pod development project.

Particularly noteworthy in 1961 were sharp gains in Beech export business aircraft sales. Total commercial export sales of more than $10 million represented a 31½ per cent increase over fiscal 1960. European markets, where sales climbed nearly 100 per cent, recorded the greatest growth. And for the first time in company annals, two export distributors—Transair S.A. and Travelair G.M.B.H., both located in Europe—paced the entire Beech retail sales organization, domestic and export, in dollar business volume.

The prototype of the all-new Beechcraft Model 23 Musketeer four-place business airplane, priced in the $12,000 category, successfully completed first flights in October. Well into its test program by year-end, the engineering prototype is powered by a 160 hp Lycoming (O-320-B2C) four-cylinder engine. An all-metal, low-wing design with fixed landing gear, the Model 23 structure incorporates certain advanced fabrication techniques used in the manufacture of the most powerful jet aircraft flying today. Deliveries of the certificated airplane will begin in the fall of 1962.

In September company officials confirmed that Beech will build a new twin turboprop-powered, fully pressurized executive transport seating six to eight people. This new model will cruise at more than 300 mph on nonstop flights of over 1,500 miles with all allowances and adequate fuel reserve. The FAA-certificated airplane will be ready for delivery in 1964 at a basic list price of less than $400,000.

Beech turbine studies date back to 1955. And for the past three years Beechcraft Model 18 and Travel Air turboprop testbeds have been flying successfully in France. However, final determination of the new turboprop transport configuration was based on an extensive market and engineering research program during which the majority of large corporate fleet operators were queried as to desired specifications.

In January the firm announced signing of a formal agreement with Societe Francaise D' Entretien et de Reparation de Materiel Aeronautique (SFERMA) for further development and application of French turboprop engine installations in Beechcraft airplanes. The agreement also authorizes distribution of Turbomeca Astazou-powered Beechcraft Baron (Marquis) planes in certain European areas, although there are no immediate plans to market the model in the United States.

Because of a growing product line, projected increases in retail volume and market demands, Beech in 1961 staggered its introduction of new business airplanes. Also for the first time, the new models were presented in the field at regional meetings conducted by factory teams of marketing specialists. In past years the company unveiled its complete new line at the annual international distributor and dealer sales meeting. The new procedure was aimed at effecting economies at factory and retail levels and benefiting national promotion programs.

Introduced in October were the new Beechcraft Model 65 Queen Air and the B33 Debonair, followed in December by the new A55 Baron and the P35 Bonanza. Each new model featured major improvements designed for greater operating comfort, efficiency and utility. No changes were contem-

Wichita plant turned out one Beechcraft model every three hours and eight minutes during 1961.

plated for the Beechcraft Super G18, Twin-Bonanza and Travel Air until sometime in 1962.

An upward trend in business aircraft sales first appeared in April when factory orders rose 55 per cent over the month of March. And during its first production year, the 1961 Beechcraft Baron flow rate was increased three different times to meet consumer demands. Queen Air production was also stepped up by late spring.

Significant projects designed to enhance business flying acceptance, utilization and maintenance were inaugurated in 1961, including the industry's first general aviation orientation symposium geared specifically to college and university students, a factory-sponsored mobile service training school, and a mechanic certification program for distributor and dealer personnel. The company also became the first commercial aircraft manufacturer to stage a trans-Canada tour of an entire business airplane fleet, beginning in May at Montreal, Quebec, and ending 30 days later in Victoria, British Columbia.

The 13th annual Beechcraft Service Clinic, the only nationwide program of its kind offered by an aircraft manufacturer, brought to nearly 16,000 the total number of airplanes which have received free maintenance inspections since the clinic's inception in 1949.

First powered flight of the Beech-designed supersonic Navy KD2B-1/Air Force Q-12 was made in May at the Naval Missile Center, Point Mugu, California. In October the target exceeded an operational performance requirement when a test vehicle flew more than twice the speed of sound and above 70,000 feet. Service evaluations were scheduled early in 1962, upon completion of contractor flight trials. Designed to provide realistic training and development testing for advanced weapon systems, the KD2B-1/Q-12 is the nation's first missile target developed with performance capabilities matching those of the latest aircraft.

Army orders for the Beech Model 1025 Cardinal propeller-driven medium performance target missile, Army version of the Navy KDB-1, were in excess of $3 million near the end of the year, with bright prospects for follow-on production contracts. Beech in 1961 also received new contracts extending flight support services in connection with the target's use by Army air defense missile batteries.

Early in 1961 Beech announced the formation of its new Aerospace Division for more efficient, effective administration of expanding research, development and production activities relating to weapon system technology and space exploration. Marked progress in these areas was noted in October when Beech reported an acceleration of its investigations and participation in some of the country's most advanced aerospace programs, including the Apollo, Saturn and Centaur projects.

An indication of increasing government and industry recognition of Beech Aircraft's diversified capabilities came in June as the company announced a major $600,000 expansion of its Boulder (Colorado) Division facilities, which occupy 1,500 acres of Beech-owned property north of Boulder and utilize an assembly fabrication plant at nearby Longmont. Boulder projects embrace cryogenic engineering, environmental testing and systems design studies involving rocket, missile and spacecraft applications. Beech experience in these fields dates back to 1954.

In May the company announced a contract with Convair/Astronautics for initial production of 75 "topping control" units, an assembly which serves as part of Atlas ICBM launch silos. The new automatic system delivers liquid oxygen to the missile immediately before firing and controls the oxidizer flow at a given volume and pressure to insure the mission's success as programmed.

A contract announced in July by Beech and the Aeronautical Systems Division of the Air Force Systems Command called for design, development and production of fuel and oxidizer transporters for the Titan II ICBM program. Valued at approximately $800,000 exclusive of spares, the work was assigned to the Boulder Division.

During the year a new Beech-designed air refueling system for Navy fighter and attack aircraft successfully passed initial flight evaluations at the Naval Air Test Center, Patuxent River, Maryland. Result of some 30 months of engineering research, the new range extension system completed nearly 50 successful connections by five of the latest Navy jet aircraft—the F9F, F4H, A4D, A3J and F8U. The fuel pod was slung beneath a modified B-26 bomber for the flight test operations.

Toward the end of the year, Beech concluded negotiations on two new production contracts, one valued at over $4 million for an additional quantity of Army L-23F utility transports, the other an $8 million follow-on order for Republic F-105 aft fuselage sections. Beech work for the military during 1961 included both prime contracts with the services and other government agencies, and major subcontracts with other leading aircraft, missile and space vehicle manufacturers.

By year-end, Beech was engaged in more than 120 different projects, ranging from the development and marketing of new business aircraft accessory packages to the design and production of an encapsulated seat escape procedures trainer for the supersonic B-58 Hustler bomber.

BELL AEROSYSTEMS COMPANY

Research and production at Textron's Bell Aerosystems Company in 1961 spanned a broad range of aerospace advancements from flights of the company's rocket belt to tests of a new lightweight inertial reference navigation system.

The Textron Company's Aerospace-Rockets Division continued production and further development of its Agena rocket engine.

Manufactured under contract to Lockheed for the Air Force's Discoverer program, the Bell Agena engine also provides final stage propulsion for Midas, NASA's Ranger and other U.S. space projects. In 1961, the 15,000 pound thrust Bell rocket had placed more payload in orbit than any other engine in the free world space arsenal.

In the field of reaction control technology, Bell maintained its leading position during the year when its capsule control system performed "as required" during the historic Mercury flights. Bell reaction control systems were also being used or being developed for the X-15, Agena, Midas and Centaur. The company's reaction control development program covered a full range of liquid monopropellant, liquid bipropellant and gaseous bipropellant systems and components.

On April 20, Bell test engineer Harold M. Graham made the world's first free-flight with back carried rocket equipment. It is noteworthy that this first attempt with a long sought "flying belt" covered 100 feet, 20 feet less than the Wright brother's initial attempt.

The Bell rocket belt was built for the Army to prove that man could achieve controlled free-flight with portable rocket equipment. More than 80 free flights were made during the year. Ground distances up to 400 feet were covered and obstacles of 25 feet were easily surmounted. Having conclusively proven the feasibility of flying belt concept, Bell centered its effort on the development of operating hardware with less weight and considerably more range than the first experimental model.

Bell made a significant contribution to the technology of high temperature structures with the successful completion of its "Double Wall" test program for the Air Force. The company built a full-scale fuselage and wing root section of a hypersonic glide vehicle employing the Double Wall. Air Force tests indicated that the Bell structure was able to withstand the extreme temperatures that will be encountered by boost-glide vehicles during the critical re-entry phase of earth orbit missions.

In the area of advanced transportation techniques, Bell continued to investigate VTOL and ground effect machine concepts. Bell engineers designed a VTOL transport configuration featuring rotatable ducted fans that provide both lift and forward propulsion. Navy evaluation of the experimental Bell Hydroskimmer—a craft that rides over the water on a cushion of air with forward momentum provided by an outboard motor—were completed in 1961. Based on knowledge gained during the development and tests of the craft, Bell proposed a much larger ground effect machine to the Navy for evaluation as a cargo and troop transport vehicle. The vehicle is in the 15 to 20 ton class and would be capable of speeds up to 90 knots.

Bell's Avionics Division completed development and laboratory tests of its HIPERNAS (HIgh PERformance NAvigation System) for the Air Force in 1961. Flight tests of the system were underway at year end. The system is built around the Bell developed BRIG II gyroscope, the first floated gyro employing case rotation for use on lightweight inertial reference platforms. The BRIG II has achieved laboratory performance at least an order of magnitude better than currently available units and compares with the performance expected from exotic gyro concepts such as electrostatic and cryogenic devices.

The Midas III satellite launch on June 12 was a space proving ground for one of Bell's latest electronic developments. In addition to the Agena rocket engine which provided propulsion, a recently developed Bell digital velocity meter was vital in achieving the satellite's record high circular orbit. The Bell rocket engine powered the Midas into an elliptical orbit and then was restarted to drive the satellite into its near perfect circular orbit. The Bell digital velocity meter provided "shut down" signals for the engine during both firings.

During the year flight tests of an advanced automatic landing system for the Air Force were also completed by Bell's Avionics Division. Bell's new ALS, the GSN-5A, is a land based version of the system which has been accepted for Navy carrier use.

The most salient feature of Bell's GSN-5A is a radar beam coding and beacon track system. Coded commands utilizing the radar beam itself serve as a data link an an S-band beacon is used for tracking in the automatic mode of operation. An earlier Bell land based system, the GSN-5 (ST) was under evaluation by the FAA at Atlantic City, New Jersey. The system utilizes simulated ILS transmissions to relay commands to the aircraft ILS receiver. A corner reflector serves as the aircraft tracking target in the automatic mode.

Both GSN-5 systems, unlike the SPN-10 system developed for the Navy, perform the flare maneuver and include an indicator that inform the pilot of the time to perform the decrab maneuver.

Following successful flight tests during the summer, the new ALS was turned over to the Air Force for further evaluation and personnel training.

BELL HELICOPTER COMPANY

Among Bell Helicopter Company's achievements in 1961, a significant year for the company, were these:

The company's commercial helicopters set eight

First tests were made of Bell's Army "flying belt."

world records.

Bell was named one of three winners of the Army's design competition for the turbine-powered LOH (light observation helicopter).

Bell activity in the commercial helicopter field, domestic and foreign, continued at a high-rate.

A new turbo-supercharged commercial ship, the 47G-3B, was introduced to the market.

The YHU-1D, latest Bell model in the Army's famed Iroquois Series, began Phase I test flights.

A $4,100,000 order for Bell's Model 204B (basically, same ship as the U.S. Army's HU-1B Iroquois, now in production) was received from the Australian government.

Two HU-1B's were chosen by the Navy to fly special missions in the Antarctic as part of Operation Deepfreeze.

Bell helped to develop and refine helicopter armament missions now operational with Army units, and development was continued on other rotary-wing armament. Work also proceeded on helicopter instrumentation under ANIP (Army-Navy Instrumentation Program).

The company also designed and delivered two remote-controlled Army H-13 ships. The drone program was under Navy contract.

Bell's XV-3 convertiplane, being developed for the Army, underwent NASA tests and made more than 100 in-flight conversions of its tilting prop-rotors.

The Navy's HUL-1M, a turbine-powered light helicopter prototype, was flown for the first time. The flight marked first time Allison's new 250-SHP T63 engine was used to power any aircraft.

For 1962, Bell planned to manufacture three commercial helicopters, the three-place 47G-2A and 47G-3B and the four-place 47J-2.

Bell has made and sold more commercial helicopters than all other U.S. manufacturers combined and in 1961 saw its ships at work from polar zones to tropics and on all continents.

In the military field, Bell will continue in 1962 with production of the Army's turbine-powered Iroquois Series and will build LOH test ships for the Army with flight evaluation scheduled to start in 1963.

Bell helicopters' flight time since its first ship was built reached 8,500,000 hours in 1961—equivalent to almost 1,000 years in the air.

In the fall of 1961 Bell employed approximately 3,100 persons and predicted its business for the year would gross more than $51,000,000.

THE BOEING COMPANY

Boeing Airplane Company became "The Boeing Company" in May of 1961, and a new division consolidating military aircraft activities of the Wichita and Seattle areas was announced late in September.

"We have felt for some time that the name 'Boeing Airplane Company' does not reflect completely the diversified nature of the company's activities," President William M. Allen said after the new corporate title had been approved by the stockholders. "At the present time more than one-third of our effort is in areas other than aircraft, and this percentage is likely to increase in the future."

The new division, known as the "Military Aircraft Systems Division," is headed by Vice President E. C. Wells as general manager, with the Wichita Division becoming the Wichita Branch. C. B. Gracey continues as Vice President—General Manager of the Wichita Branch, while G. C. Martin, formerly Vice President—Assistant General Manager of the Aero-Space Division, is Vice President—General Manager of the Seattle Branch.

Primary responsibility of the new division is to design, develop, produce and support military aircraft weapon systems. Both the Seattle and Wichita branches are engaged in the design and development of new systems, with the Wichita Branch the principal source of manufacturing capability.

AERO-SPACE DIVISION

Dyna-Soar, Minuteman, Bomarc and a number of diversified new products provided the principal highlights for the Aero-Space Division in Seattle during the year.

An inspection in September by a government review team of a full-scale mockup of the Dyna-Soar manned space glider marked a major milestone in the development of this Air Force program.

Full scale replicas of various elements of the Dyna-Soar system were involved in the mockup. It was the first time that all major pieces of the system —glider, booster, subsystems and the like—had been brought together under one roof.

Boeing announced in May that it had signed all of its eight major subcontractors for work on the glider portion of the system. Approximately $40,000,000 will be spent by Boeing on these major subcontract items: Nose cap by Chance Vought Corp., Dallas, Texas; test instrumentation subsystems by Electro-Mechanical Research, Inc., Sarasota, Fla.; hydrogen cooling system by Garrett Corporation's AiResearch Manufacturing Division, Los Angeles; flight control electronics subsystem by Minneapolis-Honeywell's Aeronautical Division, Minneapolis, Minn.; accessory power unit by Sundstrand Corp., Denver, Colo.; solid fuel acceleration rocket to be used either as escape rocket in case of emergency during launch or as a small booster rocket for additional acceleration after the last stage burns out, by Thiokol Chemical Corp., Elkton, Md.; reaction control power component to stabilize and control the glider during flight through space or when aerodynamic controls are not completely effective, by Thompson Ramo Wooldridge, Cleveland, Ohio, and generator and control unit as source of the glider's electrical power by Westinghouse Electric Corp., Lima, Ohio.

Successful start of the Minuteman flight test program and beginning of missile site activation work were 1961 features for the Air Force's newest intercontinental ballistic missile weapon system.

On February 1, the first flight was made with all three engines staging correctly and re-entry vehicle landing on the target area. It was the most successful first firing of an ICBM in the nation's missile history.

Construction began in March on the missile's first deployment area in Central Montana, followed by the start of work on other missile squadrons in South Dakota, North Dakota and Missouri.

Boeing occupancy of the missile assembly plant near Ogden, Utah, began in the summer, and construction of combat crew launch training facilities at Vandenberg Air Force Base in California neared completion. Compatibility checkout of all elements of the weapon system in their operational environment progressed at the Boeing-Seattle launch complex, and Air Force crew training courses were started at Chanute AFB, Illinois.

Boeing's 38-foot hydroplane was launched in June.

Public attention on the Minuteman in 1961 was also focused on test flights at the Atlantic Missile Range. After three flights from a surface pad the launchings were switched to underground launch tubes known as "silos," which resemble the operational site except for installation of test equipment.

Additional funds were allocated during the year to continue research and development work on the mobile concept whereby the solid fuel missiles will be mounted aboard special railroad trains.

With the start of 1961 came an Air Force announcement that all five Model A Bomarc sites on the eastern seaboard of the United States were operational. In the early months of the year crews from these same operational sites traveled to Eglin AFB, Fla., to launch some of their operational missiles. The first of these was the 26th Air Defense Missile Squadron from Otis AFB, Mass. On March 28, the Otis missilemen prepared one of two Bomarcs sent from their home base and the target, a supersonic Regulus II missile, was speared on the first try. Three weeks later a QF-80 remotely controlled jet fighter went spinning into the Gulf of Mexico, victim of the second Otis missile.

The Air Force announced in March that a Model B Bomarc, the second-generation air defense missile, had intercepted a simulated target at a range of more than 400 miles and at an altitude higher than any operational aircraft can fly. Reflecting Bomarc B flight test for the previous 12 months, the North American Air Defense Command in April reported the following score:

Number of flights, 23; number of successes, 21.

The first of eight Model B Bomarc bases under construction was declared operational at Kincheloe AFB near Sault Ste. Marie, Mich., on June 1, and two months later the second "B" site was ready at Duluth AFB, Minn.

On September 7, with the flight of the 35th missile in a two and one-half year research and development flight test program, Boeing completed a list of 86 demonstrations to the Air Force to finish the Boeing-managed flight test program.

The fall of 1961 saw delivery of the first combination of A and B missiles at Langley, Va. This base, which previously had had an operational flight of "A" Bomarcs, was augmented with a 28-shelter "B" flight declared operational in September. First deliveries of Model B missiles to Canadian Bomarc sites at North Bay, Ontario, and LaMacaza, Quebec, were also made in the autumn months.

Boeing Associated Products, a new department, was organized in January of 1961, as an outlet to the commercial market of discoveries and inventions made by Boeing researchers and technicians—by-products of the company's main lines of endeavor. By mid-year it had combed through hundreds of patents in search of usable, salable products and had licensed the first 10 items for manufacture and sale. These included a fluidized bed furnance, a plastic metal compound for tool and die making, and miniature electronic medical instruments.

Several major steps in Boeing's advanced hydrofoil program were taken in 1961. In February, the keel for the Navy's new 110-ton hydrofoil subchaser was laid at the J. M. Martinac Shipbuilding Corp. at Tacoma, Wash., and construction begun. It was scheduled for completion in the summer of 1962.

Construction of the new boat had been under way only a few months when the Navy announced that Boeing also had won the competition for construction of a 15-ton twin-hulled experimental hydrofoil boat, to be used as a test bed for the development of supercavitating foils. Speeds are expected to reach 100 knots.

A 38-foot hydroplane, developed to test foils and other marine shapes, was constructed and launched in June. Shaped like a tuning fork, the craft has two sponsons forward, between which the shapes to be tested are suspended.

TRANSPORT DIVISION

Tooling for production of the new Model 727, continued on-schedule production and deliveries of the 707 and 720 series of commercial jet airliners and KC-135 military tankers, plus the inception of two new military transport versions of this airplane, were the major activities of the Boeing Transport Division in Renton, Wash., during 1961.

In addition to its 727 tooling program, Boeing also moved forward with its plans for testing this new three-engined jet. This test program, it is believed, will be the most extensive ever given a commercial airliner and will require the expenditure of several millions of dollars of company funds.

Six new customers placed orders for Boeing jetliners during the first three-quarters of the year, while 13 established customers placed additional follow-on orders to augment their present Boeing fleets. Included among the latter were 727 orders from Lufthansa German Airlines for 12 aircraft and American Airlines for 25 of the new short-to-medium range jetliners. These brought total 727 sales to 117.

The Boeing P&W turbofan-powered 707-120B and the 720B airplanes received their Federal Aviation Agency certifications and entered regular airline service during this period. Incorporating the latest aerodynamic and powerplant advancements, these airplanes immediately began setting new records for their operators. A total of 386 point-to-point speed records were held by Boeing jet airliners in 1961.

Boeing also announced that it would build the 707-320B, a turbofan-powered version of the large long-range Intercontinental series. The engine will be the Pratt & Whitney JT3D-3. These new powerplants plus design improvements will enable the -320B to carry a 40,000-pound payload more than 5,400 miles. Pan American World Airways ordered five of this new model, Trans World Airlines six, and Air France four.

The Boeing modification center continued to retrofit early 707 and 720 jetliners with the latest engine, airframe and systems improvements for its customers to make these early models as up to date at the newest airplane off the production line.

As the year entered its final quarter, Boeing had delivered 237 jetliners to the airlines, the Air Force (VC-137) and the FAA. In service, these airplanes had logged a total of 831,750 flight hours and flown more than 368,000,000 miles carrying 17,940,000 passengers.

Deliveries of the military KC-135 tanker-transports to the Air Force passed the 500 mark during 1961. In service with the Strategic Air Command, the KC-135s serve as its standard refueling tanker as well as in a number of other important support roles.

Contracts for 15 Boeing C-135A and 30 C-135B jet transports were placed by the Air Force with Boeing during the year. Developed from the service-proven KC-135, these all-cargo versions will be used for strategic airlift of cargo, troops or medical evacuation over intercontinental ranges. The C-135A is capable of carrying 64,000-pound payloads more than 4,000 miles. The turbofan-powered C-135B will provide even greater range-payload capabilities. The first of the C-135As was delivered to the Air Force in June.

WICHITA DIVISION

Continued on-schedule production of the B-52H global ballistic missile bombers and delivery of them to four operational units of the Strategic Air Command highlighted 1961 Boeing activities at Wichita, Kansas.

Throughout the year, production of the B-52H bombers was the prime assignment. Additional B-52Hs were to be produced until mid-1962, under present schedules, for two other SAC units, with final deliveries scheduled for August.

The B-52H first was unveiled to the public at the Wichita facility January 5, and made its maiden flight March 6. Initial delivery was made to Wurtsmith AFB, Mich., to SAC's 379th strategic wing. The eight-jet global weapon system, designed to carry four hypersonic Douglas Skybolt ballistic missiles, is being equipped with North American Hound Dogs until Skybolts become operational.

Other 1961 Boeing features at Wichita included the 20th anniversary of the giant final assembly area and defense production involving expenditures of more than $6.5 billion during the two score years; delivery of the Minuteman mobile transfer unit, designed, engineered and produced at Wichita, to the Aero-Space Division in Seattle, and extension of the Boeing-Air Force "Sky Speed" field modification program to include on-site maintenance at Castle AFB, Calif., and Biggs AFB, Texas, resulting in less down time for operational B-52 aircraft.

Support of other divisions by Wichita tooling and manufacturing groups also included 707-720 parts fabrication and 727 tooling for the Transport Division and design, engineering and fabrication of components for the Vertol Division's helicopters.

VERTOL DIVISION

Two new twin-turbine helicopters—the Boeing-Vertol 107 and the HC-1B Chinook—rolled off the production line at Morton, Pa., and made their initial flights in 1961.

In February, a special military version of the 107 designated HRB-1 was named winner of a Navy design competition for a new assault transport helicopter and 14 were ordered for the U.S. Marines.

Between February and October firm orders for 37 other 107s were received from New York Airways, the Royal Canadian Air Force, the Swedish Navy and Air Force, and Kawasaki Aircraft Company, Boeing-Vertol's licensee in Japan.

An order also was received in February for 18 HC-1B Chinooks for the Army, boosting to 28 the total number of Chinooks on order.

During the first nine months of 1961 employment at Morton rose from 2,900 to 4,500.

INDUSTRIAL PRODUCTS DIVISION

The Boeing Industrial Products Division in Seattle provided two notable "firsts" during the year. Its T50-BO-4 turboshaft engine became the first United States turbine in the 250-horsepower range to earn a military-approved 150-hour qualification rating, and the world's first gas turbine-powered fire truck went into service with the Seattle Fire Department. The truck, built by American LaFrance Corp., of Elmira, N.Y., is powered by a 330 shaft horsepower Boeing turbine. A second fire truck powered by a Boeing turbine went into service with the San Francisco Fire Department shortly afterward. Also in the fire-fighting line, two Boeing turbine-driven pumps were selected to provide fire-fighting power for a United States Army 100-foot tug-fireboat.

Production was under way during the year for T50 engines for the Navy's DASH helicopter, and in seven weeks of around-the-clock running, Boeing's turbine-driven compressors successfully completed tough Air Force 500-hour, 5,000 start-stop endurance tests.

D. J. Euler, former director of planning, was named Vice President—General Manager of the Industrial Products Division early in 1961, and Vincent Moore, former chief of design of the Hamilton-Standard Division of United Aircraft Corporation, was later named chief engineer of the division.

CESSNA AIRCRAFT COMPANY

Cessna Aircraft Company kicked off its new sales year in the fall of 1961 with the introduction of its "50th Anniversary Fleet," symbolic of the half-century of progressive change which has marked the company's products since Clyde Cessna modified his first airplane in 1912.

The 1962 Anniversary Fleet is a 13-model line which includes two new twin-engine planes—the Skynight and the Skymaster.

The Skynight, a five-place, executive twin with speeds up to 265 mph, features turbochargers which give full 260-horsepower to its engines at altitudes from sea level to 16,000 feet. Designed to fly long distances at high altitudes, it cruises at 19,500 feet and has a single-engine service ceiling of 17,300 feet.

The Skymaster, a revolutionary new design in business aircraft, made its maiden flight on February 28 and underwent extensive testing during the year. First deliveries were scheduled for late 1962. The Skymaster features an engine on each end of the fuselage and twin tail booms supporting a common stabilizer. It combines twin-engine performance and safety with the flying simplicity of a single-engine airplane.

Other models in the 1962 commercial product line are the 150, 172, Skyhawk, Skylark, 182, Skylane, 180, Skywagon, 210, 310G and the rotary-wing Skyhook.

Cessna invested more than twice any previous year's expenditure in developing the Anniversary Fleet and offers a six-month warranty—double what it was previously—on all models.

Cessna's international operations grew rapidly during 1961. Sales of business, utility and pleasure airplanes outside the United States were up approximately 20 per cent, an all-time record high in the company's 34-year history. Deliveries included a record shipment of 37 single-engine Cessnas to the company's Australian dealers in February.

Overseas sales of military products included the delivery of a quantity of twin-jet T-37 trainers to Peru. The sale amounted to approximately $3,500,000 and marked the first sale of T-37's outside the U.S. The airplanes were being used to introduce all-jet pilot training to the Peruvian Air Force.

The company also announced the formation of a wholly-owned subsidiary, Cessna Industrial Products Ltd., which opened a hydraulics plant in Glenrothes, Fife, Scotland. In June, the new subsidiary started assemblying hydraulic components from Cessna's Industrial Products Division in Hutchinson, Kansas, for farm machinery customers in the United Kingdom and eventually will manufacture components.

Cessna also was studying the possibility of starting aircraft manufacturing operations in other parts of the world.

Delivery of 35 U-3B's to the Air Force was made early in the year. The U-3B is a military version of the commercial Model 310 used for personnel and light cargo transportation missions. A total of 160 of the earlier Model U-3A's have been delivered to the USAF and have logged a record utilization rate for the Air Force.

In May, Cessna received a contract amounting to $410,000 for the production of additional transporter-ercetor containers for the Minuteman missile. The contaners house the Minuteman while it is being transported to missile sites and lowered into underground launching silos.

Contracts for additional T-37 twin-jet trainers totaling approximately $5,000,000 were received from the USAF in July. The new contracts will extend production of the T-37 into mid-1963. The aircraft were scheduled to go to several friendly foreign countries under the Military Assistance Program.

Production of the rotary-wing Skyhook got into full swing during the year. The four-place Skyhook is a short-haul business aircraft which will link users to facilities, customers or operations within 250 miles of their home base.

A Cessna Skyhawk toured Russia during the fall of 1961 as part of a special traveling exhibit sponsored by the U.S. Information Agency. It was exhibited along with a Ford Thunderbird, a Buick engine and large-scale models of jet airliners and ocean-going vessels to show Russian viewers typical means of transportation used by Americans.

Production of 70 Cessna L-19 Bird Dog liaison and observation planes for the Army was to begin in the spring of 1962 under a contract announced in July. Deliveries will start in June and run through May, 1963. The airplanes will be L-19E models, latest in the famous Bird Dog series. More than 3,000 of the aircraft were built between 1950 and 1959.

A Cessna T-37 visited seven European and Near East countries during a demonstration tour last summer. It was on display at the Paris Air Show in early June and then embarked on an 8,000-mile tour through Denmark, Spain, Germany, Greece, Italy and Turkey. Training and defense capabilities of the T-37 were demonstrated to 161 key air staff and training commanders in the various countries.

Two senior vice-presidents were elected by Cessna's board of directors on September 20. They are Frank A. Boettger, former vice-president and treasurer, and Delbert L. Roskam, former vice-president of aircraft divisions.

CONTINENTAL AVIATION AND ENGINEERING CORPORATION

Throughout 1961, two J69 engine models continued in production at Continental: the J69-T-25 for the Cessna T-37B twin-jet trainer and the J69-T-29 for the Q-2C, Ryan's latest "Firebee" model. The production Division also expanded its program of subcontracting activities compatible to its capability and avaliable capacity for close tolerance, multi-operation machiniig of highly refined precision parts for industry.

The J69 again proved itself to be an important item in American powerplant inventory. At the end of 1961, 1,300,000 engine operating hours had been logged in the USAF Primary Jet Training Program. This was exclusive of production, research, overhaul and airplane flight test operations which, coupled with the "Firebee" target drone program, would extend total J69 operation hours over the 1,500,000 hour mark.

Research and development programs in turbine powerplants and their application were continued and many advanced models growing out of the J69 program were further developed with industrial applications in mind. These included aircraft turbojets of 1400 and 2400 pounds thrust, turbofan engines of 2600 and 4000 pounds thrust, a target missile turbojet of 2550 pounds thrust, altitude thrust augmentation devices for existing turbojets, and the J69-T-35 air pump for boundary layer control on large transport aircraft. In addition to gas turbine engine powerplant system technology, Continental simultaneously continued advancing the act of the

Wright Aeronautical used hydro-spinning technique on rocket motor cases.

solid fuel ramjet engine and its application as the propulsion device for various weapon systems concepts.

A company sponsored development program produced the 217-5A, 6000 RPM, 500 horsepower turboshaft engine which was designated *T-72-T-2* by the Navy.

The ten year license and sales agreement between Continental and Turbomeca, S.A. of France for the exclusive sale and production of Turbomeca engines in the U.S. was extended, and under the agreement close coordination will be maintained for the sale and manufacture of each company's gas turbine engines.

CURTISS-WRIGHT CORPORATION

The Curtiss-Wright Corporation continued, in 1961, to place increasing emphasis on aerospace propulsion systems, missile components and in expanding its electronics program. Research and development were highlighted in the over-all corporate picture, particularly in the areas of propulsion and electronics. Research and development projects were initiated or expanded to supplement products already in production and those being contemplated for both the military services and industry in general.

The Wright Aeronautical Division, Wood-Ridge, N.J., made a major metallurgical break-through in the development, during 1961, of advanced rocket nozzles utilizing Pyrolytic Graphite.

Under contract from Lockheed, the angle drive system was being produced for use on the P2-V radar and search aircraft—which, incidentally, is also powered by two Turbo Compound engines. This is a power accessory drive which runs high speed generators and other equipment needed to provide the extra electrical power necessary to maintain search and radar aircraft. Research, development and testing of aerospace projects were intensified by the division to keep pace with the rapidly expanding space technology. During 1961, solid and liquid pulse rocket engines, used primarily for missile attitude control but with many other space propulsion applications, were developed. Both engines came through advanced testing above expectations, the division reported.

Testing and manufacturing under research and development contracts of variable thrust liquid rockets for vernier and attitude control applications were also accomplished by the Division during 1961. In the missile field, Wright Aeronautical Division was a major developer of the all-plastic nozzles for the Pershing missile produced under contract to Thiokol. Also in production during 1961 were first-stage Minuteman cases and first- and second-stage Pershing cases. The division was also producing rotating nozzles for the Polaris.

Work continued on the Rotating Combustion Engine at the Wright Aeronautical Division. Originally announced in November, 1959, the engine was developed jointly by Curtiss-Wright and NSU Werke of West Germany. An entirely new type internal combustion engine, it has only two major moving parts and offers an excellent weight to horsepower ratio. Several versions of the engine, suitable for both aircraft and industrial uses, were intensively tested during the past year.

Development and advanced engineering work continued at the division on a family of pre-packaged throttleable liquid rockets, ram jets, supersonic turbojets, turbofan and dual cycle engines which are projected for future aircraft developments. Production was also continued on versions of the Curtiss-Wright turbojet engines which power many first-line Navy carrier-based aircraft.

Turbo Compound engines manufactured by the Division continued to carry a large portion of commercial air travel on both domestic and overseas routes. The engine also continued in use on current long-range military patrol aircraft.

More than $16,000,000 in new contracts was received during 1961 for the "Cyclone 9" engine to power rescue and Anti-Submarine Warfare aircraft for the military services. The engine was also in production for commercial use in Sikorsky helicopters.

The "Cyclone 9" is an excellent example of one engine's ability to benefit from technology. First put in production in 1930, the "Cyclone 9" in 1961 was rated at 1625 horsepower—almost three times the rating of the original engine. Both the 1930 and 1961 versions of the engine have the same displacement of 1823 cubic inches.

Late in 1961, a new name appeared in the Curtiss-Wright divisional listing. Curtiss—one of the oldest names in aviation—was given to the Propeller Division, the oldest propeller manufacturer in the industry.

The Curtiss Division, Caldwell, N.J., during 1961 developed and announced a new glass fiber VTOL/STOL propeller. The new feather-weight propeller was ground and flight tested for more than 1,000 hours and has passed every standard test for strength and aerodynamic efficiency.

The VTOL type aircraft, announced by the division in April of 1960, which utilizes new radial lift-type propellers to lift the airplane vertically and provide the horizontal thrust for flight, was extensively tested and development work continued.

The Curtiss Division continued the development of mechanical controls and actuation systems for aircraft and missile use. A "power hinge," a mechanical system which will be used for raising and lowering wing tips of the huge B-70 supersonic nuclear bomber, was put into production during 1961. A rotor fold actuating system for helicopter blades was developed and was being built under contract from The Boeing Company. The system, built into the rotor hub, is a light-weight compact device which drives the rotor to the fold position.

Under contract from the Army, an actuation suspension system for artillery pieces was developed. This system, called Cannon Jacking Actuator, was developed for the light-weight 105 millimeter field piece. Another off-shoot of the mechanical actuation system is the breech actuator developed by the Curtiss Division for the U.S. Army's atomic cannon.

Production was started and advanced development continued on the variable exhaust nozzle control systems which are used in the Air Force supersonic T-38 Talon jet trainers. This device is an all-mechanical power unit and actuation system which affects a precise change in the area of the jet exhaust opening.

The Electronics Division, East Paterson, N.J., during 1961 continued its expansion program by taking three new steps to supplement and broaden its electronic development and production capabilities. The assets and product lines of the Abrams Instrument Corporation, Lansing, Mich., were acquired. The Electronics Fittings Corporation of Bethel, Conn., and Advanced Miniaturized Electronics, Inc. of Needham, Mass., were established as subsidiaries. The division also built a new 20,000 square foot facility at Albuquerque, N.M., to house the Intermountain Branch. These acquisitions increased the division's capabilities in the area of components including high quality circuit boards, radio frequency connectors, miniaturized digital modules and solid state elements.

Many of these components have aerospace applications. For example, Curtac connectors, manufactured by the Electronic Fittings Corporation, have an extremely high degree of reliability for rocket and missile applications. Miniaturized digital modules manufactured by Advanced Miniaturized Electronics, Inc., offers unusual characteristics in the method of incapsulating circuits and welding techniques which increase the reliability of these components. The Abrams Instrument Corporation lists among their products count limiters whose miniature size and extremely light weight make them particularly suitable for aerospace applications.

In addition to broadening the research capabilities in the over-all electronic field, the Electronics Division continued its work in simulation, ground support equipment and training devices for the military services. During 1961, the Six Target Radar Simulator was announced and delivered to the Federal Aviation Agency and at year-end was in use at major FAA centers. Additional units were in production at the East Paterson plant of the Division for the FAA. It was expected that all major air control centers will have them in the near future. The Six Target Radar Simulator was also being evaluated by the Swedish Air Force Board for air traffic control and training. The new device provides air controller trainers with realistic practice for moving aircraft in and out of holding patterns and shows the trainee how to handle actual problems he will face on the job.

Development of the Photran Land Mass Simulator, designed to train radar operators in navigational bombings and tactical missions, also continued under Navy and Air Force development contracts. Photran provides the realistic image of any land mass, 400 miles by 600 miles, through the use of a unique photographic transparency map that reproduces exactly the radar reflectivity of the selected area. Through the use of Photran, radar operators can be trained to recognize any target in the world from altitudes which range from treetop heights to the maximum capability of current aircraft.

Aircraft simulators for both American and European military aircraft continued in production during 1961 by the Electronics Division. Crew training simulators and other electronic training devices continued in production under a variety of contracts. The Electronics Division continued development of "C-Band" Meteorological radar, a high-powered precision land-based radar designed to detect and analyze weather phenomena. The distinguishing feature of this special purpose meteorological radar is its ability to penetrate clouds, in this way, gathering more accurate data than can now be obtained with standard radar units.

During 1961, the Marquette Division, Cleveland, Ohio, put the Swench manual impact wrench into mass production. Used to loosen the most stubborn frozen nuts or for precision tightening, the Swench is an impact, hand-operated wrench that multiplies torque applied to the handle more than fifteen times and delivers it as torsional impact each time the handle is advanced 30 degrees. The Swench has wide applications in many industries for machining nuts that previously had to be burned or sledged off. Production of aircraft windshield wipers continued at the division.

Stressing production in the nuclear field, the Princeton Division, Princeton, N.J., increased its nuclear system department to further specialize in the design and manufacture of rod control systems for nuclear reactors. The division was the major supplier of such controls for nuclear submarines. The ultrasonic testing equipment of the Division has been used extensively during 1961 at Cape Canaveral and the other launch sites to test launching pads for structural flaws prior to and after blast off of a missile.

The Radiographic "Puff" Camera was used both on Commander Shepard's and Captain Grissom's historic space flights to check the solid-fuel in the rocket engines of their re-entry vehicles. The division also reported that DetectoTemp paint, a temperature indicating color-changing paint, was being used in many metallurgical research and development projects throughout the aerospace industry. DetectoTemp paint was being used on the X-15; during its supersonic flights, the paint changes color at a pre-determined heat and allows the engineers to note at what temperature structural changes occur.

The Princeton Division was also producing broad lines of isotopic controls and testing equipment utilizing ultrasonic non-destructive devices.

During 1961, the Metals Processing Division, Buffalo, N.Y., under contract to American Machine and Foundry Company, extruded and delivered 132 missile launch guide rail assemblies. "I" beams ranging from 7 to 54 feet were extruded by a 12,000-ton horizontal extrusion press—the world's largest—in a matter of seconds. The rails are used for the launching of Air Force "Atlas" and "Titan" long-range missiles from underground silos.

Under contract, special alloy steels were extruded into 40 foot long "T" sections which were roll-formed and butt welded into structural members for the Navy's newest type nuclear powered Polaris submarines. The division also continued production of high-quality jet engine turbine blades, rotary forgings and castings for aerospace applications.

During 1961, the Research Division, Quehanna, Pa., continued as a major producer of beryllium oxide components for nuclear applications. The division also developed a method of incasing fuel elements for nuclear reactors. The new method is basically the ability to bond a container of superior strength which results in greater efficiency and longer life of the fuel.

DOUGLAS AIRCRAFT COMPANY, INC.

A major organization realignment; prominent roles in the nation's missile and space programs, and continued large scale production and research in the aircraft field, were among significant developments during 1961 at the Douglas Aircraft Company.

Two product-oriented divisions were created: one for missiles and space, and the other for production of future and existing aircraft. C. R. Able was appointed vice president-general manager of the Missile and Space Systems Division, and Jackson R. McGowen, vice president-general manager of the Aircraft Division.

MISSILE AND SPACE SYSTEMS DIVISION

Noteworthy developments included the 100th successful firing of the Douglas built Thor rocket, which continued as one of the nation's most reliable space vehicles. The milestone success was achieved in a total of 129 launches, with 13 more of that total considered as partial successes.

During 1961, the USAF Thor boosted 17 instrumented payloads into orbit. This record led to additional purchases of Thor rockets and Douglas Thor-Delta vehicles by the Air Force and NASA.

Future space assignments for Thor included the Nimbus weather satellites, polar orbiting geophysical observatory satellites, rigidized Echo passive communications satellites and additional Discoverer and Transit payloads.

The Delta vehicle, for which Douglas was prime contractor to NASA, orbited the Tiros III and Explorer X and XII research satellites during 1961. Future assignments for Delta included additional Tiros satellites, the S-6 atmospheric structure satellite, several orbiting solar observatories, and additional S-3 energetic particles satellite, the joint British-American S-51K ionosphere satellite and active communications satellites.

Development continued at Douglas on the S-IV stage of NASA's Saturn vehicle. The top stage of the Saturn will provide the final surge of power for the Apollo spacecraft, carrying astronauts on orbital and lunar flights.

Modification and construction of facilities for the S-IV manufacturing and test program were completed in 1961, tooling was developed, fabrication of components begun, and the liquid hydrogen testing program, including cold flow testing, moved along on schedule. First flight of the S-IV stage, atop the S-I booster, was scheduled for 1963.

Studies of advanced design nuclear-powered vehicles for space exploration continued apace. The Douglas concept envisions a one-stage reuseable vehicle, permitting costs to be amortized over many missions.

The RITA vehicle (meaning reuseable interplanetary transport approach) would be capable of round trip flights to the moon and to the nearest planets at any time of the year. Subjects of other "man-in-space" studies at Douglas included rocket structures, life support systems, nuclear propulsion, radiation shielding, electronic systems and fuels.

The year also saw the first in a series of drop tests of the Air Force's Douglas Skybolt air launched ballistic missile, at the Air Proving Ground Center at Eglin AFB. These tests followed compatibility studies of the ALBM with B-52 bombers from SAC and Vulcan bombers from the RAF.

Development and testing of the Army's Nike Zeus, the only anti-missile missile system under development in the free world, was expanded during the year. Test firings were begun at Pt. Mugu, California, in addition to those under way at the White Sands Missile Range. The Pt. Mugu series of firings will lead to testing of the Nike Zeus third stage.

The Army was preparing for full scale tests of Zeus against ICBMs. Buildup of the Zeus launch sites at Kwajalein Island in the South Pacific was well advanced.

Production also continued on three other Douglas-built missiles. One was the MB-1 Genie which provides the Air Force Air Defense Command with a nuclear air-to-air capability and has already been delivered in quantity. Another was the Nike Hercules ground-to-air Army missile, which also has a nuclear capability and was rapidly replacing Nike Ajax rockets at sites ringing many strategic areas and important cities in the U.S. and abroad. During the year launch tests were begun with Hercules missiles fired from mobile battlefield transporters.

The third was the Honest John, dependable Army ground-to-ground rocket which continued to be deployed in quantity with Army ground forces.

AIRCRAFT DIVISION

During the year Douglas acquired the Air Force-owned portions of the Douglas Aircraft Division plant at Long Beach, California. Contracts for the $14,370,344 transaction were signed with the GSA, acting for the government. The Long Beach facility is the home of the DC-8 Jetliner, and the headquarters for the Aircraft Division.

The major aircraft production program centered on the DC-8 Jetliner, including the Series 50 DC-8. Certified by FAA in May of this year, the Series 50 model is powered by four Pratt and Whitney JT-3D powerful turbofan engines.

An unofficial distance record for commercial jets was set by a production model Series 50 DC-8 in April on a flight from Long Beach, California, to Rome of 6,890 statute miles. This exceeded the previous record by 1060 miles.

Another highlight of the year came in August when a DC-8 Jetliner became the first transport to exceed the speed of sound. True air speed of over 660 mph was attained on a test flight from Long Beach to Edwards Air Force Base. Altitude was 40,350 feet.

Douglas employed huge space age welding torch in producing the S-IV stage of the Saturn launch vehicle.

Airlines which have ordered Series 50 DC-8s are KLM, Iberia, United, Delta, Philippine Air Lines, Aeronaves de Mexico and Trans Caribbean. These orders brought the total number of announced sales of the DC-8 to 172, of which 23 are fan-powered versions.

Late in the year the FAA certificated an extended leading edge for the wing of the DC-8 Jetliner. This increases both the range and the speed. The FAA approval permits installation of the leading edge on the DC-8s already delivered as well as on those scheduled for delivery. The DC-8 flight exceeding the speed of sound was a test flight of this leading edge.

A variation of the basic DC-8 offered to the airlines during the year was the DC-8F "Jet Trader." The interior of the Jet Trader can be quickly converted to accommodate a variety of combination freight and passenger loads.

As an all-cargo transport, the DC-8F will carry up to 94,668 pounds of freight. As an all-passenger transport, it will accommodate 183 economy class seats.

Under its agreement with SUD Aviation Company of France, manufacturer of the twin-jet Caravelle passenger transport, Douglas has responsibility for Caravelle sales and product support in almost all of the Western Hemisphere, Far East, Middle East and Australia. Sales through 1961 in the Douglas area totaled 47 aircraft. United Air Lines, Panair Do Brazil, Aerolineas Argentinas and TWA ordered the Caravelle.

In April, the company announced it will develop jointly, with the Piaggio Company of Italy, a light, jet utility airplane for both military and commercial use. Designated as PD-808, it will be a twin-engined, six-place all-purpose vehicle with a cruise speed of 500 mph and a range of 1500 miles. In its arrangement with Piaggio, Douglas will sell and service the PD-808 throughout most of the world. It will be manufactured initially in Italy, with future manufacture in the U.S. by Douglas under certain customer and production rate conditions.

In the field of research, Douglas unveiled its design for a 2,000 mph supersonic transport. The Douglas SST has a designated gross weight of 400,000 pounds; it can accommodate 104 first class seats and 3500 pounds of cargo, or 130 tourist class seats. A typical non-stop flight from New York to Paris would require only two and one-half hours.

Highlight of the year in Douglas' military aircraft programs came in February with delivery of the 1000th A4D Skyhawk to the Navy. Skyhawk's importance as a major striking force of the Navy was emphasized during the year with an order for additional, improved A4Ds. These were officially designated as A4D-5. This version, which successfully passed its first flight test during the summer, features a newly developed Pratt & Whitney jet engine of greater thrust and lighter weight, substantially increasing the aircraft's payload and range.

Among major research projects in the aircraft division was design of a Ground Effects Machine for the Maritime Commission. Douglas' role was that of subcontractor to Vehicle Research Corporation of Pasadena.

NEW FACILITIES AND EXPANSIONS

During 1961 Douglas completed purchase of the 3900-acre facility it had operated as a missile and space vehicle test site near Sacramento, California. The land was acquired from Aerojet-General Corporation, from which Douglas had leased it.

In June the company formally opened its new $2,000,000 hypersonic wind tunnel at El Segundo, California. It is used to explore aerodynamic characteristics of proposed Douglas missiles, space vehicles, and other craft of the future.

Announcement was made in August of plans to establish a research station in the Antarctic for study of solar flare radiation. Data from the station, sponsored jointly with the National Science Foundation, will be applied to the company's space travel studies and will be made available to scientists about the world.

A site was leased in October near Costa Mesa, California, for a research and development center for Astropower, Inc., a Douglas space propulsion subsidiary. Astropower also acquired a test site and successfully test-fired a small thrust rocket engine it had proposed for the Apollo spacecraft. Astropower scientists also were active in such fields as high-temperature materials, fuel cells and hydropower propulsion systems.

FAIRCHILD STRATOS CORPORATION

After more than 20 years of manufacturing equipment for terrestrial flight as Fairchild Engine and Airplane Corporation, a combination of new management and expanded space-age capabilities dictated the need in 1961 for a name more descriptive of the firm's aerospace activities.

The name change followed naturally from a growth plan which had not, in 1961, yet reached maximum momentum. Objectives of this plan were established as: Expansion into new areas of drone development based upon the USD-5 combat surveillance weapon system; expansion of research and development capabilities in selected, key areas; and intensified effort to develop additional military and commercial potential for the F-27 airplane.

Author of the plan Edward G. Uhl was elected president of Fairchild Stratos in February, 1961. Under Mr. Uhl's direction a general reorganization took place. This had the dual effect of creating new concentrations of technical strength and of attracting to the firm some of the best missile and space talents in the country.

Fairchild expanded facilities

Early in 1961 results of the growth plan began to appear. One of the first was a new, advanced version of the F-27 propjet transport, designated the F-27F, four of which were delivered to corporate operators by April. This aircraft featured transcontinental range, newer MK 529-7E dart engines, increased take-off weight capability and an expanded center of gravity range.

In June, Tribo-Netics Laboratories, Vermillion, Ohio, specialist in gas-lubricated bearings was acquired. Business and equipment of this research firm was transferred to the Stratos Division, to complement its engineering efforts in the field of gas bearings and lubrication at high speeds and extreme temperatures.

An additional name change saw the former Astrionics Division become the Electronic Systems Division in Wyandanch, L. I. At the same time the firm's St. Augustine, Florida operation received divisional status as the Aircraft Service Division.

Continuing effects of the growth plan included a development contract from the Army for use of the USD-5 in a new mission capacity, the sale of a new F-27 aircraft to IBM and the taking of an option on another F-27 by Bonanza Airlines, now flying nine F-27's.

at Aircraft Service Division, St. Augustine, Fla.

By November the 15th mission of the USD-5 drone had been flown at the U. S. Army Yuma, Arizona testing site. The vehicle maneuvered portions of its flight under a pre-programmed inertial guidance navigation system and accomplished many of its flight objectives.

AIRCRAFT-MISSILES DIVISION

The division continued to manufacture the F-27, turning out its 88th airplane in the series, an F-27F purchased by IBM. Certification for the F-27F, for transcontinental range and a maximum gross takeoff weight of 39,400 lbs., was issued on August 31. The F-27, America's first propjet aircraft, of year-end was being flown by 12 airlines and 29 corporations around the world. During 1961, the F-27 continued to be the only American wet-wing aircraft to remain free of algae corrosion. Known as the "green slime" problem, this multi-million dollar headache to military and commercial operators was eliminated from F-27 wet wings by a unique anodizing process performed at division facilities in Hagerstown, Maryland.

Under subcontract to Boeing the division continued production of vertical fins, fuselage and outboard wing sections for the SAC B-52 bomber. The number of wet wings reached a grand total of 1,140 during the year. A new contract for B-52 modification kits was received.

Development activities on the USD-5 drone advanced with important flight tests. The program received impetus in May when the Army awarded a $7.8 million contract to develop new military applications for this weapon system. Much of the information concerning the current and new program remained classified. On the current program, the mobile-launched USD-5 is a long-endurance airborne electronic combat surveillance system designed to provide an army field commander with information on enemy positions and activities while it flies over enemy territory.

Indications of the rapidly expanding aerospace potential of the division were manifested through components provided for Explorer satellites and the latest solar collector. Work continued on the fabrication of large diameter space-vehicle-tracking antennas and aircraft radar antennas. In these areas extensive use was made of the division's outstanding bonding facilities.

ELECTRONIC SYSTEMS DIVISION

New breakthroughs in the state of the art of electronic geodetic surveying were recorded at the division's Wyandanch, N. Y. facility. Various application studies were made for a new system under development to provide range and location information in both electronic form and on a digital indicator showing measurements to within six feet at up to 450 miles maximum range.

The division also accomplished the successful flight of a model of a rotary wing drone vehicle called the "Helevator". The "Helevator" was being developed for extensive military and commercial uses as a means of sending up antennas from submarines, ships or field locations.

Earlier in the year the Navy's Special Devices Center awarded the division a contract to develop a helicopter flight simulator, expanding its capabilities into a new area of growth.

Development of the classified, multipurpose electronic systems for the USD-5 weapon system continued to receive attention. A major portion of the division's responsibility involved subsystem compatibility and the development of interconnecting elements.

During 1961 the division completed a modification program on SPQ-2 radar for ship-board tracking of missiles. In addition, it proceeded on a variety of training systems covering bombing and navigation, countermeasurers, visual night landing and fire control.

STRATOS DIVISION

Advanced development programs continued to highlight the Bayshore, N. Y. division's activities. These programs included systems and equipment for environmental application, high and low pressure pneumatics, ground support, cryogenics, electronic and other equipment cooling, auxiliary power, transmissions, servos and regulators.

Among important contract awards was one for emergency air turbine motors for the F-106 interceptor, to be installed under a retrofit program. Work continued on contracts with Douglas, Culver City, and Douglas, Tulsa, for units to be used with the Skybolt missile.

Considerable progress also was made in the application of gas lubricated bearings subsequent to the acquisition in June of Tribo-Netics Laboratories, Inc. The acquisition included 37 patents.

AIRCRAFT SERVICE DIVISION

Located in St. Augustine, Florida, the division announced the renewal of all four of its Air Force and Navy aircraft overhaul and modification programs. These contracts called for IRAN (inspection, replacement as needed) and corrosion control work, including component overhaul of C-119 Flying Boxcars and C-123 Assault Transports. Navy contracts included overhaul of R4Y and R6D aircraft.

The facilities of the division were expanded during 1961 and aggressive efforts were launched to obtain foreign business, component overhaul work and to diversity into manufacturing of parts to support the growing aerospace industry of Florida.

The division showed its capability dramatically on Operation "Hot Hand", a project involving modification of a C-119 Flying Boxcar to a configuration enabling the aircraft to successfully recover missile reentry vehicles in mid-flight. The aircraft was strengthened, equipped for long range flying, equipped with special navigation and electronic flight equipment and had installed the special gear required to make an aerial "catch."

FORD MOTOR COMPANY

AERONUTRONIC DIVISION

In its fifth anniversary year of 1961, Ford Motor Company's Aeronutronic Division of Newport Beach, California, continued the phenomenal growth which characterized its existence since it was founded in 1956.

From a handful of people five years earlier, Aeronutronic at year's end had more than 3,000 employees, and was well on the way to its goal of a research and development staff which will consist of more than 5,000 engineers, scientists, management, manufacturing and support personnel by the end of 1962.

The Aeronutronic organization is made up of several major components—Space Systems Operations, Tactical Systems Operations, Electronics Operations, Special Programs Operations, Research Laboratories, and Manufacturing Operations, plus a supporting Technical Staff and Administrative Staff.

Under contract to the National Aeronautics and Space Administration's Jet Propulsion Laboratory, Aeronutronic was developing a 300 pound lunar capsule which will be landed on the surface of the moon in 1962, after travelling its 240,000 mile journey aboard the JPL "Ranger" spacecraft.

As NASA fired Rangers I and II from Cape Canaveral, engineers at Aeronutronic continued at a steady pace in preparing the payload package for the Ranger III, IV, and V for launches during 1962. Aeronutronic designed and was building the lunar capsules which will be carried aboard the Ranger III, IV, and V.

Aeronutronic was system integrator and payload carrier contractor to the Air Force on the Blue Scout solid fuel rocket program, and was responsible for conduct of launch operations at Cape Canaveral.

During the year, a series of Blue Scout rockets were fired by Aeronutronic and the Air Force Canavera. Launched during 1961 were several configurations of the multi-stage Air Force rocket—the Blue Scout Junior, Blue Scout I and Blue Scout II.

The problems of manned space flight were studied by scientists at Aeronutronic. Working under a contract awarded by the Aeronautical Systems Division of the USAF Systems Command, the Ford-Aeronutronic scientists were investigating possible space structures which could form a multi-unit space vehicle and be adapted in flight to a variety of tasks. The Aeronutronic investigation was focused on three structures for "space train" cars—pressure-stabilized membrane structures, rigid-panel inflatable structures or "space shingles," and telescoping structures.

Another major area of activity in Aeronutronic Space Systems Operations was the continued development and testing of decoys in support of the Air Force ICBM program. Details of this program are classified.

In Aeronutronic's Tactical Systems Operations, the still-secret Shillelagh guided missile was under development for the Army. The Shillelagh is a new surface-to-surface guided missile being developed for close-in support of front-line troops which will greatly increase fire power against armor as well as troops and field fortifications. Vehicle mounting is one application of the Shillelagh system. Like its Irish namesake, the Shillelagh missile system will combine simplicity of operation, reliability and lethality. The extreme accuracy of this small guided missile will provide a first round kill probability against stationary or moving targets. The Shillelagh's minimum maintenance and high effectiveness will result in a low-cost-per-tank kill at ranges far exceeding those of historical anti-tank warfare. In the development stage, the Shillelagh is expected to be operational in the mid-1960's.

An artificial MIND unit which duplicates portions of the human nervous system as part of Aeronutronic's self organizing machine research work was but one small phase of important activity carried out in the Division's Research Laboratories.

The "Battlefield Command Post of the Future," a mobile electronic command post known as ARTOC (Army Tactical Operations Central), was rapidly taking shape for the U.S. Army Signal Corps at Aeronutronic. ARTOC will provide the Army Field Commander an easily assimilated display representation of the rapidly changing tactical situation. A radically new concept in battlefield control, ARTOC utilizes highly advanced systems of communication, data processing and display techniques and controls an area of 500,000 square miles.

Air Cushion vehicles which can travel five feet above the surface of the ground at 80 miles an hour were under study by another group of engineers. These vehicles, riding on a cushion of air, can potentially replace most existing wheeled and tracked vehicles in those instances where off-road and amphibious mobility is of prime importance. They could transport men and equipment equally well over dry land, water, mud, swamp, sand or snow.

BIAX computer elements so small you can hold 5,000 in the palm of your hand were another product at Aeronutronic. This tiny ferrite computer element is capable of storing information and supplying it to a computer on demand within a ten-millionth of a second. BIAX devices can be incorporated into many types of memory units—from small storage equipment to large "working" memory complexes.

During 1961, Aeronutronic personnel occupied the last of 10 buildings in the Engineering and Research Center located on a 200 acre site overlooking the Pacific Ocean. The modern research facility contains nearly 1,000,000 square feet of covered area.

Additional facilities in southern California included 90,000 square feet of office, shop and laboratory space in Santa Ana, and a special test firing range located on a 25 acre site at El Toro. Both are near Newport Beach.

In the spring of 1961, Aeronutronic established a field test office at the White Sands Proving Ground in New Mexico to support a classified Army missile program. Work at White Sands was being done by Aeronutronic in connection with the Army Rocket and Guided Missile Agency (ARGMA).

Aeronutronic also had a facility at Cape Canaveral, Fla., and maintained offices in Boston, Mass.; Red Bank, N.J.; Dayton, O.; Washington, D.C.; Huntsville, Ala.; and Los Angeles, Calif.

Although Aeronutronic in 1961 was active in research and development, the division was establishing a manufacturing capability for production of reliable end-products and advanced systems.

THE GARRETT CORPORATION

Garrett's 25th year comprised another new era of progress in research, development and manufacture of both commercial, military and space components and systems.

The organization at year-end was composed of seven divisions and two subsidiaries employing approximately 9,500 people in operations which spanned the world. The company was the leading manufacturer of environmental control systems for aircraft, missiles and spacecraft. From the wartime Boeing B-29, first production aircraft ever pressurized, to Project Mercury's space capsule, Garrett's pressurization and air conditioning equipment, or related products, have been a part of every manned, high altitude vehicle of flight built in the United States.

In addition to its primary role in aeronautics and space, The Garrett Corporation operated in a number of other important fields.

The success of Garrett's life support system in sustaining the astronauts aboard Project Mercury's first flights brought additional orders for the system. Garrett was also called upon by McDonnell Aircraft Company, the prime contractor, to supply further equipment related to astronaut survival, namely, an automatic blood pressure measuring system.

Garrett was invited to participate in a feasibility study for a similar life support system—the three-man Apollo capsule being readied for a two-week trip to the moon and back to earth.

Garrett was well into a three-year study of environmental control systems for future space vehicles under contract from North American Aviation for the Air Force.

Soon after the first Mercury shoot, Garrett was in receipt of a new contract from Boeing Airplane Company to develop a hydrogen cooling system for the Air Force's Dyna-Soar.

While Garrett's environmental control systems have been traditionally associated with human survival, the need for controlling temperature within unmanned space satellites has become equally important. Garrett in 1961 received a contract in this field from RCA for such a vehicle, crammed full of electronic products which must operate under specific temperatures in order to function. An AiResearch space radiator, among other heat transfer equipment, is a feature of this project.

Garrett's AiResearch Manufacturing Division in Phoenix was well into the Air Force's SPUR project, largest space power system now funded and under development in the U.S. Garrett is prime contractor and systems manager for SPUR, which will be a nuclear power station in space. Based on a number of technical break-throughs in the art of handling hot, corrosive atomically generated temperatures, SPUR was expected to be ready for moon shots and other space probes by the late 1960's.

Solar power for use in space was the object of another important Garrett project continuing at AiResearch, Phoenix, under an Air Force contract. The order called for first test of a space boiler and heat storage unit actually using the sun as a heat source. The energy thus stored would be used in a space vehicle when orbiting in the earth's sunless shadow.

Other space and missile programs in which Garrett participated on a contractual basis during 1961 included: Atlas, Discoverer, Green Quail, Hawk, Hound Dog, Jupiter, Mace, Mauler, Minuteman, Nike Hercules, Nike Zeus, Pershing, Polaris, Redstone, Saturn, Sergeant, Sky Bolt, Space Plane, Subroc, Titan and the X-15.

The nation's airlines continued to be the biggest commercial users of AiResearch's gas turbines, for ground support of their planes—air conditioning, engine starting, etc. However, a new trend was developing among aircraft manufacturers, airlines and corporate aircraft owners to carry the gas turbine engine aboard to make a plane self-sustaining wherever it goes. A number of these installations were made during the year and others were on order in increasing numbers.

Further commercial possibilities were seen in a number of other products developed during the year. An ingenious portable source of breathable air—the AiResearch "back pack"—applied to a pressurized suit, makes the wearer independent of outside atmosphere. Built for future use in space, it was sold commercially for the more immediate function of protecting a man working under toxic conditions of fumes and smoke.

A revolutionary automatic blood pressure measuring system, developed for Project Mercury capsule flights to telemeter an astronaut's blood pressure while in space, has definite commercial possibilities, according to medical authorities. Hospitals, they believe, would find many vital uses for such a machine to provide automatic reports on patients requiring continuous or periodic blood pressure tests.

A unique, high speed dental drill developed in Phoenix was delivered to the Air Force. It is the highest speed air-bearing handpiece ever built for dentistry. It operates quietly and requires little maintenance. Because it requires almost no pressure, and reduces contact time by 75 per cent, discomfort for dental patients is greatly lessened.

The coming year holds many expectations of other products adaptable to the commercial market to add to Garrett's traditional diversification of interests.

Participation in the Lockheed F-104 Starfighter program saw Garrett completing contracts with six foreign countries and the U.S. for installation of AiResearch products and systems on this advanced jet all weather fighter.

The AiResearch central air data computing equipment for the F-104 is one of the most scientifically accurate and ingenious systems yet devised for aircraft. It literally "thinks" for the pilot, readily giving him simple answers to otherwise complex problems of the mathematics of supersonic flight in push-button style. In addition to environmental and air data systems, and depending upon the particular specifications of individual customers, other Garrett equipment which is part of the F-104 includes starters, actuators, heat exchangers, ground support units and related components to amplify the program.

Nations actively involved in acquiring the F-104 include Germany, Canada, Japan, the Netherlands, Belgium, Italy and the U.S.

The success of such turbine aircraft as the Boeing 707, the Douglas DC-8, the Convair 880 and the Lockheed Electra spurred the development of several new passenger transports to fit various new requirements. Different in design from its predecessors is the Boeing 727, a three-engine transport, designed for short haul airline routes. This plane will be fully air conditioned and pressurized by Garrett, and depending upon the requirements of the individual airlines, will contain a number of other Garrett components. One particularly interesting feature being used in the Eastern Airlines version of this aircraft is an auxiliary gas turbine engine, installed within the fuselage to make the plane entirely independent of supporting ground power for lighting, starting, and other essential support services. Versions of Sud Aviation's newest Caravelle VII model also contain the on-board gas turbines as well as a full complement of Garrett environmental controls and other components.

Other new transport aircraft developed since last year include the Boeing 720, fully pressurized and air conditioned by Garrett, and the Convair 990 which carries Garrett equipment in this and other areas.

Air Cruisers, the majority of whose sales continued to be in the air transport industry, enjoyed a pronounced increase of participation in military business.

Military contracts for approximately 7,000 life vests and 500 protective fuel handlers' suits, the latter a new product line, were received in addition to research and development contracts from government sources which encompassed such products as inflatable Arctic shelters, air aspirated military rafts and raft sleeping bags.

Emergency flotation systems for B-58 crew ejection capsules and inflated air springs for the protection of Polaris missiles in transit were other interesting products being sold by Air Cruisers.

Sale of the air aspirated life raft reached a top position during the year and Air Cruisers' aircraft escape slide attained new highs in popularity. Air Cruisers in 1961 counted every U.S. airline operator utilizing these types of equipment as a customer.

International sales grew by 63 per cent over 1960. Despite a slight tapering off of commercial airline business in foreign countries, a compensating upturn in sales to Garrett licensees, airframe manufacturers and Government agencies overseas was evident. The F-104 program in NATO countries was creating a substantial backlog which will be reflected in 1962 sales.

Activities abroad, which included solidification of operations of jointly owned companies in Europe and Japan for the manufacture, sale and overhaul of Garrett equipment abroad, were proceeding as planned, and additional exploratory inroads were being made in Latin America.

Garrett took a prominent part in the internationally important Paris Air Show with a striking display of its products and heightened interest by aeronautical and industrial leaders in attendance from all over the world.

Garrett Manufacturing, Limited of Canada reported quite significant increases in backlog during fiscal 1961, requiring enlargement of facilities to double the space available at the beginning of the year.

Expansion also was apparent in the development of new support activities with the addition of repair and overhaul facilities and increased manufacture of ground support and test equipment.

Working under the Canada-U.S. defense sharing agreement, Garrett Manufacturing, Limited began to sell a substantial amount of products into the United States and expected to continue to expand in this area.

One of the largest wire and cable companies—Anaconda—was the newest principal to be represented by the Air Supply-Aero Engineering Division. The latter was applying its nationwide sales and engineering facilities to make Anaconda's wide capabilities directly available to the space, missile, aircraft and electronic industries.

Other new principals added to the Air Supply-Aero Engineering clientele during the year included the Raymond Atchley Division of the American Brake Shoe Company, and the Potentiometer Division of Calbest Electronics Company.

AiResearch Aviation Service Division continued to be one of the busier locations at Los Angeles International Airport. It handled daily arrivals and departures of scores of business, military and private aircraft, as well as unscheduled airliners.

Engaged in modification and maintenance for this category of planes the division continued to retain a commanding position in the adaptation of new Grumman Gulfstream turboprop aircraft for business use. In spite of considerable competition, it modified and completed more Gulfstreams than any other agency. Also, following a preparatory planning program, the division expected to handle the majority of the first deliveries of certificated Lockheed Jet Stars for business use.

An additional contract for conversion of five Convair planes from piston to turbine power utilizing Napier Eland engines was received, and airline servicing work continued to grow, particularly with jet transport aircraft.

GENERAL ELECTRIC COMPANY

FLIGHT PROPULSION DIVISION

FLIGHT PROPULSION LABORATORY DEPARTMENT

The Flight Propulsion Laboratory Department is responsible for flight and space research, and the development of advanced components and propulsion systems.

In November, 1961, the department received a $6,900,000 initial contract to conduct a VTOL flight research program. The Army's Transportation Research Command made the award. Ryan Aeronautical Company will design and build the fan-in-wing aircraft in its capacity as major subcontractor to General Electric. First flight was targeted for May, 1963.

The Company's X353-5 lift fan propulsion system completed full-scale wind tunnel testing at NASA's Ames Research Center, Moffet Field, California, with both the fan-in-fuselage and fan-in-wing configurations. The diverter valve, which directs engine exhaust either to the lift fan for vertical flight, or through the jet nozzle for forward flight, was developed under Air Force contract.

Research and development work in electrical propulsion and power generating systems that began in 1957 continued during 1961. The XT-761, a 30-kilowatt a-c arc jet engine producing one-half pound of thrust was test-demonstrated, and mission studies were begun under NASA contract.

The plasma accelerator and ion engine were two other types of electrical space engines under development. A computer program was developed that can evaluate a new ion engine configuration quickly and effectively. With this program, direct interception of the ion beam with the electrodes has been virtually eliminated; thus engine life and efficiency are improved.

A 50-kw alkali metal test facility was placed in operation, and construction was begun on a 100-kw and a 300-kw unit. Temperature capabilities of these units range from 1600 to 2200 F.

Another NASA contract received during 1961 called for demonstration of a potassium vapor turbine applicable to large space power systems. Two stages of a 500-kw turbine will be designed, built, and tested for more than 2000 hours in wet potassium vapor.

Also, in 1961, contracts totaling $9,000,000 were received from Thiokol Chemical Corporation for continued production of solid rocket cases for the Minuteman missile. These contracts extend through 1962, and also include advanced case development work.

Fundamental investigations of aerodynamics, combustion, thermodynamics, mechanics, metallurgy, chemistry and physics were also carried on by the department. To help further this work, a hydrogen facility for fuel and combustion research was installed, and a vapor phase deposition facility for high temperature material research was designed and built.

LARGE JET ENGINE DEPARTMENT

General Electric's J93 turbojet engine, advanced powerplant for the trisonic B-70, successfully completed an unofficial PFRT endurance run in mid-1961, and the company's J79 turbojet engine, which passed its 200,000th flight hour in September, continued powering Mach 2 aircraft to new flight records.

In a 90-hour endurance test, the J93 engine ran for nearly 22 hours at a Mach 3 power setting, while being subjected to the same inlet conditions it would encounter at a speed of 2000 mph, and altitude of 65,000 feet. These conditions were simulated in a multi-million dollar ram-test facility, built last year at G. E.'s Evendale plant. The official PFRT schedule requires 18 hours of Mach 3 running, 50 hours of static sea level testing, and altitude performance demonstrations at the Arnold Engineering Development Center, Tullahoma, Tennessee.

Most of the J79 engine's 200,000 hours of flight were logged by the Lockheed F-104, General Dynamics' B-58, McDonnell F4H and North American A3J. Together, these Mach 2 aircraft established 19 world class records. Significantly, only nine of the more than 50 records recognized by Federation Aeronautique Internationale are at speeds greater than 1000 miles per hour—and the J79 powered eight of them. The ninth was also held by the U.S.

Four J79 engines powered the B-58 Hustler to six world speed and payload records early in 1961. Later, the Air Force bomber accomplished what no other aircraft had ever done: it maintained an average speed of over 1300 miles-per-hour for more than 30 minutes. The Hustler also streaked from New York to Paris in a record time of 3 hours and 20 minutes—one-tenth the time taken by the "Spirit of St. Louis" in 1927.

The twin-engine McDonnell F4H, in addition to setting a new coast to coast speed record in July, averaged 902 miles per hour over a 3-km, low-altitude course in September to claim a world record in that event. The Phantom II also held the 500-km and 100-km closed-course records with speeds of 1216 mph and 1390 mph, respectively.

The F4H and A3J aircraft scheduled for fleet deployment by the Navy are powered by the J79-8 engine. The advanced powerplant is rated in the 17,000-pound thrust class. Both the F4H all-weather fighter and A3J heavy attack-bomber have passed carrier suitability trials under "Dash 8" power.

In addition to U.S. production of J79 engines, hundreds were being built by foreign countries for use in their F-104 Super Starfighters. Under Technical Assistance Agreements, General Electric was assisting manufacturers in Canada, West Germany, Belgium, Italy and Japan in the production of the J79.

Progress in propulsion technology resulting from 1961 development programs at General Electric include:

- Improved temperature materials for use with extremely high gas temperatures.
- STEM drilled air cooled turbine buckets that permit high turbine inlet temperatures.
- High-temperature control and accessory components.
- Variable-area exhaust nozzles that function in conjunction with fuel control to optimize efficiency of engine throughout flight spectrum.

Under Air Force contract, G. E. was conducting component demonstration tests for a high Mach number engine that has a much higher thrust-to-weight ratio than existing engines.

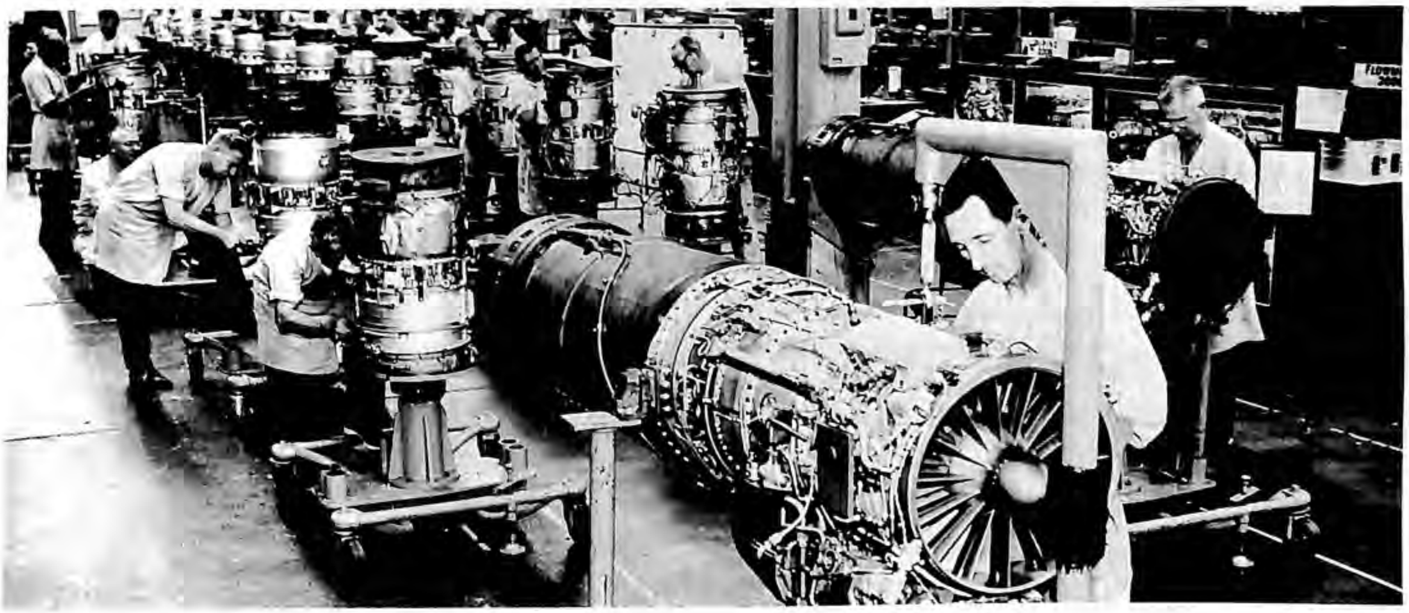
SMALL AIRCRAFT ENGINE DEPARTMENT

T58 helicopter engines and J85 jet aircarft and missile engines were in full production and the T64 entered the flight test phase of development during 1961.

The T58 went operational in the Navy's Sikorsky HSS-2, the nation's newest anti-submarine warfare helicopter and the first one able to both search out and destroy enemy submarines. In May a T58-powered HSS-2 set two world helicopter speed records—recapturing one of them from the Russians.

The J85 went operational with the Air Force in the Northrop T-38 which is the nation's first supersonic trainer. Jacquelin Cochran flew the J85-powered T-38 to nine women's world speed records. The McDonnell GAM-72 decoy missile with a J85 engine became operational with Strategic Air Command.

The T64 began flight tests in the deHavilland Caribou. The engine was selected as the powerplant for the Tri-Service VTOL Transport to be built by a team of Vought, Hiller and Ryan.



GE's Small Aircraft Engine Department reached all-time production peak in 1961.

The CT58 (commercial version of the T58) was the powerplant for the turbocopters of every major domestic helicopter airline—New York Airways' Boeing-Vertol 107's, Los Angeles and Chicago Helicopter Airways' Sikorsky S-61's and San Francisco and Oakland Helicopter Airlines' Sikorsky S-62's.

The CJ610 (commercial version of the J85) was introduced as a powerplant for business jet aircraft and was named a powerplant for the Aero Commander Jet 1121, Piaggio-Douglas DP-808 and the Swiss-American SAAC-23 executive jets.

COMMERCIAL ENGINE OPERATION

High point of the year for the Commercial Engine Operation was TWA's announcement of its purchase of twenty Caravelle 10A's powered by GE aft-turbofan engines. This transaction was significant, since it meant that TWA will be the first airline in the world to inaugurate short range turbofan-powered service.

It also marks a new application for GE's turbofan engine. TWA will call its Caravelle 10A "La Nouvelle Caravelle".

Further confidence in General Electric powered jets was evidenced by repeat orders for the Convair 880 from Delta, Viasa and Japan Air Lines. Cathay Pacific also joined the list of 880 purchasers in 1961 with an order for a single airplane.

In 1961, the Convair 880 was in service over five continents with eight airline customers. Its GE engines had logged a total of more than 375,000 flight hours by year-end.

Time Between Overhaul continued its rapid growth, and by December, the TBO was expected to be at 1600 hours for Delta Air Lines and 1400 hours for Trans World Airlines and Northeast Airlines.

The company's aft-turbofan engine will enter service with a basic TBO of 1200 hours, as compared with an original 800 hours TBO for the GE straight turbojet. This applies to the Convair 990's ordered by American Airlines.

The extended TBO was awarded on the basis of service experience of the CJ-805 straight jet and design features of its turbofan version. Operating characteristics of the CJ-805 gas generator are the same, whether its exhaust flows through a reverser/suppressor or an aft turbofan.

During 1961, the company intensified its study of the advanced technology necessary for development of a propulsion system for the supersonic transport. Increased national interest in the SST is being spearheaded by an FAA-sponsored development program.

As a result, GE received an Air Force contract for a conceptual study of an optimum-type SST powerplant. Work covered in the contract is consistent with the company-funded study programs that have been going on for two years.

DEFENSE ELECTRONICS DIVISION
MISSILE AND SPACE VEHICLE DEPARTMENT

The Missile and Space Vehicle Department, the General Electric Company component responsible for research, design, development, and production of equipment and systems for missiles, earth satellites, and space vehicles for civilian and military application, continued its steady growth during 1961.

During the year, the department's new multimillion dollar Valley Forge Space Technology Center neared completion, and personnel began moving into the facility in July. One of the largest privately-financed space research centers in the country, the Valley Forge facility will house approximately 4,000 Department employees and will contain the most advanced equipment and laboratories for development of space technology.

Research, development, and production of nose cones for ballistic missiles continued to be a major function of the Department during the year. Development of the Mark 3 re-entry vehicle, the "second generation" nose cone for the Atlas missile was completed during the year. This vehicle, the first ablative type ICBM re-entry vehicle to become operational, in July 1961 established a long-distance flight record with a flight of 9,054 miles from Cape Canaveral to an impact area in the Indian Ocean.

Other re-entry vehicles on which the Department conducted work during the year included the nose cone for the Titan II ICBM, and the nose cone for the Skybolt air-launch ballistic Missile.

In June, a $10 million contract was received for development and production of ICBM target vehicles required by the Army to test its Nike-Zeus anti-ICBM weapons systems. These vehicles will be designed to simulate as closely as possible various combinations of re-entry vehicle threats.

Research and development of new materials for use in space continued throughout 1961. This work included investigation of new ablative materials for use in re-entry vehicles, and in research in metal and ceramic technology.

Work in the area of manned space vehicle development was accelerated during the year, culminating in the preparation of a proposal to the National Aeronautics and Space Administration for the Apollo manned space flight program.

Much effort was also devoted to the development of equipment and systems to provide electrical power in space. Contracts were received from the military services and NASA for research and development in the fields of solar cell technology, fuel cell batteries, and other devices.

Investigative work in magnetohydrodynamic power generation was also continued during the year and a Repetively Pulsed Plasma Propulsion Engine (REPPAC III) developed by the Department was fired continuously for 60 hours during one test held during the year. Department scientists believed that was a record for this type of device.

In the area of satellite development, the department received a contract from the National Aeronautics and Space Administration for the construction of the spacecraft and integration of the subsystems for the first two Nimbus meteorological satellites. This satellite system is the second project in NASA's long range research and development program to explore the problems and technology of a global weather analysis system.

A $6 million contract to develop the control system for NASA's Orbiting Astronomical Observatory was also received during the year. This contract was received from the Grumman Aircraft Engineering Corporation, which has overall responsibility for the OAO Satellite System.

The department also continued work on the Army Advent communications satellite system. In this project the department had the responsibility for development of the space vehicle and its associated equipment. In this communication system, active repeater satellites orbiting the earth's equator at a height of 22,300 stature miles and a speed of 7,000 miles per hour would provide virtual worldwide instantaneous communication.

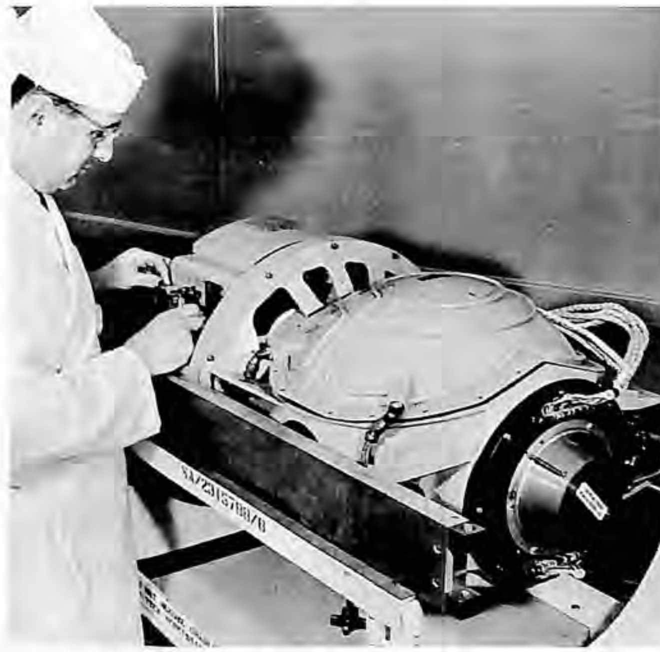
Work in the area of re-entry technology continued and the department built several re-entry capsules for use in the Department of Defense's "Trailblazer II" program. In this program, which is part of the overall Project Defender program, the capsules will be launched as the fourth stage of the Trailblazer vehicles. Two stages will carry the capsules nearly straight up to 190-miles altitude, and then the final two stages will "power dive" nearly straight down at speeds up to 17,000 miles per hour. The purpose of the flights is to duplicate hypervelocity re-entries for analysis which will be applied to re-entry technology.

Vulcan, the six-barrelled cannon developed by General Electric, was maintained in production during the year for both American and European aircraft, and studies on the development of helicopter armament systems were continued. Work was also carried out on the development of a "thin-film" evaporator system for purifying saline and brackish water.

Employment in the department continued to rise during the year, reaching a total of over 8,000 during the third quarter. Approximately 25% of the employees were professional engineers and scientists, and another 15% were professional technical support personnel.

ORDNANCE DEPARTMENT

Emphasis by the Ordnance Department on the first-generation MK 1 inertial guidance system for the Polaris missile gave way during 1961 to the more sophisticated second-generation MK 2. This smaller, lighter inertial guidance system will be used on advanced, longer range, Polaris A-2 (1500 nautical mile range) and A-3 (2500 nautical mile range) missiles. The first fully guided flight of the MK 2 was scheduled for sometime before the end of 1961.

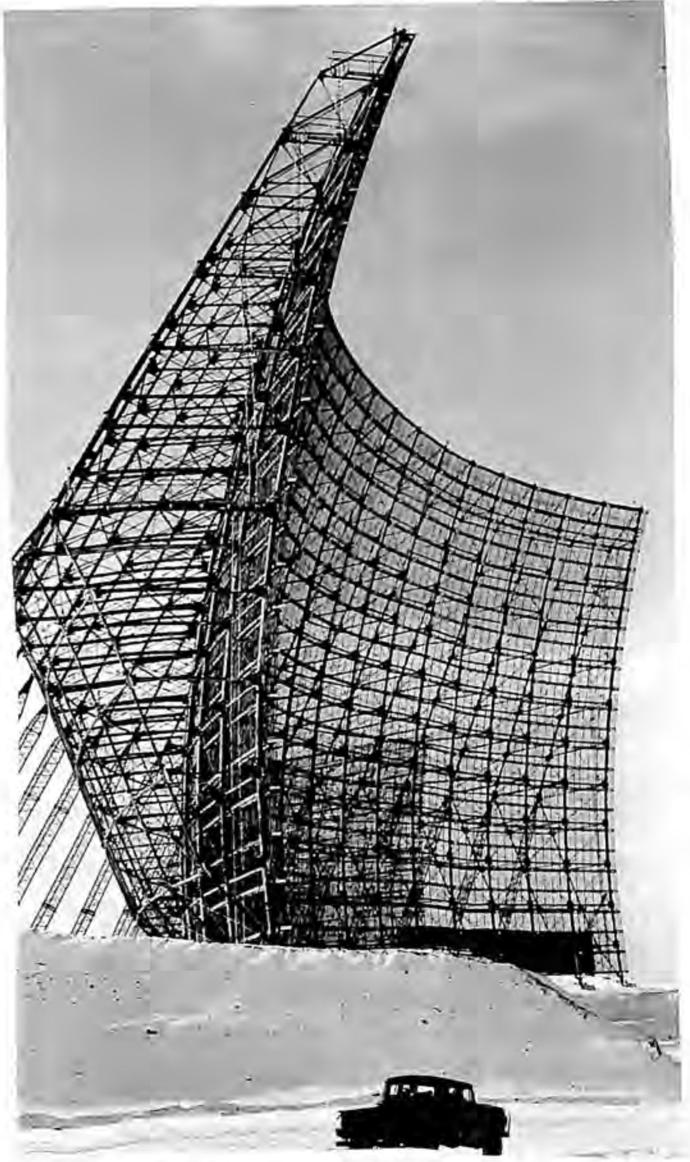


GE-Ordnance technician "buttons up" Polaris Mark I inertial guidance system.

The MK 80 fire control system, used in repeatedly successful underwater submarine launches of Polaris missiles from FBM submarines, will be supplanted by the second-generation MK 84 fire control systems aboard advanced submarines. Design was completed during 1961 and systems testing of the first MK 84 system was to get underway in February, 1962. Plug-in wire-wrap modules are used in the easy-to-maintain and extremely reliable MK 84, and extensive efforts were expended to automate manufacture of the new system's components.

In September, the USS Long Beach, equipped with the MK 12 weapon handling system, was launched. The Ordnance Department MK 12 handles the 30-ft long, 2½ ton Talos missile aboard this nuclear-powered vessel. In addition to the Long Beach, which is the Navy's first guided missile cruiser, three additional cruisers were being equipped with MK 12 systems.

Research efforts concerned with the development of cryogenic inertial components, to improve missile and space vehicle guidance accuracy, continued apace during the year. The 1961 gyro effort was a continuation of an earlier program which resulted in the proving of feasibility of a cryogenic gyro. The design was refined to enhance the producibility and



GE-built radar antenna at Clear, Alaska.

a new gyro was built. Preliminary phases of a comprehensive test program were completed with encouraging results, and final test data were anticipated early in 1962. A similar development program was underway for a cryogenic accelerometer; a prototype accelerometer was built and a test program will follow closely the gyro development.

The 600-ft radio telescope at the Naval Research Station at Sugar Grove, W. Virginia, will depend for its accuracy in a unique Ordnance Department optical alignment system. The Ordnance Department completed a feasibility study and was designing the system that will provide continuous line-of-sight monitoring of the antenna.

A unique shipboard communications tracking antenna system for Project ADVENT was under design at the Ordnance Department. Gearless power drives (servo-controlled direct-drive motor), developed by the Ordnance Department, employed in three axes, will enable ultra precise positioning of the antenna's 30-ft reflector. Project ADVENT objective is to demonstrate the feasibility of a microwave communications satellite that would operate in a twenty-four hours synchronous equatorial orbit, receiving and amplifying radio signals and retransmitting them to ground stations thousands of miles from the point of origin. First application of the General Electric gearless power drive was with the ultra high precision tracker for the Atlas ICBM radio command guidance system. It is used also with the fire control director for the shipboard TARTAR missile system and with the stable platform for the Polaris inertial guidance system.

HEAVY MILITARY ELECTRONICS DEPARTMENT

During 1961 the General Electric Company's Heavy Military Electronics Department at Syracuse, N. Y., expanded its role as one of the foremost producers of radars and sonars for military applications.

Early in January the first operational AN/FPS-24 Search Radar—a new family of long range, high power air defense radars—was installed at an Air Force station north of San Francisco. Designed to detect high altitude, supersonic aircraft at great distances despite the presence of interference and enemy countermeasures, these new radars will supply data to the Air Defense Command Semi-Automatic Ground Environment (SAGE) System. In 1961, the Heavy Military Electronics Department was awarded production contracts for the FPS-24 totalling more than $40,000,000.

Late in September, General Electric field service engineers and technicians completed installation and testing of the missile surveillance radars at the second station for the Air Force's Ballistic Missile Early Warning System (BMEWS). Located at Clear, Alaska, this station will detect any ballistic missile attack launched against the United States and Canada from the Western flank of the northern polar regions.

A similar giant missile detection radar has been operational since October, 1960, at the USAF's first BMEWS station at Thule, Greenland. Together these two General Electric-built missile detection radars represent the largest such installations ever undertaken. They will thrust huge curtains of radar signals some 3,000 miles across the top of the world to detect oncoming ballistic missiles as they rise over the horizon and penetrate the radar curtain.

Also during 1961, the first operational High Power Acquisition Radars (HIPAR) for the U.S. Army's Improved Nike-Hercules Weapon System were installed at Army missile sites guarding our nation's industrial and population centers.

Developed by General Electric's Heavy Military Electronics Department under a subcontract with the Bell Telephone Laboratories, this advanced surveillance radar detects and locates far smaller and much faster airborne targets at much longer ranges than previously possible. Its addition more than triples the defensive capabilities of the Army's Nike-Hercules system against advanced manned aircraft, air launched missiles and short range surface-to-surface missiles.

In May, a $36,000,000 contract for production of the U.S. Navy's new AN/SPS-30 long range height finding radar was awarded to General Electric's Heavy Military Electronics Department. The longest range height-finding radar in quantity production for the Navy today, the pencil-beam SPS-30 is designed to increase the anti-air warfare capability of the fleet and will replace General Electric-built SPS-8 radars now in use aboard many of the Navy's combat ships. The first operational SPS-30's were scheduled for delivery to the Navy in May, 1962. They will be installed aboard modern missile cruisers and carriers.

Undersea warfare equipments being developed and produced by the Heavy Military Electronics Department, during 1961, included the SQS-26 anti-submarine sonar, believed to be the world's largest for surface ships; the UQS-1 mine detection and location sonar; the BQN-3 depth sounder; and many other advanced anti-submarine detection and sonar countermeasures equipments and underwater communication and navigation devices.

For land warfare, the Department continued production of MPQ-4 mortar locator radars, which pinpoint the location of enemy batteries and assist in counter-firing; and TPQ-10 Radar Course Directing Centrals for precise control and guidance of close support tactical aircraft. Completely air or ground transportable in two light-weight units, the TPQ-10 consists of a precision tracking radar, and a control central which resolves aircraft position and manually inserted target, wind and ballistic data into aircraft guidance and bomb release commands.

Research and development work on the new Situation Display equipment for use with the Air Force's Missile Defense Alarm System (MIDAS) neared completion. Heart of this new display equipment is the unique Military Electronics Light Valve (MELVA) Projection System. To be utilized in MIDAS for the analysis of infra-red sensed data being flashed back to earth from orbiting satellites, MELVA will supply real-time, high intensity displays in multi-color on a TV-size console, or a 6x9 foot command display. Push-button controls on the display console will permit the battle commander to view individual sectors for more detailed information. Data from multiple satellites will be displayed in various colors for rapid identification. MELVA's combination of color, high intensity picture quality, and instantaneous time display has never before been available for military applications. It will provide a major improvement over the low-light levels necessary for viewing present-day battle command displays.

To keep pace with rapidly changing customer needs and technologies in the missile and space age, the General Electric Company's Heavy Military Electronics Department organized a Systems Operation during 1961. This new organization consolidates the Company's vast management skills and technical know-how in surface-based surveillance systems, undersea warfare systems and aerospace defensive systems under one organization.

This new System Operation will enable the Department to better meet the nation's defense needs by applying the systems management knowledge and techniques developed during the past seven years, while engaged in large scale projects such as BMEWS and the 412L Air Weapons Control System, to major defense programs in the undersea warfare, missile defense and aerospace defense systems.

In the undersea warfare systems area, extensive work was being done on anti-submarine warfare systems for detecting and destroying enemy submarines; undersea surveillance systems, such as Fishbowl, for keeping track of all underwater targets in the wide expanses of ocean that cover three fourths of the earth's surface, and underwater communication systems for transmitting information between submerged submarines. Numerous investigations were being conducted on future missile surveillance systems, anti-missile system, and surface-to-air missile systems. Likewise, the Department was expanding its scope in the areospace defense field. In cooperation with the Company's Missile and Space Vehicle Department, it was studying a ground communications system for Project Apollo, the nation's next major manned space flight program after Project Mercury.

To maintain its leadership in the radar and sonar fields, General Electric's Heavy Military Electronics Department completed its new 465,000 square foot, ultramodern $8,000,000 engineering and manufacturing facility as the Farrell Road Plant, in March, 1961.

DEFENSE SYSTEMS DEPARTMENT

The year 1961 was eventful for the Defense Systems Department, Syracuse, New York. In January (the 23rd) the Air Force fired the last "D" series Atlas from Cape Canaveral—using General Electric's radio-command guidance. This event was the culmination of an R & D test program for the radio system which included guidance of the nation's first two 9,000 mile ICBM flights, placement of Midas satellites into orbit and a string of 21 successful Atlas launches. In two years of test flights, the system guided 33 Atlases without having a single in-flight failure.

On September 13, 1961 the radio-command guidance system was successfully employed to guide the Project Mercury space capsule into orbit with an electronic astronaut aboard. General Electric engineers and space technicians continued to apply their skills to the task involved in placing the first manned U.S. spacecraft into an earth-orbit with the radio-command guidance system.

In 1961, man was once again reaching for the moon—and once more using radio-command guidance for the attempt. Earlier launches of the National Aeronautics and Space Administration's Ranger Program are designed to test the launch vehicle and the Ranger Spacecraft. Later Ranger test will attempt to send television pictures back from the moon, and eventually impact one of the Ranger vehicles on the moon, plus having the vehicles carry out a host of scientific experiments during their flights. In the Ranger Program, the Defense Systems Department's guidance system controls the Atlas booster which carries the spacecraft up to its parking orbit. The Ranger Program was the first application of General Electric's new lightweight, transistorized airborne beacons that were used aboard the Atlas booster. During 1961, radio-command guidance was also selected for guidance of the Atlas boosters' for the Army's Advent communications satellite.

Rapid developments in the areas of missile range instrumentation during the year included installation of MISTRAM equipment on the Atlantic Missile Range, GERSIS on the Pacific Missile Range and pre-GERSIS range safety functions at PMR and trajectory instrumentation and range safety functions for all Atlas and Titan launches at AMR. The MISTRAM system for the Atlantic Missile Range is a missile trajectory measurement system under development by the Defense Systems Department for the Air Force Missile Test Center.

The system was scheduled for operation in the Spring of 1962. MISTRAM will monitor missile flights at AMR and was expected to give extremely precise data on a missiles's position and flight path. GERSIS is a G. E. range safety and instrumentation system which will provide real-time impact prediction data to the range safety officer at the U.S. Naval Missile Facility at Pt. Arguello, California. This instantaneous display of information is designed as an aid in the protection of personnel and property particularly downrange during missile flights. The system will also be vital during the Nike Zeus tests, the Navy reports.

1961 was also significant for the Defense Systems Department due to the fact that it assumed the management and development responsibilities of the 412L Air Weapons Control System under a contract with the Electronic Systems Division, AFSC of the Air Force. This advanced electronic control system is a closely coordinated network of data acquisition stations, data processing and display centers, and weapons bases that will provide the tools for effective aerospace management. The system, designed for use throughout the Free World, will operate at rapidly erected mobile sites as well as permanent stations. Through effective integration of many different types of existing equipment, 412L will tie radar sites, command control centers and weapon bases into a unified, highly capable air weapons control operation.

LIGHT MILITARY ELECTRONICS DEPARTMENT

During 1961 General Electric Light Military Electronics Department continued development and production of aerospace electronics systems across a broad spectrum of military products, including:

Development and production of armament and flight control systems for the F-105 high performance fighter bomber.

Production of guidance and control systems for SIDEWINDER.

Production of digital guidance computers for POLARIS.

Development of the digital guidance computer for SKYBOLT.

Development and flight testing of GESAC flight control systems aboard the F-106.

Development and production of missileborne radio guidance system for Atlas and missileborne telemetry system for the MISTRAM System.

Avionics consultant for the W2F-1, conducting studies to optimize the avionics system for this carrier based early warning aircraft.

Development and production of horizon sensors used with several satellites including Discoverer.

Development of a thermoplastic recorder/display system capable of correlating radar signals.

GENERAL DYNAMICS CORPORATION

GENERAL DYNAMICS/ASTRONAUTICS

A high level of activity in space projects, initiation of new space programs, production of advanced models of the Atlas intercontinental ballistic missile, and work on an advanced missile tracking system were the highlights of 1961 for General Dynamics/ Astronautics.

GD/Astronautics provided the first stage booster for the Midas detection satellite, intended ultimately to give the Air Force a capability for detection of enemy missile launchings seconds after launch. The booster was a specially modified Atlas missile, 68 feet in height with a launch weight of approximately 260,000 pounds. The booster's three liquid fuel engines produced a total of 360,000 pounds of thrust. The Atlas was topped by a second stage Agena-B.

The company also built the booster for the first stage of the Ranger I unmanned spacecraft, designed for "hard" lunar exploration. This version of the Atlas, known as Atlas III-D, was 78 feet tall, including an adapter section to accommodate the second stage Agena-B. A successful test flight of the initial Ranger was conducted during the year.

The Atlas also figured prominently in the national man-in-space program during the year. On February 21, the modified Mercury Atlas booster sent an unmanned space capsule on a trip down the Atlantic Missile Range. On November 29, a Mercury capsule containing a chimpanzee was boosted into a two-earth-orbit mission by the Atlas, in a prelude to the first American manned orbital mission scheduled for early 1962.

General Dynamics/Astronautics was also engaged in work on a number of other major space programs during the year. The company was building three ARENTS (Advanced Research Environmental Test Satellites) craft for the Advanced Research Projects Agency. The satellites, scheduled for launch in 1962, were to gather data on radiation in space.

For Project Mariner, GD/Astronautics was producing the first stage booster, again a modified Atlas, and the company was working on the Centaur high energy rocket, with hydrogen powered engines, for the National Aeronautics and Space Administration. Atlas-Agena B vehicles were also scheduled to launch NASA's OAO (Orbiting Astronomical Observatory) and OGO (Orbiting Geophysical Observatory) spacecraft. An Atlas-Centaur launch vehicle was designated the booster for the Surveyor lunar exploration craft scheduled for launch in 1963.

In 1961, Astronautics was awarded an Air Force study contract to determine the requirements for SLOMAR, a space logistics and maintenance system. The company was also conducting a study of the requirements for a permanent satellite base for the Ballistic Missile Division, USAF.

In the missile field, GD/Astronautics was advancing development of the Atlas ICBM, already on alert status with Strategic Air Command at two bases. The Series E Atlas, containing a new all-inertial guidance system, was successfully launched for the first time on February 24.

Also successfully launched during the year was the Series F Atlas, designed for 6,300 miles range and for launch from hardened silo sites. Total thrust in the F model is 389,000 pounds, with 57,000 pounds in the sustainer engine. One Atlas F was used in a 5,000 mile test of the nose cone of the new Minuteman missile.

Stainless steel tank sections for Atlas await welding.

Other developments at GD/Astronautics during the year included:

- Receipt of a NASA study contract to determine the design of a launch vehicle powered by chemical and nuclear engines developing 6,000,000 to 12,000,000 pounds thrust.
- Development of an air purifier for recycling air in a manned space capsule.
- Delivery of an advanced missile tracking system, the Azusa Mark II, which permits the Air Force

to track missiles fired down the Atlantic Missile Range and to pinpoint their impact points.

• The start of operations of a new, underwater explosive part-forming facility designed to form special parts for spacecraft. The explosions take place in a 12-foot tank which is part of the new $40,000 facility comprising two buildings, a five-ton hoist and two explosive magazines in a 16,000 square foot area. The new method was expected to lower tooling costs by 40%, since a "punch", necessary in normal fabrication operations, is eliminated.

• Development of a method to receive and process space satellite signals automatically for weather analysis.

• Development of an optical beacon which helps the USAF pinpoint the flight of Atlas missiles. The beacon flashes twice during the last moments of powered flight, a 4,000,000 candle power light fixing the missile's position against background stars. The light, recorded by optical tracking cameras at down range stations, can be photographed more than 400 miles away, and the photographs show the precise trajectory of the missile prior to nose cone separation. The company was also developing a later model of the beacon for the Minuteman missile, under subcontract to Boeing Airplane Company.

GENERAL DYNAMICS/CONVAIR

The jetliner production and testing programs continued at General Dynamics/Convair during 1961. Near the year's end a total of 46 Convair 880's and 880-M's were in airline passenger service.

In January, Trans World Airlines inaugurated Convair 880 service. Later in the year TWA received the last of the 20 615-mile-an-hour jets it had on order. Other 880 deliveries were made to Northeast Airlines during January and by mid-February the airline had six of the planes in service.

Other Convair 880 deliveries were made to Delta Air Lines and late in the year Delta had 11 of the jets in operation. In July Delta placed an order for four more 880's, which will be delivered in July and August of 1962.

On July 25, the FAA issued airworthiness type certification for the Convair 880-M. During the next few months deliveries were made to Civil Air Transport of Formosa, 1; Japan Air Lines, 3; Swissair, 2; Viasa of Venezuela, 2; Federal Aviation Agency, 1; and Alaska Airlines, 1. Additional orders for the Convair 880-M were received during the year from Japan Air Lines, 2; and Cathay Pacific, 1.

First flight of the medium and transcontinental range Convair 990 took place on Jan. 24. Flight testing and FAA certification flying with the plane continued throughout the year. On May 8, during a dive, the plane reached a speed of Mach .97—only three per cent short of the speed of sound. The FAA awarded a provisional airworthiness certificate for the Convair 990 on Nov. 3 and revenue ticket in December. The plane was scheduled to go into passenger service with American Airlines, Swissair, SAS, and Real/Varig.

The last of the Convair F-106 jet interceptors on order by the Air Force were delivered during 1961. A modification program to convert F-106s from test to tactical status was also completed by the company.

On June 6, the first human ejection from the Convair F-106 supersonic pilot escape system climaxed over four years of development and extensive testing of the General Dynamics/Convair-designed escape system.

Nine Air Force squadrons flew Convair F-102s and Convair F-106s at the 1961 William Tell interceptor weapons meet at Tyndall AFB, Fla. An F-102 team from Labrador registered the only perfect missile firing score in the competition.

Design work was started by the company under a subcontract to build empennages for the Air Force C-141 jet cargo plane.

An Air Force contract was awarded on July 1 for continuation of the atmospheric geophysics research program. Purpose of the program is to determine the suitability of using the edge of the horizon as a reference for space vehicle navigation instruments. The contract calls for collection and reduction of data on the infrared characteristics of the horizon as seen from high altitude vehicles.

A research program was started by General Dynamics/Convair on the feasibility of using electric propulsion engines to propel vehicles through deep space under a contract from the National Aeronautics and Space Administration. Research is expected to lead to design of engines, known as electric or ion propulsion or magnetohydrodynamic, operating on the principles of plasma propulsion. A variety of gases—hydrogen, helium, argon and nitrogen—were being used in the experiments.

During the year the company developed a cryogenic pumping system, which, when put into use, will eliminate gases emitted during dynamic testing of small rocket engines within a chamber. The cryopump principle is the freezing of gases into ice, thereby creating an evacuated area.

A new engineering and materials and process laboratory was completed in early 1961. It contains 30 separate laboratory functions for research and development into every phase of fabrication for aircraft and missiles. The 18,700-square-foot-facility includes lab functions for: mechanical properties, creep test, heat treatment, vacuum fusion, welding, ceramics, thermal properties, X-ray diffraction, emission spectroscopy, analytical chemistry, microchemistry and bacteriology, radiochemistry, vacuum metallurgy and plasmatron, absorption spectroscopy, nuclear magnetic resonance and mass spectroscopy, organic chemistry, chemical processes, plastics and adhesives, finishes, corrosion, electrochemistry, high vacuum, hazardous testing, paint application, accelerated weathering.

A 24 x 30 foot concrete building for physics research was also completed. The experimental infrared laboratory is designed for launch phase radiation studies.

GENERAL DYNAMICS/DAINGERFIELD

A high quantity of jet engine testing was achieved during 1961 at the Ordnance Aerophysics Laboratory, operated by General Dynamics for the Bureau of Naval Weapons. The facility, located nine miles south of Daingerfield, Texas, had two modern high altitude test cells, two sea level tests cells and one small scale cell.

The two high altitude cells are designed for blowdown operation with maximum air flow capacity of 1600 lb./sec. at 215 psia pressure. They are capable of free-jet and connected inlet testing of full scale ramjet engines.

The laboratory is staffed with competent engineers and technicians, many of whom have been associated with the facility since operations began in 1945.

Employment totaled approximately 260.

In July, the test facility became a division of General Dynamics/Pomona.

GENERAL DYNAMICS/FORT WORTH

Advanced developmental effort on the B-58 supersonic bomber, continuing studies of nuclear propulsion for aircraft and spacecraft, and research programs ranging from interplanetary space to suboceanic depths highlighted the activities of General Dynamics/Fort Worth during 1961.

As the division continued to turn out more B-58's for the Air Force, the USAF itself concentrated on combat readiness training of the first B-58 unit, the 43rd Bomb Wing at Carswell AFB, Fort Worth, and the new 305th Bomb Wing, Bunker Hill AFB, Peru, Ind., which started operating the supersonic bombers in May, 1961.

With the B-58, the USAF set nine new world speed and payload records in the first five months of the year. The records, certified by the National Aeronautic Association to the Federation Aeronautique Internationale, included:

- Closed-course 2,000-kilometer flight at an average speed of 1,061.8 miles an hour on January 12 for a total of three world records;
- Closed-course 1,000-kilometer flight at an average speed of 1,284.73 miles an hour on January 14 for a total of three more world records;
- Closed-course 1,073-kilometer flight in 30 minutes and 43 seconds at an average speed of 1,302.07 miles an hour for a seventh world record and capture of the Bleriot Trophy that had remained unclaimed since 1930; and a—
- Trans-Atlantic flight from Washington to New York to Paris that set two more world speed records. The Washington-to-Paris time was three hours, 39 minutes, and 49 seconds for an average speed of 1,048.68 miles an hour. The New York-to-Paris leg was covered in three hours, 19 minutes, and 51 seconds for an average speed of 1,089.36 miles an hour. These average speeds include the slow-downs necessary for refueling from slower tanker aircraft.

General Dynamics/Fort Worth continued to multiply effectiveness of the double-sonic weapon system. The B-58 originally was equipped with an externally mounted pod slung beneath the fuselage. The pod carried both fuel for the aircraft's four General Electric J-79 engines, and the bomber's payload. In combat, the B-58 crew would drop the pod containing the bomb load on the target.

In a later version, the aircraft was equipped with a two-component pod. The lower portion carries fuel to supplement the supply in the wing and the fuselage. In combat, the lower component would be dropped when its fuel supply was exhausted. The upper part, carrying both fuel and the bomb load, would be dropped on the target. This would leave the bomber "clean"—and without a useless empty bomb compartment—to streak its way home.

Newest configuration for the B-58 in 1961 gave the weapon system additional externally mounted bombs, thus providing more firepower and greater versatility, since with more bombs, a B-58 crew could choose to drop all its devastating load on one target—or choose to knock out a number of different targets.

Another advance in the B-58 program in 1961 was the installation of shatter-proof wheels. The B-58 rolls on a two-wheel nose gear, plus a pair of eight-wheel main gears beneath the wing. Tests showed that in event of one or more tire blow-outs, there was a possibility that wheels might break into fragments. The fragments, in turn, might pierce parts of the aircraft carrying fuel, thus creating danger of fire.

To minimize this danger, General Dynamics/Fort Worth engineers conceived landing gear wheels incorporating shatter-proof rims. In event of tire blowout on takeoff or landing, the so-called non-frangible rims support the aircraft safely until it comes to a stop.

Effectiveness of the new wheels was proven in tests in which tires were shot out with ballistic-driven spikes during a high-speed B-58 takeoff run. With the tires out, the B-58 made a successful take-off, and subsequently an uneventful landing.

Another 1961 innovation in the B-58 program was development of an escape capsule that will protect Air Force flight crewmen when emergency circumstances make it advisable to leave the aircraft either while rolling on the runway or in flight.

The capsule system's effectiveness as an "on the deck" escape vehicle was demonstrated at Edwards Air Force Base, California, on October 5, 1961. A B-58 streaked down the runway at around 115 miles an hour when a crewman triggered the escape system. The capsule hurtled up and along the runway. The parachutes then deployed, and slowly lowered the capsule to the runway. Although only a dummy was used for the first such test, the demonstration proved that a man inside the capsule would have safely survived.

Demonstrations by volunteer Air Force crewmen were scheduled for the capsule late in the year, and capsules were due to be installed in the crew compartments of all tactical B-58s.

In an emergency, the escape capsule encloses the crewman. It then is ejected from the aircraft, and rocket engines propel it approximately 250 feet upward and away from the aircraft. The capsule protects the crewman from windblast at speeds up to and beyond the speed of sound. It also protects him from low temperatures and lack of oxygen at high altitudes. At an appropriate altitude, a parachute opens to lower the capsule safely to land, sea, or ice.

Upon landing on ground or ice, the capsule's impact is softened by a built-in "cushioning" mechanism. If the capsule lands in water, built-in "bladders" automatically inflate to keep the capsule afloat.

After landing, the crewman will find inside the capsule any number of articles designed to assure his survival until rescue arrives. These items include fishing gear, a rifle, a radio transmitter, a flare to attract rescuers, food, items to start a fire, and so on.

The capsule—replacing the bulky and awkward pressure suit, parachute and associated body-borne equipment—is designed to return flying to a "shirt-sleeve" operation.

While concentrating on the B-58 program, General Dynamics/Fort Worth was engaged in a number of research projects. In use were three nuclear reactors built for radiation effects studies. These studies will be valuable in the future in the design and development of nuclear-powered aircraft and spacecraft.

The division was also using the reactors and other advanced nuclear laboratory equipment to amass data for more than 20 other nuclear-related programs, including radiation-measurement devices that will go aboard satellite vehicles planned for study of the environment of interplanetary space.

Scientists and engineers were also taking a look beneath the sea, since General Dynamics/Fort Worth was designing and producing extremely precise dosimeters used to measure radiation levels in atomic powered submarines.

GD/FW was also conducting studies to determine what shielding will be necessary to protect astronauts from radiation as they travel through space, in addition to numerous other nuclear programs. It also was associated with a sister plant, the General Dynamics/Astronautics Division at San Diego, in the Apollo program to orbit man around the moon.

General Dynamics/Fort Worth scientists and engineers were also doing down-to-earth work on the surface of their own planet. This is under contract for the Army, which has ordered design, development, and production of a radioactive-shielded crew compartment for a combat vehicle of a classified nature.

In line with the Fort Worth plant's ever-broadening areas of activities, the facility's name was changed in 1961 from Convair-Fort Worth to General Dynamics/Fort Worth, and given full status as A Division of General Dynamics Corporation.

GENERAL DYNAMICS/POMONA

The Naval Weapons Industrial Reserve Plant, operated by General Dynamics in Pomona, California, assumed a new name during 1961. Formerly known as Convair/Pomona, the plant's official name became General Dynamics/Pomona on May 29, reflecting full corporate division status with the General Dynamics Corporation.

On the same date, Charles F. Horne was named President of General Dynamics/Pomona and a Senior Vice President of General Dynamics Corporation. On July 6, the Daingerfield, Texas jet engine test facility was made a division of General Dynamics/Pomona and placed under the supervision of President Horne.

Combined administrative control of the electronic operation of General Dynamics/Electronics at Rochester, New York and San Diego, California with General Dynamics/Pomona was announced on August 29. The General Dynamics/Electronics division also was placed under the supervision of Horne.

Production of Tartar and Advanced Terrier supersonic surface-to-air guided missiles, and development of the Redeye guided missile and the Mauler weapon system continued at General Dynamics/Pomona. The Advanced Terrier incorporates improved guidance features and substantial improvements in range over original Terriers, which have been operational with fleet units since 1956.

The Advanced Terrier missile is a major element in the Navy missile arsenal, operational in 1961 aboard 19 ships. During 1961, the missile was installed on the nuclear-powered guided missile and cruiser USS Long Beach, the carrier USS Constellation, the carrier USS Kitty Hawk, and the frigates USS Luce, USS Dahlgren, USS MacDonough, and USS William V. Pratt.

Advanced Terrier is powered by two stages of solid fuel rockets. The first stage, a separate booster rocket, supplies high thrust for a short period to launch and accelerate the missile to supersonic speeds.

At booster burnout, the empty booster case falls away and the second stage rocket ignites. The second stage, called the sustainer, is part of the missile proper and maintains the velocity required to match any evasive maneuver the target aircraft might take.

The beam-riding missile also is suitable for beachhead operations by Marine Corps units, and has surface-to-surface capabilities.

In 1961, Tartar was becoming the primary antiaircraft battery aboard destroyers and secondary battery on cruisers of the U. S. Navy. At year-end, the missile was operational aboard seven of an entirely new class of destroyer-type ships being commissioned for Tartar use. Tartar ships commissioned during 1961 included the destroyers USS John King, USS Lynde McCormick, USS Towers, USS Sampson and USS Sellers.

Tartar is a supersonic homing guided missile. The guidance system is made up of several interrelated units. These units are constructed to form the basic airframe of the missile. Each unit houses a major part of the homing and control system and can be replaced easily if there is a malfunction. Extensive miniaturization techniques are used to package the guidance system.

The dual-thrust rocket of Tartar is an integral part of the missile. A high-thrust, short-duration burning period serves to launch and accelerate the missile to supersonic speeds. After this, a lower-thrust, long-duration-burning period maintains this high speed to target interception.

Redeye is a new infra-red, surface-to-air guided missile designed to give combat troops the capability of destroying low strafing or bombing aircraft. Redeye is shoulder-fired and readily man transportable.

The missile launcher outwardly resembles the bazooka of World War II. It is about four feet long, three inches in diameter and weighs about 20 pounds. The launcher tube serves as a shipping container for the missile, when capped at both ends.

Redeye is a composite structure containing propellant, an electronic guidance system and a high-explosive warhead.

Mauler will be a compact, highly mobile weapon which will use solid-fuel, radar-guided missiles to destroy aircraft and short-range missiles near forward battle area positions.

Each Mauler unit will be contained entirely on a self-propelled chassis of standard design. It will be fully mobile and capable of delivering accurate fire while moving.

Mauler units will be light enough to be carried by a fixed-wing aircraft, helicopter, and to be dropped by parachute into battle areas.

General Dynamics/Pomona also was named as a major subcontractor for the Long Range Typhon weapon system during 1961. The Mishawaka division of Bendix Corporation was named prime contractor.

General Dynamics/Pomona continued work on support equipment for prime missile programs, and also was awarded Air Force contracts for study of airport landing services and a track comparator simulator.

Employment on October 12 was 6,371 compared with 6,103 for the same period of 1960.

GRUMMAN AIRCRAFT ENGINEERING CORPORATION

A contract to produce a second open ocean hydrofoil ship, another space contract, and development or production of ten other hydrofoil, space or aircraft projects marked the business picture of Grumman Aircraft Engineering Corporation during 1961. The year also disclosed a significant acceleration in the acquisition or construction of research and development facilities, formation of the company's first international sales corporation, and establishment of a business office on the West Coast.

In the development status as the year came to a close were:

• The AG(EH) hydrofoil research ship, a 300 ton, 200 foot long Navy vessel which will be used to develop techniques to be employed by hydrofoils in finding and destroying enemy submarines. The Navy ship will be capable of a speed of 50 knots. A second set of foils under development will provide a speed potential of 85 knots.

• The HS Denison, a 90 ton experimental hydrofoil under development for the U.S. Maritime Administration, was being prepared for launching. The Denison will achieve speeds in the 60 to 80 knot range.

• Nine vacuumized magnesium cannisters to contain a passive communication satellite scheduled for launching during 1963 by the National Aeronautics and Space Administration were being developed and produced. Test launchings were to take place during 1962. The cannisters will contain 135 foot rigidized mylar plastic and aluminum foil laminate spheres which will serve as reflectors of radio signals.

• The W2F-1 Hawkeye, representing a new generation of early warning of attack and intercept control aircraft for the U.S. Navy, progressed well into its development program. Five Hawkeyes were flying by the end of the year. Two were in the avionics flight test program. First Navy Preliminary Evaluation had been completed and the second evaluation was scheduled to begin during the early months of 1962.

• The A2F-1 Intruder, the Navy's new low altitude attack aircraft, completed its third Navy Preliminary Evaluation during December. The evaluation amounted to the first formal inspection of the Intruder's unique all weather attack-navigation system. Eight A2Fs were flying. Four were in the Avionics Flight Test program. During 1961, the Intruder demonstrated an unprecedented light attack capability at a special bomb dropping demonstration at Cherry Point, Va. The two place aircraft carried a total of 30 five hundred pound bombs—more than twice the amount carried by the famed World War II Flying Fortress.

• A third model of the Mohawk, the AO-1CF entered its flight test program. Under development for the U.S. Army, the modification will provide the service with a highly utilitarian STOL aircraft capable of performing nighttime tactical observation with special infrared camera equipment. The "CF" Mohawk was to enter the production phase during 1962, joining the AO-1AF and the AO-1BF. The company held contracts covering the production of a total of 140 Mohawks, and at year-end additional contracts were being discussed. Delivery of the "AF" and "BF" models were made to the Army.

• An Orbiting Astronomical Observatory, a more precise astronomical instrument than any man has ever possessed, was being developed for Goddard Space Flight Center, NASA. The first phase of the project, a detailed engineering report analyzing the design of the hexagonal shaped aluminum satellite, was completed. The second phase of the project, implementing the design in the production of a prototype, was begun. Structural testing of a full scale model was underway. Phase II will culminate in a completely tested OAO structure and system sometime during 1962. OAO will be launched in 1963.

Research and development facilities were greatly augmented at Grumman during the year. A new $5 million Electronic Systems Center became fully operational and was fully staffed in 1961. The Systems Center houses the most advanced electrical and electronic test equipment available and was already contributing to the development of aircraft and space systems at Grumman. In addition to the research and development work the systems center is used to ground test space and aircraft systems (radio, radar, guidance, control and power). The 65,000 square foot building contains the largest radio frequency Anecohic Chamber in the U.S.

As 1961 came to a close the finishing touches were being put to new space age tools costing approximately $2.7 million. Included was a 15 by 20 foot (internal dimensions) Environmental Space Chamber capable of simulating vacuumized conditions comparable to those found at 200 miles altitude, a huge shaker which will be able to impart vibrations of one to 2,000 cycles per second to structures at a force of 3,300 pounds, and a centrifuge capable of subjecting a one ton payload to a stress 40 times the force of gravity.

Also under development was a space age manufacturing area, a clean room in which all major subsystems and the structure of the OAO itself will be assembled. Work on the third in a series of Grumman designed and developed air bearing tables, a nine foot platform supported by a 22-inch diameter steel ball resting on a column of air, was started. These frictionless platforms were being used to develop the guidance and control system of the OAO.

A new 13,000 square foot research wing, which will house nuclear and physics laboratories was begun. Included in the new facility will be a $200,000 Van der Graaf accelerator. The 3 million electron volt accelerator, complete with positive and negative ion capabilities, will be used for pure nuclear research in addition to investigating such space craft contingencies as secondary state radiation properties in matter (space craft shielding) and the effect of Van Allen Belt electrons on solar cells.

In addition to those aircraft already mentioned as in the "development" status, the following were in production during 1961: The ASW version of the SA-16 B, S2f-3 Tracker, the Navy's newest ASW, the AO-1AF and AO-1BF models of the Mohawk, the Ag Can and the Gulfstream.

GYRODYNE COMPANY OF AMERICA, INC.

The Gyrodyne Company of America, Inc., during 1961 made first flights of its Model DSN-2 and Model DSN-3 helicopters and delivered pure drone DSN-3's to the Navy for shipboard evaluation. First flight of the manned version of the DSN-3 took place on April 6, 1961.

An outstanding achievement took place when the world's first free drone helicopter—the Model DSN-1 drone—completed its sea evaluation trials aboard the USS Hazelwood (DD 531) in March. One DSN-1 made 38 drone flights, 22 from aboard ship. During these flights 18 complete simulated ASW missions were performed.

Further advances in helicopter technology were achieved by the company during the year when the first flights were made of a Rotorcycle equipped with tiltable floats to enable the helicopter to land in heavy seas. Successful landings were achieved in sea states 2 and 3 with additional testing being projected to enable the tilt-float Rotorcycle to land in sea state 5 and maintain a high degree of stability.

The company took occupancy of its new 60,000 square foot main plant and put into operation additional flight test facilities. Total plant footage and test facilities at year-end exceeded 112,000 square feet.

Sales for Gyrodyne continued to increase and the company again doubled its employment figure and expected to add another 200 engineering and production personnel during 1962.

The Rotorcycle, Gyrodyne's one-man helicopter, was awarded the Grand Prize by the Aeroclub of France for the best performance of a helicopter at the helicopter competitions at the Paris International Air Show held this year. At the close of the Paris Air Show the Rotorcycle was demonstrated in Germany, and other European countries.

HILLER AIRCRAFT CORPORATION

Heavy corporate funding of new aircraft development during 1961 helped make possible a leadership position for Hiller in a year noted for historic vertical flight activity.

In May, the Hiller light helicopter entry was chosen one of the three finalists in the largest design competition in helicopter history. Five prototypes of the company's four-place, T63 turbine-powered HO-5 were begun late in the year, for competitive evaluation in mid-1963. This program was aimed toward the largest manned aircraft production quantity since World War II: 4,000 units.

World cold war crises augmented the force of light observation helicopters required by the Army to fill interim requirements prior to the availability of the winning turbine HO series. The Hiller-built H-23D "Raven", a three-place helicopter powered by a 250 hp reciprocating engine, was selected in competition as the light helicopter to fill this requirement. In a production order originating in September, some 226 H-23D's were involved, with deliveries begun in January 1962. Meanwhile, the Army procured an initial quantity of four-place, 305 hp H-23F helicopters, military counterpart of the commercial Hiller E4. These were being evaluated to fill special high performance missions.

Perhaps the most noteworthy step in the short history of vertical flight was the awarding of $70 million-plus Tri-Service VTOL transport program, another competition which Hiller, in concert with Ling-Temco-Vought and Ryan, won in September. Five 18-ton field evaluation transport planes will be built, identical in concept to the Hiller X-18 tilt wing test bed, which was manufactured and tested under Air Force contract. Designated the VHR-447, this new Army-Navy-Air Force program marks the first VTOL effort to reach a full prototype phase. A number of other VTOL projects continued at Hiller, including advanced work in the field of pure jet lift and jet lift augmentation, areas which have been in study for over five years.

In November, Hiller unveiled its new six-place, turbinized "Ten99", an all-purpose half-ton payload utility helicopter. Powered by the Canadian Pratt & Whitney PT6 500 horsepower turbine, a Ten99 prototype completed flight tests in secrecy earlier in the year.

Hiller also revealed plans for a giant flying crane called the "STORC" (Self-ferrying Trans Ocean Rotary-wing Crane), which is an outgrowth of over ten years of study in the rotor-tip jet propulsion field. STORC's rotors are powered by two turbojet engines in each blade tip. The helicopter can be landed and converted to a long-range, high speed airplane by revolving one blade in its hub, and locking the blades to become a high aspect ratio, fixed wing.

Commercial sales of the 305 horsepower, three-place 12E and four-place E4 helicopters continued to new heights in 1961. Sales abroad and particularly in Latin America became a large percentage of the total. A major procurement decision by the Canadian Army and RCAF selected from competitive evaluation the Hiller 12E (Canadian designation CH-112) as the standard light observation helicopter for these services. An initial order for 24 helicopters was completed during the year.

Hiller Aircraft Corp. was operating as a subsidiary of The Electric Autolite Company of Toledo, Ohio.

HUGHES AIRCRAFT COMPANY

Early in the year engineers of the California Institute of Technology Jet Propulsion Laboratory and Hughes Aircraft Company revealed details of Surveyor.

The lunar soft landing spacecraft will carry four cameras aboard to send television pictures of the moon's surface back to earth, each camera transmitting pictures at the rate of one every few seconds. Plans call for seven Surveyors to be launched in the period 1963-65.

An earlier step is the Ranger series which will include five Ranger spacecraft, the last three of which are scheduled to rough land on the moon starting in 1962. The first two Ranger spacecraft will be sent on long elliptical trajectories away from the earth. Rangers 3, 4 and 5 will be sent on trajectories to impact the moon.

In 1960, scientists at HAC announced that for the first time man had created a source of "coherent" light which they described as an atomic radio-light brighter than the center of the sun. Early in 1961, the same scientists annouced a new radar, called "Colidar" (Coherent Light Detection and Ranging) which employs the coherent light beam.

Colidar has the low weight, low power needs and small size to make it practical to launch in a satellite into outer space. Essentially the device uses the laser's narrow light beam—instead of microwave signals used by conventional radar—to detect distant targets.

With future refinements in beam formation, power sources and receiving devices, Colidar would have a range in outer space of hundreds of miles

Part of the laser light triggers a timing system which notes the exact moment the light pulse is emitted. When the light pulse has bounced off the target and has been reflected back to the collector, the time again is registered, and this measure of time provides the distance of the target.

In the attenuating atmosphere of Earth, the Hughes working-model Colidar would have a range of nearly six miles, and at this distance its narrow beam would discriminate between two diffuse objects only ten feet wide placed side by side, even though the targets would reflect only ten per cent of the light pulse.

If Colidar's transmitter and receiver were separated and placed aboard two space ships 100,000 miles apart outside the Earth's atmosphere, and carefully aimed at each other, the receiver would get the same signal strength as from the six-mile target in the radar application on the ground.

HAC began manufacture of an air-to-air guided missile with a nuclear capability—the "Nuclear Falcon"—early in the year in its Tucson, Arizona plant under a $23,000,000 contract with the Air Materiel Command.

Deliveries for test and evaluation of this latest in the Falcon series began in March. Air Defense Command units equipped with F-102 all weather jet interceptors received the new GAR-11 late in the year.

Larger than earlier Falcons it is still somewhat small considering its capabilities. The GAR-11 is 7 feet long, 11 inches in diameter and weighs slightly over 200 pounds.

Announcement of two contracts totaling $9 million for new Polaris work raised Hughes's dollar volume in that program to approximately $30 million.

One contract was awarded by the Navy for combining several Polaris inertial guidance platforms with Hughes-produced guidance electronic systems while a second $2.4 million was awarded Hughes by General Electric for the manufacture and delivery of several hundred replaceable electronic surface boards for the digital computer used in the Polaris guidance unit.

In mid-year, the Air Force and Hughes launched a program to modernize existing all-weather jet fighter interceptor planes in the North American air defense system to provide "more defense for less money."

The planes selected were the McDonnell F-101B Voodoo and Convair's F-102A Delta Dagger and F-106A Delta Dart, all of which carry Hughes armament control systems.

A USAF evaluation team successfully completed preliminary flight testing of the first of five proposed modifications—an infrared search and track device, which gives the interceptors increased capability to detect targets at low altitudes without allowing the target to know that it is being tracked.

The four other scheduled modifications include a redesigned radar antenna, counter-counter-measure capabilities, and a parametic amplifier which reduces interference in the radar system. The Century Series aircraft will be supplied with all or some of the five modifications, depending on each plane's capability.

In the winter of 1961-62 installation of a Frescan 3-D radar system was expected to be completed on the Italian missile cruiser Garibaldi.

Frescan, developed by the U.S. Navy and HAC was operational on more than 20 of America's missile cruisers and destroyers. It provides simultaneous 3-D pinpoint information of range, height and bearing on many airborne targets with one antenna, transmitter and receiver.

In late summer HAC announced that America's first helicopter-carried air defense control system was being used in field training with the Marine Corps in the Mojave Desert. The system coordinates the firing of Hawk and Terrier missile batteries to assure nearly instant destruction of hostile supersonic aircraft.

The air defense system is installed in five "helihuts" plastic and aluminum shelters about the size of a van of a 2½ ton truck—which are transported underneath Marine helicopters. The system can be operational within minutes.

An important aerospace announcement of the year came in late September with a joint HAC-NASA showing of an experimental ion engine in actual operation. A more advanced version of the engine was to be ready for flight in 1962. It could eventually send a manned spacecraft to Mars at a speed of two million miles a day. Demonstration was conducted at HAC research labs in Malibu, California.

The 1962 flight test, the first of a series, will see a capsule launched by a Scout rocket carrying two ion engines, one developed by Hughes and one by the Lewis Research Center. The capsule will be launched almost vertically to an altitude of about 5,000 miles. This will provide a flight of about one hour duration in which to demonstrate the functioning of ion engines under real space conditions. Launchings will occur at NASA's Wallops Island.

HAC scientists stated that an electrically propelled spacecraft to Mars and back to Earth could be built with a useful payload of the order of 50 per cent of its total initial mass, and with a travel time which is about equal to that of a spacecraft with a chemical or a nuclear power plant.

Also displayed at the same time was an advanced type of computer-controlled analog trajectory tracer which simulates the electrical condition in the engine and allows tracing of the exact ion paths to aid in the design of optimum electrode configurations.

For satellite use, new Hughes radar uses "coherent light beam" to detect distant targets.

In the fall Hughes unveiled its ultra-modern research laboratories in the Santa Monica mountains overlooking the Pacific Ocean where a 400 man scientific staff was working on a wide variety of space-age projects ranging from discovering new materials to packing "space dummies" with ionization chambers to measure radiation in a spaceman's body.

The labs have a staff of 17 consultants, prominent scientists chiefly from academic institutions, who regularly confer with and lecture to the HAC scientists. The world's top scientists are also invited to lecture there on subject matter ranging as wide as the scientific mind.

Late in the year HAC announced that launching of the National Aeronautics and Space Administration's first synchronous communications satellite will be possible late in 1962.

Under Project Syncom, Hughes will build three experimental high altitude communications satellites for NASA.

HAC scientists have designed a small satellite which is stabilized by spinning, like a gyroscope, and which transmits a signal beam in the shape of a pancake with the "edge" toward the earth.

Syncom will be only 28 inches in diameter, weigh 55 pounds and can be boosted to a 22,300-mile orbit by the Delta rocket of proven reliability. Yet the satellite will be fully capable of relaying telephone conversations to Europe across thousands of miles of space.

Syncom will be the first spacecraft to be placed in an synchronous orbit, one in which a satellite's orbital velocity is matched to the earth's rotation so that it appears to hover over a given area, according to the project manager.

The first Syncom will not be a true stationary satellite, however, because its orbit will be inclined approximately 33 degrees to the earth's equator. As a result the satellite will appear to describe an elongated figure-8 pattern every 24 hours, moving 33 degrees north and south of the equator while remaining at a fixed longitude near the East Coast of the United States. Later Syncoms may be made to hover over one spot on the earth's equator.

Maneuvering Syncom into a synchronous orbit and the correct longitude probably will require several days.

After burnout of the second stage of the Delta, the satellite will be spun up to approximately 2½ revolutions per second. After burnout of the third stage, Syncom will be at 160 miles altitude and at the perigee of an elliptical orbit. About 5½ hours later the satellite will have "coasted" to the 22,300-mile apogee of its orbit and will be over the Indian Ocean.

An apogee rocket motor attached to the satellite will then be fired to place it into a circular and nearly synchronous orbit. It will then drift westward to a longitude near the eastern United States. A number of small vernier rockets will then be fired to bring it to approximate synchronism with the earth's rotation. Final precise adjustments in velocity and in the spacecraft's attitude in space will be made by pulsing small nitrogen gas jets.

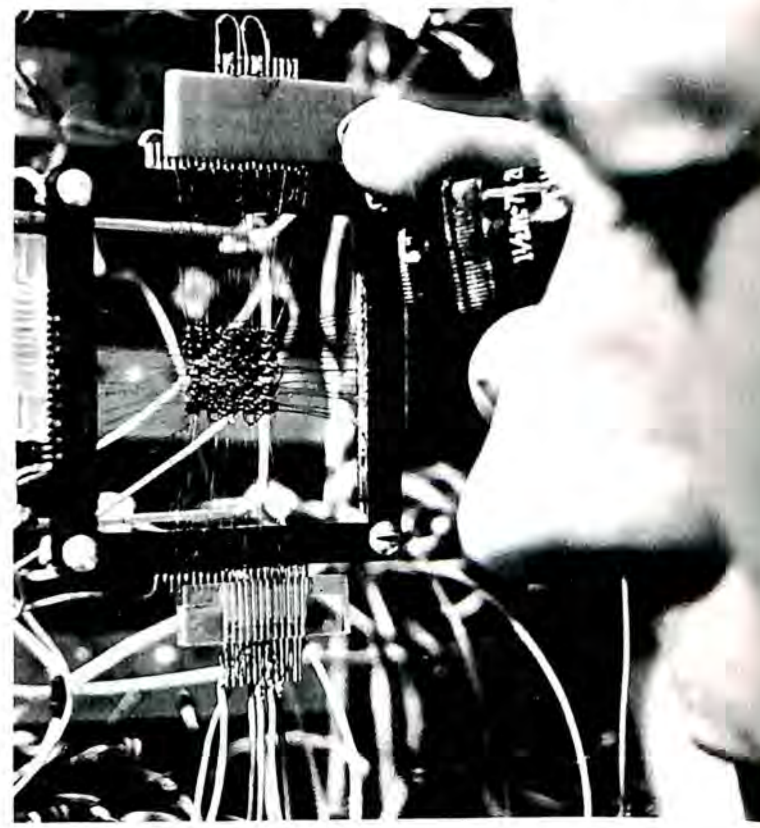
INTERNATIONAL BUSINESS MACHINES CORPORATION

FEDERAL SYSTEMS DIVISION

During 1961, IBM's Federal Systems Division continued to expand its capabilities and accomplishments, providing government space and defense agencies with many important new developments in systems for data processing, guidance control, and information handling.

Within FSD, one of the most important events during 1961 was the opening of the Communications Systems Center in Rockville, Md. The Center specializes in the analysis, simulation, development and programming of communications devices and applications. Its resources include scientists with records of achievement in such areas as voice and data transmission, digital communications, radar and sensors, electronic switching, and associated mathematics. FSD was adapting the digital computer to message processing and automatic switching of both voice and data communications. The computer was being applied to the control of traffic, storage, switching, and routing of messages based on their content.

In May, IBM dedicated the Thomas J. Watson



IBM memory device for Orbiting Astronomical Observatory can store 200,000 bits of information on single orbit.

Research Center in Westchester County, New York, the world's largest center for computer science.

FSD's Systems Development Department created two additional problem solving facilities—a Space Systems Center and an Intelligence Systems Center—in Bethesda, Maryland. Space Systems Center will develop data handling techniques in space, satellite and missile systems, including systems for space surveillance and tracking, ground support equipment, ballistic missile defense, military space systems and scientific space experiments.

The Intelligence Systems Center is responsible for the development of information-handling systems for Federal Government intelligence agencies and for the development of techniques for indexing, storage and retrieval of digital and graphic information.

FSD participated in many projects of significance to military and civilian space exploration and aviation. Among the important contributions was to Project Mercury. FSD scientists and engineers at the Space Systems Center in Bethesda, Md., and the Command Control Center in Kingston, N.Y., under contract to Western Electric Co., were assigned the responsibility of:

- Providing the real-time computing system for the world-wide tracking and ground instrumentation network.
- Designing, programming and testing the launch, orbit and re-entry computation system.
- Developing the data flow simulation programs for systems checkout and personnel training.
- Developing the system for automatically testing the readiness of the world-wide network.
- Developing and manufacturing the special computer equipment necessary to receive radar data transmitted in real-time from the tracking network.

IBM 7090s at the NASA-Goddard Space Flight Center in Greenbelt, Md., automatically receive reports from the *Mercury* world-wide radar and telemetry tracking network. The computers process the information and transmit the results to the Mercury Control Center at Cape Canaveral to drive real-time digital and graphic displays. NASA control officers monitor these displays to follow the progress of the flight so that they can make command decisions.

IBM designed and manufactured the special real-time channels for the computers at Cape Canaveral, Bermuda and the Goddard Center. The channels, with high and low speed input-output subchannels, accept data directly from communications lines and send the information to the proper location in the computer memory. Processed information is then sent through the real-time channels and communications links to drive the Mercury Control Center displays at Cape Canaveral and to provide the tracking sites with acquisition data.

Also for Project Mercury, the Federal Systems Division designed, developed, installed and was maintaining the Ground Launch Monitor Subsystem. This system uses the link between Cape Canaveral and Goddard Center to communicate information in real-time during Mercury missions.

At the FSD Systems Development Department, Bethesda, Md., work continued on the development of total information systems to enable commanders to gather intelligence and to manage global military resources more effectively. These control systems immediately display the significance of millions of electronic computations as the basis for command decision.

FSD was performing the systems analysis and design for the Air Force Command and Control System (473L). The system includes real-time data processing, automatic switching, data storage, and displays designed to translate the status of Air Force resources into visual images that can be instantly comprehended as the basis for decision. For 473L, FSD will also determine equipment specifications, human engineering factors, methods and procedures, and reliability.

Other projects were:

Aerospace Intelligence Data System (AIDS), intelligence data-handling system for the Strategic Air Command including operations analysis, system design and system implementation.

Electromagnetic Intelligence System (466L), integration of ground and airborne systems to gather electromagnetic data. IBM was associate prime contractor with Radio Corporation of America.

Command Control Center personnel participated in developing the Informer, a member of the Army's FIELDATA family of combat area data processors. Housed in a S-109 shelter mounted on a two-and-a-half ton truck, Informer was delivered to the Army Signal Research and Development Laboratory, Fort Monmouth, N. J., for evaluation and acceptance testing. Designed to aid the intelligence, logistics and personnel operations required in the modern Army, Informer can be adapted to check out tactical missiles before launch and guide them to targets.

Building on IBM's experience in developing advanced guidance systems, the Space Guidance Center in Owego, N. Y., in 1961 applied digital techniques to control systems for satellites, space vehicles, missiles, high-speed aircraft, advanced weapons systems, and submarines.

Under contract to Grumman Aircraft Engineering Corporation, the Space Guidance Center was also developing an advanced memory and processor for NASA's Orbiting Astronomical Observatory (OAO), to be launched in 1963. Based on the new RANDAM (Random Access Non-Destructive Advanced Memory) technology developed at the Center, the memory has no moving parts, can withstand the violence of launching and is designed to operate reliably in the spacecraft for more than a year. For the first time, large volumes of data will be read out of core memory many times, without erasure, either to command the spacecraft or to report experimental data to the earth stations. The processor and RANDAM memory will provide complete timing for the OAO system; verification, decoding and distribution of both radio and stored commands; over 200,000 bits of storage; control signals for the stabilization and operation of the spacecraft and its equipment.

The Space Guidance Center developed and was producing the bombing-navigation systems, including the Advanced Capability Radar, for the Strategic Air Command's operational B-52 fleet. With terrain avoidance features that permit extremely low-level flying, the systems provide the B-52's with unlimited global navigation and precision bombing capabilities at all altitudes.

In the field of applied research FSD held its position as a leader in the development of experimental cryogenic devices. Early programs explored fundamental problems of the phenomenon of superconductivity, film insulation, fabrication, film geometry control and materials. FSD was experimentally fabricating, reproducing and testing large numbers of interconnected cryotrons deposited on a single substrate. Low temperature devices were produced with sharp transition and high critical currents.

In mid-1961, the Navy awarded FSD a contract to develop a high volume production system for the continuous manufacture of ultra-reliable thin film subassemblies, potentially the building blocks of the next generation of electronic systems. The new system will be produced with technical guidance from the Naval Avionics Facility, Indianapolis (NAFI), as part of the Bureau of Naval Weapons Industrial readiness program. The Navy says the system will be the first that replaces slow laboratory assembly techniques with automated fabrication of these advanced electronic components. The equipment will be used by NAFI to produce thin film devices for experimental electronic systems. Among these are missile guidance systems, satellite electronic systems, communications devices and computing equipment where savings in weight, space and power are vital. Using thin film subassemblies, it is possible theoretically to design electronic equipment containing the equivalent of a million present day components per cubic foot.

In addition to being smaller and lighter than present components, thin film devices are more rugged and better able to resist heat and humidity. Thin film circuits generally use less power than today's circuits and because of their compactness, can do their electronic jobs faster.

FSD's Command Control Center in Kingston, N. Y., also developed and shipped in 1961 a system five times more powerful than that in SAGE Air Defense System—the solid-state AN/FSQ-31(v) which will keep inventory of the Strategic Air Command's world-wide resources. Prime contractor is International Electric Corp.

Also, more than 200 specially developed data transmission terminals were to be delivered to Western Union by IBM under a contract signed in the summer of 1961 by the two companies. The terminals—capable of sending and receiving up to 60 million words or an equivalent of four million punched cards daily—are for installation in the Air Force Combat Logistics Network (COMLOGNET). The new IBM TELEPROCESSING terminals, built to Western Union specifications, will be an integral part of the world's largest data and message network due for completion in 1962 by Western Union as prime contractor for the COMLOGNET. The terminals will be located at Air Force bases, depots and stations, and at offices of civilian suppliers. COMLOGNET will provide logistic support for command and control operations. Its primary function will be to help the Air Force maintain its striking force at maximum readiness by making possible the rapid exchange of information on aircraft, missiles, personnel and supplies.

An IBM 704 system located at the Federal Aviation Agency Aeronautical Center in Oklahoma City, Okla., was playing an important role in the new intermediate-altitude flights inspection system designed and produced by the AIL Division of Cutler-Hammer, Inc. The IBM 704 reduces millions of individual readings recorded on magnetic tapes in the inspection aircraft and translates them into a series of meaningful reports. The IBM 704 is also the tool used by FAA personnel to prepare the magnetic tapes which the AIL equipment reads to automatically control the aircraft during inspection runs and to maintain a complete tape history file on all enroute navigational aids in the United States.

DATA PROCESSING DIVISION

IBM's Data Processing Division participated in developing the world's fastest and most reliable commercial application of computer and microwave transmission equipment which was installed at North American Aviation, Inc.

The system provides the company with an answer to the mounting industrial problem of how to obtain high speed communications to effect fast turnaround time, especially on engineering and high-volume commercial applications. The hookup, expanded from a system installed in 1960, has more than tripled its initial speed.

The new North American system was developed in cooperation with the International Business Machines Corporation and the Bell Telephone System.

Linked by the ultra-high frequency radio network are the computing and data processing centers at North American's Autonetics, Downey, Calif.; Los Angeles, Calif.; and Rocketdyne, Conoga Park, Calif., divisions. The firms General Offices, technical and administrative computation requirements are met at the nearby Los Angeles division center. Two other divisions, Atomics International, Canoga Park, Calif., and Space and Information Systems, Downey, Calif., enjoy access to the loop due to their geographical proximity to Rocketdyne and Autonetics, respectively.

DPD also participated in developing a powerful new computer language, designed to broaden the use of numerically controlled machine tools for automated production of complex parts. IBM's AUTOPROMT program is the first that enables the user to describe the surfaces of the three-dimensional shape to be milled, rather than each path the tool must follow to machine the part. AUTOPROMT leaves to a computer the task of automatically generating these tool paths on the basis of a simple description, in English-like terms, of the part to be milled and the tool to be used.

United Aircraft Corporation, East Hartford, Connecticut, which cooperated with IBM in the development of AUTOPROMT, was the first company to put the new program to use. The part programmed by AUTOPROMT and produced at the firm's research laboratories was a gearbox cover for the turbine-powered S-64 "Flying Crane" helicopter developed by Sikorsky Aircraft, a division of United Aircraft.

LING-TEMCO-VOUGHT, INC.

A diversified firm described as "a strong new force in community and country" came into being August 16, 1961, with the combination of Ling-Temco Electronics and Chance Vought Corporation into Ling-Temco-Vought, Inc.

Chance Vought Corporation, the nation's third oldest aircraft manufacturer, was re-established as a new Chance Vought Corporation, the aerospace subsidiary of Ling-Temco-Vought, Inc.

Named as chairman of the board and chief executive officer of LTV was Robert McCulloch, veteran aerospace industrialist and co-founder of TEMCO (Texas Engineering and Manufacturing Company). Other officers were James J. Ling, chairman of the executive committee; G. K. Johnson, president; Clyde Skeen, executive vice president; R. C. Blaylock, vice president and technical director; Lee D. Webster, vice president, secretary and treasurer, and J. J. Kerley, vice president and controller.

Headquarters of Ling-Temco-Vought, Inc., is at 9314 West Jefferson, Dallas, Texas, where main production units of both Chance Vought and Temco, a subsidiary of Ling-Temco Electronics, have been located since 1948.

Artist's conception of tri-service VTOL craft under development by Chance Vought Corporation.

Based on December 31, 1960 figures, Ling-Temco-Vought began business with more than 20,000 employees, assets of $194,000,000 and a backlog of unfilled orders approximating $300,000,000. The pro forma combined sales of both companies and their subsidiaries in 1960 were approximately $362,000,000.

Approximately 7,000,000 square feet of floor space was being utilized by the combined company. LTV also had subsidiary, divisional or service activities in almost every state in the nation and at several overseas locations.

In describing the new company, Mr. Johnson said the combined corporation was "an organization with the ability to project itself profitably into the future with experienced, aggressive management, enhanced financial strength and greatly increased creative and productive capabilities."

The new company was grouped into seven major product categories: aerospace systems, electronics, communications and test systems, aerosystems, information handling systems, sound systems and commercial and industrial products.

Aerospace Systems includes the new Chance Vought Corporation with its Aeronautics and Missiles, Astronautics and Range Systems divisions, all of Dallas, and Harbor Boat Company and Harco Engineering of Los Angeles.

The Electronics Group is composed of Temco Electronics (a combination of Temco Electronics and Vought Electronics) of Dallas and Micromodular Components Division of Anaheim, Calif., both of which are divisions of Temco Electronics and Missiles Company, and United Electronics of Newark, N. J.

Communications and Test Systems is composed of Continental Electronics Manufacturing Company and Continental Electronics Systems, both of Dallas; Ling Electronics Division of Anaheim, California;

Calidyne Company of Winchester, Massachusetts, and Electron Corporation of Dallas.

Aerosystems is Temco Aerosystems of Greenville, Texas, another division of Temco Electronics and Missile Company.

Information Handling Systems includes FF&M Electronics of Los Angeles.

Chance Vought Corporation, with its aerospace production, remains the backbone of the new Ling-Temco-Vought complex. Rolling from the production lines of the Vought Aeronautics and Missiles Division at year-end was the F8U-2NE Crusader, an all-weather, carrier-based fighter capable of flying in the twice-the-speed-of sound range and equipped with greatly improved radar.

As project manager, Chance Vought joined with Hiller Aircraft Corporation and Ryan Aeronautical Company to bid successfully on production of the nation's first tri-service VTOL (Vertical Takeoff and Landing) aircraft.

The company also had an Air Force contract for work on the nuclear ramjet-powered SLAM (Supersonic Low Altitude Missile) program.

In the era of space, Chance Vought was prime vehicle manager for the NASA Scout program, produced components for the Saturn missile, and was a member of the McDonnell-Vought-Lockheed-Hughes team in bidding on the Apollo program.

In addition, the company was a large aerospace subcontractor, a leader in the anti-submarine warfare field and a provider of military management services. The Range Systems Division designed and installed instrumentation systems for the USS Range Tracker, missile and space tracking ship assigned to operate in the vast Pacific Missile Range.

The Electronics Group produced actuators for all three stages of Minuteman and check-out systems for Titan. It also produced video correlators, C-band Beacons and other radar subsystems, antennas, sonobuoys and ASW devices, autopilots, aircraft and aerospace support electronic systems, electron tubes, micromodular components and circuit encapsulations.

Super-power radar transmitters for BMEWS and Nike-Zeus systems were produced by the Communications & Test Systems Group along with military communications transmitters for all military services. The group also produced radar telescope transmitters, nuclear research devices, Voice of America transmitters, 1-kilowatt to 50-kilowatt commercial transmitters, remote control broadcasting systems, dummy loads and super-power sonar amplifiers.

A highlight of the year was the completion—one full year ahead of schedule—of the Navy's 2-million-watt VLF (Very Low Frequency) "world's most powerful radio station" in Cutler, Maine. This is the "Voice of Polaris."

Aerosystems produced specialized airborne systems and provided depot level maintenance and modification, including IRAN and PARC, for all types of military aircraft.

LOCKHEED AIRCRAFT CORPORATION

Lockheed sales in 1961 passed $1.4 billion and the company's backlog rose to a record level, primarily the result of longer-range funding on missile-space programs and substantial orders in newly emphasized fields of military airlift and antisubmarine warfare aircraft.

For Lockheed, the year's financial highlight was its achievement of fiscal objectives set forth in mid-1960. At that time Lockheed reported large write-offs and a large net loss. It promised, however, that the action would return the company immediately to profitable operations and strengthen its position for the future.

Work in the field of missiles, satellites, and space research, both military and civilian, accounted for half of Lockheed's business volume in 1961. As prime contractor on the Navy's Polaris fleet ballistic missile the company responded to the Defense Department's acceleration of the program, including authorization for additional submarine systems and faster development of a 2500 nautical mile range Polaris missile. Production of the first generation Polaris, now operational, continued. A 1500 mile second generation Polaris successfully underwent firing tests.

Lockheed's Agena satellite found wide uses. The advance Agena B demonstrated that its rocket engine can be stopped and restarted in orbit by radio signals from earth. With Lockheed as Air Force satellite system manager, the Agena B was being used in the Discoverer space research, Midas infrared detection satellite, and other space programs. A successful launch in October placed a Midas in orbit and demonstrated its ability to detect the firing of a test missile. The Army chose Agena as the orbiting vehicle in its Advent worldwide communications satellite project. And the National Aeronautics and Space Administration began using Agena for a number of civilian space programs including Ranger, a step toward landing a capsule on the moon. Lockheed's missile-space achievements won for it the Hoyt S. Vandenberg trophy, for contributions to national security in aerospace power, and the Goddard Memorial trophy.

The Lockheed C-141, 315,000-pound turbofan airlifter, for MATS use in 1964-65.

New government procurement of planes to provide airlift for limited warfare and logistic support brought additional Air Force orders for Lockheed's C-130B Hercules transport, the Navy GV-1 tanker version, and the new Air Force C-130E long-range model, which had its first flight in August. Hercules production rates were to increase substantially in 1962.

Lockheed's experience in cargo aircraft was a factor in its winning the Air Force award to develop and build the C-141 turbofan cargo and troop transport—a major step in modernizing the Military Air Transport Service. The craft was designed to meet civilian cargo as well as military needs. More than half of the new aircraft was to be subcontracted, and Lockheed placed the first major C-141 subcontracts late in 1961. The first C-141 was scheduled for roll-out in August, 1963.

In September Lockheed received a Navy contract extending production of the P3V-1 Orion propjet antisubmarine patrol bomber through 1963. The first production Orion flew in March. It is a successor to the P2V Neptune, in production since 1946. The Navy took delivery of its 1000th Neptune in May, and production was scheduled through 1962.

The company's antisubmarine warfare interest was broadening into allied fields of ocean systems and oceanography. Lockheed's ASW-Ocean Systems organization, established in 1960, undertook a feasibility study for the Navy's Atlantic Underwater Test and Evaluation Center in the Bahamas. New ocean system activities included hydrofoil research and marine biological studies. An oceanographic research vessel, the Sea Quest, was commissioned in March.

During 1961, Lockheed accelerated its F-104 Starfighter manufacturing program. With Lockheed as international program manager, six foreign nations were building under license more than 1000 F-104 multi-mission jet fighters. Lockheed itself was in production on a backlog of Starfighters for foreign countries. In addition, the Air Force in 1961 resumed purchases of F-104s for Mutual Assistance Program countries. Japanese and Canadian Starfighters had their first flights, and the first German-assembled F-104G officially joined the German Air Force.

The Lockheed 60 bush transport had first flights in 1961 at plants of Lockheed affiliates in Mexico, Argentina, and Italy, where the six-place utility monoplane was being manufactured. Lockheed research in vertical-short takeoff-landing craft gained the company an Army Transportation Research Command contract to develop the Hummingbird, a jet airplane capable of flying straight up and down, of hovering in mid-air, and of forward flight at jet speed. It utilizes ejector mixing chambers to augment the thrust of its two turbojet engines. Lockheed also had an advanced helicopter test vehicle flying. Late in 1961 it entered a bi-service competion with a new tactical fighter design, and it was continuing supersonic transport studies.

Highlights of Lockheed's 1961 accomplishments in other areas included:

Launching in July by Puget Sound Bridge & Dry Dock Company of the guided missile frigate USS Gridley, first vessel of its class ever built by a west coast private shipyard.

Development by Lockheed Electronics Company of the fuel oil industry's first fully automatic computing register.

Formation with seven Japanese industrial firms of the Nihon-Lockheed Monorail Company to build the prototype of a low-cost monorail in Japan.

Penetration of the maritime field with an anti-corrosion system that resulted in an order from the Netherlands to install the system on 11 Dutch destroyers.

Missile support activity that included test and maintenance work at Titan sites in Washington and Wyoming.

Aircraft fuel handling at an annual rate of 200 million gallons at eight airports in California, Illinois, Oregon, and Hawaii.

Successful firing of the largest solid fuel rocket motor ever tested at super-cold (50 degrees below zero) temperatures.

First flight of the QF-104 target drone, the first pilotless flight of a modified supersonic aircraft.

Design and manufacture of low-power nuclear reactors for a NASA research facility and for Purdue University.

Development of an aircraft cockpit voice recorder and receipt of an Air Force contract to supply portable devices to detect and record system malfunctions in jet bombers.

At mid-year Lockheed renamed its three principal operating divisions the Lockheed Missiles and Space Company, Lockheed-California Company, and Lockheed-Georgia Company. In September, it acquired complete ownership of the Grand Central Rocket Company, a producer of solid fuel rocket motors in which Lockheed previously held a 50% interest, and changed the firm's name to Lockheed Propulsion Company.

Courtlandt S. Gross was elected board chairman and Daniel J. Haughton became president following the death in September of Robert E. Gross, board chairman since 1932.

At year-end 1961 the Lockheed organization consisted of nine major operating divisions and subsidiaries—Lockheed Missiles and Space Company, Lockheed-California Company, Lockheed-Georgia Company, Lockheed Aircraft Service, Lockheed Aircraft International, Lockheed Air Terminal, Lockheed Electronics Company, Lockheed Propulsion Company, and Puget Sound Bridge & Dry Dock Company. Total employment among all divisions was 67,000. Lockheed's facilities covered more than 16.5 million feet of floor space.

McDONNELL AIRCRAFT CORPORATION

McDonnell attained major milestones in three leading product lines during 1961. The F4H Phantom II fighter airplane for the Navy entered the fleet combat-ready, the Gam-72 Quail missile became combat ready and was installed in Air Force B-52 "alert" squadrons, and the Project Mercury capsule for the National Aeronautics and Space Administration carried astronaut Alan B. Shepard, Jr. on the free world's first manned space flight.

The year saw the formation of a new Electronic Equipment Division, the Automation Center develop a good foundation for sound and steady growth, and receipt of nine new contracts for aerospace study and research and development work.

Operations for the year were good from a financial standpoint. Earnings after taxes were at a new high, slightly greater than last year. Working capital increased by 42 per cent to over $50,000,000. The company ended the year entirely free of any and all kinds of borrowing and in the strongest financial position in its history.

The first manned flight of the Project Mercury Capsule into space on May 5 demonstrated for the first time man's ability to perform useful control functions in space, and was of historical significance in the program leading to manned orbital space flight. The second manned flight on 21 July further demonstrated the capsule's integrity for space flight and re-entry into the atmosphere.

In addition to the design, development, and construction of the Mercury vehicle, McDonnell was given the added responsibility during the year for much of the launching preparations at Cape Canaveral. McDonnell had a team of approximately 400 personnel at the Cape assigned to final testing of the spacecraft and preparing it for flight. This included the mating of the capsule to the booster and participating in the final checkout and countdown.

Despite the complexity of the spacecraft and unusual circumstances surrounding its development, McDonnell delivered the first flight version in February 1960, only 13 months after the contract award. Fifteen were being delivered to NASA by the end of 1961.

One of the aspects of Project Mercury which merits further emphasis is the program's importance to future manned space flight. This program has been aptly described as "the Wright Brothers phase of manned space flight" and the knowledge gained from it will provide the foundation upon which the free world's capability in this field will be built.

An order for six additional Project Mercury spacecraft with a preliminary expenditure limitation of $2,500,000 was received in April 1961 from NASA. The fulfillment of this order was to extend work on Project Mercury through June, 1962. It was expected that many additional experiments will be conducted with Mercury vehicles until more advanced multiman spacecraft and space laboratories are developed.

During calendar 1962 and 1963 an average of about one testing, training, or orbital flight every two months was planned with Mercury capsules. Experiments may include orbiting the capsule as many as 18 times around the earth and orbiting animals for a week or longer. In these ways and others Mercury spacecraft would support the development of the Apollo program for manned lunar landings.

One of our most significant new research and development programs, for which McDonnell received a $9 million contract from the Air Force in June, is a project known as ASSET (Aerothermodynamic Structural Systems Environmental Tests) which calls for the design, construction, and flight testing of advanced glide re-entry vehicles.

The objectives of Project Asset is to obtain new technical data and develop sound approaches to the creation of advanced structural systems for future aerospace vehicles.

The contract called for the construction of seven re-entry vehicles which will be launched from Cape Canaveral by Scout boosters on horizontal trajectories where they will travel at speeds up to 12,000 miles per hour. The flights will be of longer duration than any heretofore conducted in the re-entry environment, and thus permit extensive data to be obtained. The vehicles, made of refractory metals, will be recovered to permit physical inspection after flight, with the objective of creating reusable aerospace vehicles.

Further recognition of the Phantom II as one of the world's most advanced airplanes grew during the year as the first combat-ready Phantoms were delivered to the Atlantic and Pacific fleets, as new world speed records were established, and as the Phantoms continually demonstrated their capability to perform both interceptor and attack roles.

The Phantom's reputation as the outstanding fighter aircraft stems not only from its speed and altitude capabilities, but from its great versatility both as a land and carrier-based aircraft. This twin-jet fighter flies at speeds appreciably in excess of Mach 2, has attained an altitude of 98,557 feet, has the longest range of any Navy fighter, and yet lands aboard carriers at speeds lower than other supersonic jet fighters.

As an interceptor, the Phantom incorporates a fire control system which assures maximum effectiveness from its loads of Sparrow III and Sidewinder missiles. As an attack airplane it carries quantities of both nuclear and conventional bombs. In exercises during May and June, a Phantom demonstrated its adaptability for limited wars by releasing in salvo, in clusters, and singly, 22 conventional bombs during bombing runs.

Because the Phantom operates from aircraft carriers and from shorter runways than other high performance aircraft, its combat effectiveness is worldwide.

Two new official world speed records were achieved by Navy pilots in the Phantom II on exacting courses.

On May 24 three teams of Navy pilots and radar operators set new transcontinental speed records in three Phantoms from Los Angeles to New York. Each Phantom bettered the previous world's record of 3 hours 7 minutes held since 27 November 1957 by the Air Force using RF-101 Voodoos. The best time was 2 hours, 48 minutes.

On August 29, a two-man Navy crew flew the Phantom II at tree-top level of an average speed of 902.768 (Mach 1.2) over the missile range at White Sands, New Mexico, and claimed a new world class record for a three kilometer course.

Navy production contracts for the Phantom II weapon system called for deliveries through 1963. The Phantom II's achievement of maximum speed within the limitations of conventional materials, combined with the flexibility of both ground attack, air superiority, and interceptor capabilities, indicate that the airplane will play a major defense role for the United States and the free world throughout the decade of the 1960's.

The delivery of the 807th F-101 Voodoo to the Air Force's Air Defense Command on March 13 marked the completion of 343 man-centuries of work, which brought McDonnell more than $1,000,000,000 of business spread over 10 years.

To strengthen the defense of the outer reaches of North America, the U.S. Air Force has transferred 66 F-101B interceptor Voodoos to the Canadian Air Force for operation under the North American Air Defense Command.

Of major importance to McDonnell missile business is the fact that the company will team with Bendix in the development of the new Typhon missile weapon system for the Navy. The Typhon will provide the fleet with a greatly improved anti-aircraft capability plus an offensive surface-to-surface capability for engaging enemy fleet units. This weapon system with its improved propulsion and a unique McDonnell-pioneered aerodynamic configuration will have an extended range and will improve the accuracy, target-handling capacity, and quick reaction capability of future guided missile warships. McDonnell will be responsible for the development of the airframe, including the ramjet engine.

The Typhon is an outgrowth of the Navy's Talos.

a surface-to-air missile which is in its 10th year of production by the Bendix-McDonnell team. Talos is established as a primary fleet defense system aboard the Navy's missile cruisers. It was expected that Talos would continue in production at least until production Typhons are delivered to the fleet.

Most of the B-52 squadrons of the Strategic Air Command scheduled to receive the GAM-72 Quail had been equipped with combat-ready missiles.

The Quail was designed to serve as a penetration aid during strategic bombardments. Several missiles are carried by a B-52 bomber. When a "covey" of Quail are launched from the bombers, they create images on enemy radar screens identical to those of the bombers, thus serving to confuse enemy defenses. Powered by a GE-J85 jet engine, the Quail flies at the speed of the bomber, about 650 miles per hour, and at the same altitude.

As weapon systems manager, McDonnell designed and was producing the airframe and electronic flight control system as well as the electronic and mechanical ground support equipment, and the launch system in the bombers.

Orders for the Quail and associated equipment were to extend deliveries through June 1962.

As the use of electronic equipment expanded with the ever-increasing complexity of aero-space products, McDonnell designed and produced a wide variety of electronic products and systems in connection with advanced research, development, and production work for the U. S. Government. In order to realize the greatest potential from this capability, an Electronic Equipment Division was organized on January 9 with the aim of improving present service through consolidation, and of competing for new electronic business from government and industry.

Among items for which McDonnell had contracts were a missile flight control system, an aircraft disaster prediction device, ballistic missile check-out equipment, and a new method of visual display of air defense radar information for the Army at the battle group level. Including items for use in MAC weapon and space systems, upward of 35 separate electronic equipments have been designed, with the majority of them in 1961 production.

Because of past experience, MAC was concentrating on development work in the fields of guidance and control, space communications, and ground support equipment.

The Automation Center completed its first year of operations with a good foundation for future growth. Following a policy that would provide the company with a broad base of applications in a variety of industries, McDonnell served clients in 30 different lines of business during the year, including banking, petroleum, retail, wholesale, electrical manufacturing, food and beverage. Among these applications was the development of a complete demand deposit system for banks, utilizing the newly developed Magnetic Ink Character Recognition (MICR) equipment. Services included consulting, systems design, programming, data processing and computing.

The professional staff of the Automation Center grew to 400 personnel, and had available nearly $10,000,000 worth of computing equipment. McDonnell substantially increased its scientific digital computing capacity with the installation of an IBM 7090 and an IBM 7080, which increased administrative data processing capacity by five times. It was delivered in August, the first 7080 to be installed in the country. Complex services and operations, such as simulation of oil refinery operations and of flights of advanced space vehicles, can now be provided with greatly increased speed, efficiency and economy.

A substantial step was taken in equipping the Research Laboratory so as to provide improved technical support for the company's Aeronautic, Astronautic, and Automation activities. Programs in progress in 1961 included: Solid state physics research involving the preparation of thin films of metallic single crystals for advanced electronic circuit elements; and involving work on quantum electronics devices required for the conversion, detection, and amplification of energy. An integral part of this work is the study and preparation of intermetallic compounds having both high melting temperatures and high thermonuclear conversion efficiencies to improve the auxiliary power systems in spacecraft.

Electro optics research included absorption studies of possible maser materials to provide data for optical pumping systems for microwave energy amplification in spacecraft communication and spacecraft and missile guidance.

Plasma physics research to investigate materials and spacecraft suitable for entering planetary atmospheres and for hydrogen arc propulsion of spacecraft.

The Navy on September 5 announced it had awarded McDonnell a contract amounting to $180,000,000 for additional F4H aircraft. The Navy also advised of its plan to increase the production rate for fiscal 1962 of the Talos missile for which McDonnell builds the airframe and the ramjet propulsion.

Marquardt demonstrated liquid air cycle operation, burning liquid air with hydrogen in 18-inch thrust chamber.

THE MARQUARDT CORPORATION

Research and development programs, both government and independently sponsored, for propulsion and directional control systems for aerospace vehicles keynoted The Marquardt Corporation's 1961 activities.

Marquardt's application of airbreathing technology to space flights evolved a number of airbreathing propulsion concepts designed for orbital speeds, including the Liquid Air Cycle Engine (LACE). LACE, a unique airbreathing device which utilizes economies and efficiencies evidenced in ramjet engines, gathers, liquefies, and stores air as the vehicle travels through the atmosphere. The liquified air and liquid hydrogen are then pumped into a rocket thrust chamber as required for the boost and space flight operations. A nuclear version of LACE, designated NULACE, is presently undergoing investigation by the company's research and development teams.

The corporation's participation in Project PLUTO, a joint Air Force-Atomic Energy Commission program to demonstrate the feasibility of a nuclear ramjet, received increased emphasis in mid-1961 when the nuclear reactor (Tory IIA) was successfully operated for 45 seconds, producing 40 thermal megawatts. These tests were conducted by the University of California's Lawrence Radiation Laboratory, developer of the Tory IIA reactor.

In the field of rocketry, Marquardt's company-sponsored investigations in the application of small controllable rockets led to the PAT-C (Position, Attitude, Trajectory Control) system designed for the orbital correction and control of space vehicles. These efforts resulted in a classified feasibility study contract from General Electric for the development of an orbital control propulsion system for Project ADVENT.

A significant advancement in rocketry was achieved by Marquardt in September when a 25-pound thrust, radiation-cooled, bipropellant pulse rocket was operated continuously for 46 minutes. Since the corporation first initiated its company-sponsored research in this area of radiation-cooled bipropellant pulse rockets and related systems for position-attitude control of space vehicles, pulse frequencies up to 100 cycles per second in engines ranging from 0.2 to 100 pounds' thrust have been demonstrated in more than one million total documented pulses.

The NA-273 Redhead/Roadrunner, the Army's newest, sleek, Marquardt ramjet-powered target missile, successfully completed a series of tests at the White Sands Missile Range. Built by North American Aviation's Columbus Division, the missile is designed to operate at Mach numbers .9 to 2.0 and at altitudes from sea level to 60,000 feet. After a 6000-pound thrust booster rocket fires the missile from the launcher, a single ramjet propels it for the remainder of its mission.

During 1961, The Marquardt Corporation began working on the largest radar land-mass simulator trainer system project ever undertaken in the company's history. This multi-million-dollar Air Force contract calls for the development of a new bombardier/navigator radar training system to be used by the Strategic Air Command and the Air Training Command in training bombardiers and navigators on simulated B-52 tactical missions. Known as the T-10, this unique training system utilizes a multi-channel memory (MCM) data storage system making use of a three-color film transparency in which terrain elevation and radar reflectivity data are stored on a map scale ratio of 1 to 3,000,000.

Also in conjunction with the B-52, the T2A trainer program was extended by the corporation, under Air Force contract, for trainers to provide on-ground training of Air Force personnel in simulated procedural launching operations of the GAM-72 Quail decoy missile and the GAM-77 Hound Dog air-to-ground missile.

Throughout 1961, the Air Force demonstrated many successful firings of the Boeing-built Bomarc B missile, which is powered by two advanced Marquardt ramjet engines. The continued success of the Bomarc missile program as evidenced in these tactical firings provided assurance of an operational Bomarc IM-99B which will ring the periphery of the United States to guard against supersonic bomber attack. The improved missile, directed toward drone aircraft and targets by SAGE direction centers, registered effective "kills" at altitudes greater than 100,000 feet and distances of more than 440 miles.

In addition to the design and fabrication of rocket motors, the corporation continued to develop and produce complete programs on payload packages, recovery systems, electronic sensors, transmitting and receiving antennae, launchers, and electronic data processing systems. Marquardt's meteorological rocket systems program was high-lighted during the year when company-developed ASPAN sounding rockets were fired off the coast of Sardinia by the Italian Space Commission. These rockets attained altitudes of 100 miles, ejecting sodium flares which permitted Italian scientists to study and gauge upper atmospheric and wind conditions.

The Marquardt Corporation accelerated its independent research and development activities in such diversified areas as space exploration, propulsion systems, industrial and manufacturing capabilities, and the gathering, storage, and transmission of complex electronic data. Company-sponsored programs of this nature led to the Air Force contracts on Project ADVENT and the B-52 trainer systems. A number of study contracts were received for explorations of chemical and electrical rockets and electrical power conversion.

In demonstrating the expanding electro-optical capabilities of the corporation, Marquardt developed, through company-sponsored research, a high-density data storage system capable of storing 5,000 times as much information per square inch as magnetic tape and with a readout time only 1/10 as long. This is a system whereby information is recorded in terms of optical density in independent dyes of color film. The readout system consists of an electro-optical system which converts the light densities of the film to electrical signals.

During 1961, independent company research conceived a new concept for nuclear powerplants for the production of electrical power in the civilian reactor field at costs competitive with conventional steam-electrical plants in the 5,000 to 20,000 electrical kilowatt range for small electrical systems. Called the Direct Cycle Diphenyl Reactor (DCDR), the concept represents a new approach to the design of small nuclear powerplants. The high waste-heat rejection temperature (approximately 300°F) of the diphenyl cycle is ideally suited to provide a source of economically useful energy for production of process heat or for saline water conversion.

A sudden expansion burner system (SUE), which incorporates the most recent developments in combustor design and heat transfer theory, was being produced by The Marquardt Corporation at year-end. The unit's simplicity makes it applicable to a wide variety of test and industrial heating and process systems. The first major application of the SUE burner was at the NASA Langley Research Center structural wind tunnel where the system is utilized to boost the air temperature to 2000°F. The generation of this intense heat is designed to test aerodynamic components and structures under high-temperature supersonic conditions.

During the year, a new automatic hydraulic-powered universal testing machine, the TM-6, was added to the line of industrial and manufacturing test machines and accessories developed and produced by The Marquardt Corporation. The test machine is designed to accommodate highly exacting test requirements for determining physical properties of all types of materials, including metals, plastics, ceramics, cermets, cloth, and paper. The machine is automatically controlled and will test materials in tension, compression, bending, fatigue, creep, creep-relaxation, and recovery.

In its seventeenth year—founded in 1944—The Marquardt Corporation employed approximately 3,500 employees, encompassing the following divisions: ASTRO (Aero Space Technology Research Operation) Power Systems Division, Facilities Engineering Division, Pomona (electronics) Division, and a major manufacturing facility at Ogden, Utah.

MARTIN COMPANY

A DIVISION OF MARTIN MARIETTA CORPORATION

On October 9, 1961, The Martin Company and the American-Marietta Company were consolidated into a new billion dollar enterprise, Martin Marietta Corporation.

George M. Bunker was named president and chief executive officer, and Grover M. Hermann became chairman of the board of directors.

Initial assets of Martin Marietta were about $600 million. Martin Marietta's sales for 1961 were expected to be around $1.2 billion.

Martin's identity as a government contractor, specializing in the aerospace area, will be maintained under the same executive management as before consolidation with American-Marietta.

William B. Bergen, who became vice president of Martin Marietta, continued as president of Martin. A major producer in space research, electronics and nucleonics, Martin also maintained its position as a leading manufacturer of missile systems, including the TITAN ICBM. The backlog of defense contracts was in excess of $1 billion.

A series of dramatic developments marked 1961 as a year of significant progress for Martin. These were some of the highlights:

—At Vandenberg AFB, a modified TITAN I became the free world's first ICBM to be launched successfully from the bottom of an underground silo.

—A second TITAN rode to the surface on an elevator and was fired successfully 5300 miles down the Pacific Missile Range in the system's first complete operational test.

—Martin engineers developed RACEP, a revolutionary concept in radio voice communications requiring no wires or central switchboard.

—A Martin-built SNAP thermoelectric generator was placed in orbit aboard the Navy's TRANSIT IV navigational satellite to become the first nuclear power source in space.

—The world's first atomic-powered automatic weather station, built by Martin for the AEC, began transmitting weather data from an island in the remote reaches of the Canadian Arctic.

—PERSHING, the selective-range missile developed by Martin for the Army, extended its string of launch successes that has won it the most outstanding test record of any missile ever fired from Cape Canaveral.

In October, the new Martin Electronic Systems and Products Division was established. Charles D. Manhart joined Martin as vice president in charge of the new division. Electronics, covering 11 different product areas, accounted for more than a third of Martin's 1961 business.

A unique, broad agreement to help insure continued labor peace and high productivity at TITAN ICBM sites was signed by Martin, the Building and Trades Department of AFL-CIO and 14 member unions.

A 41-foot full-scale space laboratory, a model of a vehicle that could carry a team of astroscientists in orbit 350 miles above the earth for long periods of time, was unveiled in October as the feature of the "Man In Space" exhibition at the American Museum of Natural History (New York). An aluminum cylinder as large as a four-room house, the Martin-designed space laboratory named ARIES was built with the aid of a $100,000 Martin educational grant to the museum. The exhibit represents in authentic detail an independent earth satellite which could be built, equipped on earth and launched into space during this decade.

In November, Martin Company completed its new General Office Building at Baltimore's Friend-

Martin's SNAP generator is fastened to Transit satellite prior to vibration tests.

ship International Airport. The two-story building is occupied by headquarters executives and staff formerly located at the Middle River, Maryland facilities.

Total employment at the Martin Company during 1961 was about 45,000 employees in seven major divisions: Denver, Orlando, Baltimore, Canaveral, Nuclear, Electronics, and RIAS.

NUCLEAR DIVISION

The Nuclear Division was involved in several major aerospace "firsts" during 1961—the first use of atomic power in space, the world's first airlift of a complete nuclear power plant, and the establishment of the first atomic-powered weather stations to augment existing meteorological reporting service.

On June 28, the Navy's Transit-4A satellite carried aloft a grapefruit-sized SNAP radioisotope-fueled generator devedoped and built by Martin under contract with the Atomic Energy Commission. The unit, which had been completely safety-tested before launch, powers two of four radio transmitters in the navigational satellite. Its use was heralded throughout the world as a scientific accomplishment presaging the application of nuclear auxiliary power in all kinds of satellite systems and space probes.

About mid-way through the year, Martin completed fabrication of a "portable" nuclear power plant designed for installation at an Air Force radar station near Sundance, Wyoming. During June and July, sixteen "modules" comprising the PM-1 plant were flown to the installation and operating site. Lockheed C-130 aircraft were used for the airlift.

This ability to assemble nuclear power plants in the factory and then deliver them by air to remote sites opens vast new possibilities for the use of nuclear energy in previously inaccessible areas of the world. A plant similar to PM-1 was also completed by Martin during 1961 and shipped to McMurdo Sound, Antarctica. Although the latter plant, PM-3A, was not air-transported, its design meets specifications for such shipments. It was anticipated that the next Antarctic reactor will be delivered to an inland station by air.

Much of the company's efforts in the field of nuclear chemistry were directed toward development of new fuels for isotopic power devices like the SNAP generator in Transit-4A. An automated laboratory was established at Baltimore to purify and encapsulate large quantities of the man-made element, americium-241. These capsules are irradiated to form curium-242 and delivered to Martin's "hot cell" laboratory in Quehanna, Pennsylvania. There, the curium-242 is removed and put into proper chemical and physical form for use in SNAP-type generators.

Curium-242 offers such high power densities that it will make possible extremely light-weight atomic generators. Operating without moving parts, such generators promise high reliability. Unlike solar cell and battery systems, they would be undamaged by radiation in the Van Allen belts and could operate for extended periods on the moon's surface, where two-week-long nights make the performance of solar cells marginal.

The first two radioisotope-powered weather stations literally carried the peaceful applications of atomic energy from one end of the earth to the other. In late summer, one automatic electronic station was installed on Axel Heiberg Island, only 700 miles from the North Pole; and less than three months later, another isotope-fueled generator was shipped to Antarctica—where it would be buried in the ice near Little America V to operate another

New Martin Star Field Tracker reads star patterns, establishes a pointing axis in space, and thereby orients spacecraft in flight.

unmanned weather monitor. Each generator uses a safety inert and insoluble chemical compound of Strontium-90 as a heat source, ringed with thermoelectric elements to convert the thermal energy produced directly into electricity. Automatic weather stations which could be placed virtually anywhere in the world and which could operate for years without refueling or maintenance had obvious significance for air safety and aroused considerable international interest.

In the field of nuclear propulsion, the Nuclear Division continued to support Martin's effort on the RIFT program under contract with NASA. Simultaneously, company-sponsored efforts concentrated on several specific technical problem areas, including the fabrication of high-temperature elements, reactor flight safety analysis, and reactor start-up.

Near the end of the year, Martin announced its program of development for a series of Direct Conversion Reactors. Operating at the 60, 300 and 2,000 kilowatt levels, these reactors would produce electrical power by means of thermionic converters within each fuel element. Parameters for the fast reactor design, employing lithium as a coolant, were based on the company's development programs in the thermionics and liquid metal flow, as well as an extensive analytical program. The DCR system would be suitable for auxiliary power in active communications satellites, space laboratories or as basic power sources for electrical propulsion units.

Other programs in the Nuclear Division during 1961 included production of the reactor core for the Elk River (Minnesota) power station, the preparation of a critical experiment for the "liquid fluidized bed reactor" under AEC contract, the construction of several isotopic power units for land and sea use, and the inauguration of work under contract with the U. S. Army Corps of Engineers to design, develop and build a 10,000 electrical kilowatt floating nuclear power plant.

MARTIN-BALTIMORE

The principal activities of Martin-Baltimore during 1961 included continuing manufacture and testing of the Air Force Mace tactical missile systems, concentrated studies on space flight and planetary colonization for both NASA and the Air Force, and modification of the Titan II ICBM for its role as a booster in the Air Force Dyna-Soar manned space glider project. The division also received the first Air Force production order for a lightweight trainer modification of the Bullpup, and continued to furnish support systems for Titan, Pershing and Bullpup.

Mace B completed its development phase in June with a final series of successful launches down the Atlantic Missile Range from Cape Canaveral. Most of these tests were from a simulated underground hard site—a heavily reinforced concrete shelter designed to protect the missile under nuclear battlefield conditions. Launch crews were training to man the weapon system when it becomes operational with U.S. defense forces overseas.

Mace B is the newest in the series of Martin-built Air Force surface to surface tactical missiles that began fifteen years ago with the Matador "pilotless bomber," and continued with Mace A.

Matador has been deployed in full combat readiness since 1954 both in Europe and the Far East, and Mace A has been similarly operational in Europe since 1959. Both are capable of carrying conventional or nuclear warheads.

At the Mace A sites in Europe, a new rapid-fire multiple launch modification introduced during 1961 makes it possible to fire four missiles in less time than it formerly took to fire one, as well as to handle the entire operation with a smaller crew.

Matador is controlled electronically in flight by ground personnel. Mace A uses a self-contained tracking system known as ATRAN, which scans the terrain by means of radar and correlates with a previously prepared film strip in the missile.

Mace B uses an inertial guidance system which operates by means of a series of built-in gyroscopes, computers and reference platforms in a form of memory navigation. Mace B can cruise at altitudes from under 1000 feet to over 40,000 feet, and can attain ranges beyond 1200 miles.

Besides prime contracting Mace, the Baltimore division produced a great number of support systems for Titan, Pershing, and Bullpup.

In August the division received from the Air Force the first production order for the TGAM-83 Bullpup trainer. The air-to-surface training missile, used to teach pilots to fire the GAM-83 Bullpup, duplicates as much as necessary the performance of the operational missile.

The $1.5 million contract provided for delivery of 424 Bullpup trainers to Nellis Air Force Base, Las Vegas, Nevada, for training of F-100 jet pilots. The Bullpup trainer utilizes obsolete World War II and Korean War HVAR (high velocity aircraft rocket) engines to achieve costs savings. The 5-inch rocket produces 5000 pounds of thrust.

The TGAM-83 is nearly eight feet long and weighs 125 pounds compared to about 10 feet and 600 pounds for the operational GAM-83A Bullpup. The Bullpup trainer underwent test flights during the year at Eglin Air Force Base, Florida.

In May, Martin-Baltimore submitted to the National Aeronautics and Space Administration the results of a paid feasibility study on Project Apollo. Apollo is the manned space flight system which will take three men in orbit around the moon and will eventually lead to lunar landings and exploration of deep space.

Another paid study for NASA concerned launch vehicle systems for lunar exploration beyond the initial Apollo flight. The study covered three basic missions:

(1) a lunar landing and immediate return for three men, (2) a 30-day stay on the moon for three men, and (3) a permanent moon base which would accommodate 10 to 12 men. A wide variety of problems was covered, including those of boosting the vehicles into space, soft-landing them on the moon and returning them to earth again. The study also considered provisions for man's extended existence in the space and lunar environments. This program was to be continued into 1962.

Among other studies conducted by Martin in the field of space flight were ones on global surveillance, satellite vehicle guidance, and a permanent satellite base and logistics system. The company was currently devoting approximately 800,000 man hours a year to studies which relate directly to space flight and planetary colonization.

Under an Air Force contract, Martin-Baltimore was modifying the Titan II ICBM for its role as a booster in the Dyna-Soar space project.

Dyna-Soar is the first U. S. program to combine the speed of a ballistic missile and the maneuverability of an airplane. The Titan II booster will launch a manned glider under development at The Boeing Company, into the upper atmosphere at speeds of more than 15,000 miles per hour.

After separation from the booster, the glider pilot will be able to bring his spacecraft to a controlled landing at an airfield of his choice. The Dyna-Soar program is aimed at eventual controlled flight of the glider around the earth.

Martin initially was awarded a contract in November, 1959 when the Air Force designated the Titan I as the Dyna-Soar booster. The more powerful Titan II was selected as a replacement for the Titan I by the Air Force in January, 1961.

The Titan II delivers about 430,000 pounds of thrust in its first stage and approximately 100,000 pounds at altitude from its second stage. Utilizing hypergolic, storable propellants, the Titan II takes advantage of simplified systems which result in greater reliability.

Primary changes planned by Martin engineers in the basic ICBM included the addition of fins to the booster to compensate for aerodynamic forces acting on the glider's wings and structural strengthening to absorb the added weight of the glider.

In April the division was awarded a Navy contract to study the structural aspects of large hydrofoil ships. The significant feature of a hydrofoil ship is its ability to travel with hull raised entirely out of water. Thus freed from the friction and motion resulting from an immersed hull, it achieves high speed and stability.

Martin conducted independent hydrofoil studies for nearly three years, utilizing both its existing marine facilities alongside its Middle River (Maryland) plant and a corps of engineering staff members and consultants long versed, through work on seaplanes, in designing high-speed marine vessels.

During the year, the computers used by Martin in Baltimore were moved to a centralized location to establish a separate data processing center. Major equipment included an IBM 7070 for business computations, a 7090 for scientific and engineering computations, an three 1401's for input-output. Similar data processing capability existed in other company divisions in Denver and Orlando.

DENVER DIVISION

The Air Force's Titan ICBM came of age in 1961. Success after success was chalked up in intercontinental-range launchings down the Atlantic Missile Range from Cape Canaveral and the entire Titan weapon system—the missile, underground base and Air Force crew—passed its first operational-type test in September in a launch from Vandenberg AFB. The first Titan operational complexes, east of Denver, were structurally complete and nearing operational readiness.

Meanwhile, development of a larger, more powerful version of the missile—Titan II—was moving at Martin-Denver. First captive firings of the Titan II propulsion system took place in the Martin-Denver test area during 1961, the prelude to flight testing from Cape Canaveral.

Titan II will be the heavy-duty member of the U. S. ICBM force. In addition to the advantages of sheer power, it will feature all-inertial guidance, liquid propellants which can be stored aboard the missile and, hence, an extremely short reaction time. Titan II also will be launched from within its underground hard site.

In May this in-silo launch concept was proved at Vandenberg AFB when a specially adapted Titan I was launched from a prototype of the Titan II silo with complete success.

It was an important year in areas of space technology at Martin-Denver, as well. Studies were under way for both the Air Force and the National

Aeronautics and Space Administration. These included: SLOMAR (Space Logistics, Maintenance and Rescue), an Air Force study of a proposed spacecraft system to provide freight, passenger, maintenance and rescue service for orbiting satellites and space stations; and RIFT (Reactor In-Filght Test), a NASA project to study vehicle preliminary design problems involved in flight-testing a nuclear rocket engine in an upper stage on a Saturn booster. While test flight of a nuclear rocket was the primary concern, NASA anticipated that data furnished by the RIFT flight test program would have a direct application to operational space exploration vehicles.

A third major study announced publicly was POISE (Photosynthetic Oxygenation Illuminated by Solar Energy), a cooperative project between the Alaskan Air Command's Arctic Aeromedical Laboratory and Martin Company space scientists. It's a study of the effects on algae of the constant sunlight in interplanetary space, with Alaska's long summer days used to supply the sunshine.

Non-contractual programs under way included an astroplane system, space laboratory and exploration vehicle design, propulsion technology, human factors and animal research.

ORLANDO DIVISION

Martin's Orlando Division continued its rapid growth in 1961, with employment passing 10,300. The division, which opened in 1957 with 1,200 employees transferred from Baltimore, became Florida's largest industrial employer and a major factor in the Central Florida economy. The division continued development and production programs on its five prime contracts—the Army Pershing ballistic missile system, the Army Lacrosse missile system, the Navy Bullpup and Air Force GAM-83 Bullpup missiles and the Army's BIRDiE air defense system.

To this, the division added its revolutionary RACEP communications systems, and by the end of 1961 was ready to deliver equipment to the Army and Air Force. Work was also expanded and accelerated in advanced studies groups, with several highly significant programs underway.

Pershing, the division's biggest project, stepped up its flight test program. In 1961 the Group Two (second in the series of development configurations) flight test program was successfully completed, and tests with the advanced Group Three configuration and its sharply tapered nose cone were initiated.

The ground support equipment was phased into the flight test program and a training program for Artillery and Ordnance school instructors was begun, moving Pershing closer to operational status. The first production contracts were awarded in mid-summer.

Secretary of the Army Elvis Stahr, on a visit to Cape Canaveral, witnessed another successful Pershing launch, then visited the Orlando Division for a detailed Pershing briefing and operational demonstration.

Lacrosse, the Army's other big missile under production by Martin in Orlando, began moving into the U.S. inventory at bases overseas in 1961. Three battalions were deployed to Europe and one to the Far East. Troops began training firings and for the first time Lacrosse was launched on the European continent.

The Navy Bullpup program moved at a rapid pace during the year, highlighted by successful first launches of the new and larger Bullpup B and a highly significant contract for accelerated production of Bullpup A missiles in connection with a step-up of the nation's limited war capabilities.

Bullpup A, now operational with Navy and Marine Corps squadrons around the world, set more high marks for accuracy and reliability during 1961. Specifications were bettered in both areas. The company and the Navy also announced significant reduction in the cost of Bullpup A missiles, almost 60 per cent since the first production missile came off the line in 1958.

The Bullpup B, which carries a 1,000-pound conventional warhead, moved into advanced development stages with test launching from A4D aircraft at Pt. Mugu, California. First photos and details of the big missiles were released during the year.

GAM-83A, the Air Force Bullpup, began moving into operational F-100 and F-105 squadrons during 1961. The Air Force also accelerated the production of Bullpups for limited war readiness.

First launchings of the GAM-83B, nuclear warhead missiles, were successfully completed early in 1961 and the Air Force later awarded the company the first production contract for the nuclear Bullpup. (The Navy Bullpup B and the Air Force GAM-83B are different missiles, though the Navy Bullpup A and the Air Force GAM-83A are almost identical.)

Both services asked the company to study advanced versions of Bullpup, and work was underway to broaden the missile's capabilities.

With the last of the 10 Missile Master air defense coordination systems for major cities and major military installations delivered by Martin-Orlando during 1960, the electronics effort of the division was concentrated during 1961 on construction of the BIRDiE (Battery Integration and Radar Display Equipment), a smaller system doing a similar job for smaller population centers.

BIRDiE is a transistorized Missile Master, using 3000 printed circuit cards to perform the system's vital functions.

A total of 19 of these "midget" Missile Masters was under contract during 1961 with the first 15 to be delivered during the year.

Costing about a half-million dollars each, the BIRDiE was accepted for use by the Department of the Army on September 6. The first BIRDiE was installed at Turner Air Force Base, near Albany, Georgia. The second was dedicated October 16 atop Mt. Tamalpais, California, guarding the San Francisco Bay area.

BIRDiE processes and distributes information about aircraft to guided missile batteries and coordinates Nike-Ajax and Nike-Hercules missile fire. It can be operated independently in its own area or as part of an over-all system.

Efficiency of BIRDiE is easily seen when it is compared statistically with Missile Master. BIRDiE occupies 97 per cent less space than Missile Master, uses 95 per cent less power, and requires 80 per cent fewer personnel.

A BIRDiE trainer was to be located at the Army Air Defense School, Fort Bliss, Texas.

Martin-Orlando unveiled a revolutionary development in radio voice communications on June 8, 1961.

Called RACEP (Random Access and Correlation for Extended Performance), the system is probably the most significant development in the field of voice communications electronics since the end of World War II.

The equipment is the equivalent of a private radio-telephone system which has all the operating characteristics of an ordinary telephone system without the use of wires or central switchboard.

Martin Company scientists have listed five basic fields where RACEP could provide new breakthroughs:

1. Pilot-to-ground-to-controller communications in both civilian and military air traffic control.

2. Communications for commercial firms and municipal departments between controller or dispatcher and fleet vehicles.

3. Communications in emergency disaster situations.

4. Ship-to-shore communications.

5. Private telephone-type world-wide communications via orbital satellite relay.

RACEP, which will accommodate as many as 700 subscribers on a single network, adapts a new modulation technique to carry voices in the form of quick pulses of radio energy on a single frequency band simultaneously between many persons and locations. It achieves its extraordinary performance by putting to use the pauses and breaks in normal conversation as well as the idle time between calls.

Inherent in the RACEP system is a good measure of military security. Full cryptography security may be adapted to it because of its digital characteristics.

The Air Force on June 21 announced purchase of six units for ground-to-ground communications tests.

The Army in July of 1961 awarded Martin-Orlando a contract for preliminary models for test and evaluation. Delivery of these sets was expected in early 1962.

Hospital atmosphere prevails at Martin Electron

With RACEP, frequency requirements of all civilian and military aircraft can be met with only two assignments of four megacycles each. Current air-to-ground communications require a total of 26 megacycles.

An approach control system is being studied utilizing RACEP with an antenna array on the aircraft. This system will enable the controller and pilot to determine automatically the glide path and flight time to touchdown at the airport.

RACEP equipment costs will be competitive with existing systems, although providing more benefits in spectrum efficiency, reliability of transmission and operational flexibility. As the RACEP system moved out of research stages, the division's advanced design groups began to explore new areas.

Research engineers were engaged in developing pneumatic computers to replace electronic components in missile guidance systems. These promise a drastic reduction in radiation interference and cooling problems which are common to electronic components in present weapons systems.

Work also continued in the thin film circuit field. Previously unused electrical properties of matter are being applied in thin film circuits, promising space and weight savings, greater simplicity and fewer solder connections and increased system reliability.

ıltra-clean infrared laboratory.

To accelerate the division's expanding basic research efforts, these programs were placed under a new Advanced Technology Staff. The Orlando division also moved to strengthen its systems research in the Advanced Systems section by adding manpower and company funding to programs in this field.

CANAVERAL DIVISION

The Canaveral Division, Martin's test arm at Cape Canaveral, had its most active year to date, launching missiles at a rate of better than three per month.

The Titan intercontinental ballistic missile was slated to be operational by the end of 1961. The Mace tactical missile completed research and development and was turned over to the Air Force.

Martin's third missile system under test at the Cape, the mobile selective range Army Pershing, continued to prove extremely satisfactory.

In June a series of test launches were begun utilizing Titan I to test the inertial guidance system which will direct the flight of the larger, more powerful Titan II.

Two launch complexes were modified and made ready for the flight test phase of the research and development program on the bigger, more powerful Titan II. The Titan II is planned to be ready for its underground silo launching sites in 1963.

The Canaveral Division, besides its missile testing, supported the space projects of Martin's Nuclear and RIAS divisions.

The Nuclear division built the first atomic powered electrical generator to be put into orbit. The SNAP-3 generator was launched in June from the Cape aboard a TRANSIT communications satellite.

In May, a RIAS-built package was sent aloft from the Cape to measure the density of neutrons in the upper atmosphere.

Both space projects proved highly successful.

The division was established in 1957 to conduct all missile flight testing for Martin's other divisions at the Atlantic Missile Range. Late in 1961 the name was changed from Cocoa Division to Canaveral Division.

Facilities assigned to and operated by Martin-Canaveral included three hangars and four launch complexes for the Titan, an assembly building and complex with hard and soft launch sites for Mace, and a complex with two launch pads for Pershing.

ELECTRONIC SYSTEMS AND PRODUCTS DIVISION

Martin Electronics, established as a full-fledged division in 1961, was responsible for applied research, development, design, manufacture and sales of systems, equipments, major components, and studies in the following product areas: aerospace surveillance, command and control, data-processing and display, electronic warfare, ground support, guidance and control, infrared, instrumentation, trainers and simulators, and undersea electronics.

Among the division's 1961 programs, infrared detection continued to grow, with detection in the difficult middle infrared region showing particular success. Multi-element arrays using doped germanium as the sensor element were developed to the point where arrays 100 microns on a side were available. Scanners for submarine wake detection, satellite detection and tracking, ground mapping, attack warning and missile-launch detection, and determination of ICBM and IRBM signatures were designed.

Ferret countermeasures receivers are well known as Martin products. New developments in electronic warfare included improved antennas; satellite direction-finding antennas; automatic detection, surveillance, and analytical systems; and rapid-scan digitally programmed receivers.

In ground support equipment, the division designed and produced systems and devices for checkout, launch control, launchers, power supplies, simulators and trainers, transport, storage, handling, propellant loading and cryogenics, and maintenance equipment. Its GSE products were used on such programs as the P5M Marlin seaplane and the Matador, Bullpup, Lacrosse, Mace, Titan, GAM-83, and Pershing missiles.

A digitally driven display system was developed for command and control to show many types of data simultaneously—maps, countours, tracks, and characters—with better than 99 per cent reliability. A digital and solid-state system up to and including the deflection circuits, it exploits the versatility of the modern computer and requires no digital-analog conversion.

Undersea electronics, a longtime interest of the division, was represented by acoustic projectors, transponder buoys, taut-wire hydrophone array, and fixed acoustic buoy used in underwater sound research.

The division had special engineering laboratories for infrared, cryogenics, solid-state electronics, materials and processes, instrumentation, magnetic components, human factors, semi-conductor products, and high-resolution recording.

RIAS DIVISION

In the comparative quiet of a suburban estate in Ruxton, Md. (near Baltimore), RIAS scientists continued to conduct basic research in mathematics, physics, chemistry, metallurgy and the biosciences. For them, the year 1961 was a particularly fruitful one, resulting in more than 50 publications in scientific journals.

Work continued at a vigorous pace at the Mathematics Center, where research was conducted in differential equations, a subject vital to the development of control theory. Fundamental work in linear filtering and prediction produced a more practical means of predicting the optimal path and position of a space vehicle operating at great distances from the earth. One of the high points of the year was the Symposium on Nonlinear Differential Equations and Nonlinear Mechanics conducted by RIAS and the Air Force Office of Scientific Research. Held at the Air Force Academy in Colorado Springs, the symposium attracted 144 scientists and engineers from eight countries.

Two members of the staff received high honors during the year. Solomon Lefschetz, director of the Mathematics Center, was named to the Royal Society of London, and Dr. Joseph P. LaSalle, associate director, was elected president of the Society for Industrial and Applied Mathematics.

The solid state physics program was an active one during the year, both in its experimental and theoretical phases. Studies of particular interest were those of thermionic emission and of the conductivity of alkali-halide crystals. Theoretical studies were conducted in relativity and particle physics, and the experimental cosmic ray program produced interesting results during the year. Instrumentation carried aloft by Blue Scout rockets provided data on the neutron density flux in the upper atmosphere. Since neutrons decay into positively-charged protons and other particles, those neutrons which escape from the atmosphere may be one source of the charged particles trapped by the earth's magnetic field in the inner Van Allen radiation belt. Information on primary cosmic particles from outer space was received from an unexpected source in 1961. The Explorer VII satellite, programmed to cease transmitting in October of 1960, continued to send back data throughout the year. Data were transmitted from the satellite during a series of solar storms that occurred after the scheduled cutoff point, and analysis continued throughout the year.

In RIAS metallurgical laboratories, studies were conducted on the resistivity of metals that had been deformed by cold-working; on the effects of surface treatment on the mechanical properties of materials, and on the allotropic transformation of metals, utilizing the techniques of electron microscopy.

Research in the biosciences was concentrated on the study of photosynthesis. Under investigation were the roles played in photosynthesis by the light factor, by the characteristic structure of the chloroplast, and by the lipid (fatty acid) constituents of the chloroplast. Closely related to these studies was research in carbon monoxide fixation, an investigation which indicates that green plants have the capability of preventing carbon monoxide from building up to concentrations that are injurious to human beings. The scope of research in the biosciences was broadened during the year by the addition of a program of research in senescence in plants.

Activity in chemistry included expanded studies in quantum chemistry; research in the chemistry of boron compounds, and investigations in the chemical physics of colloids and surfaces. Related to this work was a project to develop better means of utilizing large electronic computers for the solution of problems in logic arising in quantum chemistry.

NORTH AMERICAN AVIATION, INC.

North American Aviation's evolution from aircraft manufacturing to diversified activity in aeronautics, missilery, astronautics, rocket propulsion, electronics and atomic energy yielded important dividends in 1961 for the national defense and space programs.

North American rocket engines boosted 24 of the 26 satellites and deep space probes successfully launched during the year and the U. S. astronauts launched in 1961. The company's guidance and control systems, already on global duty with the Navy's Polaris fleet, also proved their capabilities in initial test flights of the Minuteman ICBM.

The nation's defense forces were strengthened by deliveries of A3J attack weapon systems, GAM-77 air-to-surface missiles, T-39 Sabreliner trainers, rocket engines for the Atlas and Thor ballistic missiles, electronic equipment for aircraft, missiles, surface vessels and submarines.

A cluster of eight H-1 Rocketdyne engines stood by at Cape Canaveral, test-proven and ready to launch the first test vehicle of the Saturn which is designed to orbit a three-man capsule or 10 tons of instrumentation.

The X-15 rocket research airplane continued to establish new speed and altitude records for manned flight and demonstrated reentry capabilities with flight temperatures exceeding 1000 degrees. A T-39A set an unofficial long-distance speed record for aircraft in its twin-jet class, covering a 3,873-mile Atlantic crossing (Madrid to New York) in an elapsed time of 9 hours, 39 minutes.

Manufacturing work began on all major assemblies of the first B-70 Valkyrie and assembly got under way on the 2000 mph airplane, scheduled for initial flight in late 1962.

The Army successfully test-fired the Redhead-Roadrunner, a ramjet-powered target missile, and deliveries were begun on an advanced version of the Hound Dog missile, the GAM-77A.

Each of the company's six operating divisions enhanced its capabilities in research and development as well as production, giving North American a capacity for projects of magnitude in almost any technical orientation.

For the third time in the last five years, sales exceeded $1 billion. Each division contributed to this achievement by reporting a sales increase over the previous year.

To give the company augmented computer capacity for its five divisions in Southern California, North American linked all of its computer operations through a microwave system. Believed to be the largest privately operated computer complex in the world, the microwave pooling system assures immediate flight test data reduction on such priority programs as the Minuteman and Hound-Dog missiles, F-1, Saturn and Thor, Atlas, Redstone rocket engines, and Polaris submarine SINS navigation system, for example. The system makes the fullest use of the company's five IBM 7090 computers.

During the year the company began construction of a solid propulsion research and test facility near Reno, Nevada, and a feeder plant near Princeton, West Virginia.

North American made strategic organizational revisions during the year. The Rocketdyne, Los Angeles, Columbus and Atomics International divisions were reorganized according to the changing character of their activities. The Missile Division was redesignated the Space and Information Systems Division and it joined two other divisions—Columbus and Los Angeles—in the field of complete aerospace systems.

The Space Division was selected by the National Aeronautics and Space Administration to develop the second stage (S-II) for an advanced Saturn launch vehicle.

The company's expansion in the aerospace field as a manufacturer of components as well as of major systems was paralleled by continued investment in research and development.

With the increasing emphasis on research and development, the percentage of scientists and engineers among North American employees continued to rise. About 25 percent of the company's 80,000 employees are engineers, technicians and supporting personnel, compared to less than four percent during World War II.

The new $10 million Aerospace Laboratories on a 28-acre site in El Segundo, California, took their place as one of the most complete facilities for manned space flight studies as well as for the Mach 3 flight regime. Completed during the year were an acoustic test chamber, a 45,000-gallon hydrostatic test tank, and an environmental test facility. Among other capabilities the laboratory includes the world's most advanced privately owned trisonic wind tunnel.

The Autonetics Division was studying guidance and control of manned and unmanned space vehicles in which a guidance inaccuracy equivalent to the diameter of a dime in a mile would result in an error of approximately four million miles in a mission to the planet Pluto.

The Advanced Research Center, part of the new Autonetics complex being constructed on a 140-acre site in Anaheim, California, was completed. Its 46 separate laboratories were initially staffed by some 200 scientists and engineers working in advanced areas such as moletronics and bionics, and which will be among the best in the fields of electronics and electromechanics.

The Columbus Division increased its activity in development and construction of radomes and large-scale ground antennae for radiotelescope work, satellite tracking, communications research, and other applications.

Work for the Atomic Energy Commission increased at Atomics International Division, where a second SNAP 2 reactor in the AEC's Systems for Nuclear Auxiliary Power program was placed in operation. Development continued on a higher power SNAP 8 reactor for use as a power source for electrical propulsion applications.

Among the most promising aircraft research and design projects of the year were those for a STOL (short takeoff and landing) airplane and a supersonic transport. The millions of man-hours of experience in design and fabrication in the Mach 3 regime gave North American advanced capability to develop a supersonic transport. Other research and development included studies of a nuclear powered aircraft, a next-generation ballistic missile, an anti-missile missile, and a hypervelocity manned vehicle capable of 10 times the speed of sound.

North American's sales for the fiscal year ending Sept. 30 totaled $1,262,333,263, the highest in company history, compared to $964,162,496, for the previous year. Net income after all costs and provisions for federal income taxes was $27,750,137.

At year-end, backlog of unfilled orders was $931,000,000, excluding orders not yet funded but under negotiation as continuations of authorized programs.

Activities at the various divisions were as follows:

LOS ANGELES DIVISION

Assembly of the 2000 mph B-70 Valkyrie was well under way at the Palmdale facility and Mach 3 manufacturing continued as one of the major hardware programs at the Los Angeles plant. Critical testing of major component sections was under way as assembly progressed on the first of the air vehicles which was scheduled for initial flight in December, 1962.

Production of T-39 Sabreliners rose to five a month in October. Twenty-four of the 94 twin-jet trainers on order by the Air Force were delivered. In two categories of testing, production models amassed more than 2000 hours in the air by mid-year. Air Force test programs included cold weather operations in Alaska and hot weather tests at Nellis AFB, Nevada. Other tests for type certification were being conducted by the Federal Aviation Agency and North American at Palmdale.

Completed in 1961 was world's largest rocket engine test stand, for test of Rocketdyne's 1,500,000 pound thrust F-1 engine.

A one-year program of heavy maintenance and repair work on 137 F-100 Super Sabre fighter bombers was begun at Palmdale under a $2 million Air Force contract. Modification programs on a number of F-86 Sabre Jets were completed earlier in the summer.

The Air Force awarded the division additional contracts totaling approximately $17,930,000 for GAM-83 Bullpup kits and launchers.

The last of three X-15 research vehicles designed and built by the division was delivered to the National Aeronautics and Space Administration. All were equipped with the new XLR-99 57,000-pound thrust rocket engines. The X-15 flew high performance missions at speeds above Mach 6 during the year and at altitudes above 99.9 percent of the earth's atmosphere. NASA pilot Joe Walker set an altitude record of 217,000 feet and a speed record of 3920 mph or Mach 5.21, on October 17.

ROCKETDYNE DIVISION

A total of 52 of the nation's 57 successful satellites and deep space probes have been launched by Rocketdyne engines.

Still leading the nation in production of large liquid rocket engines, the division was developing three new liquid engines designed specifically for space applications. Two of these—the 1,500,000-pound-thrust F-1 booster and the 200,000-pound-thrust J-2 upper stage engine—were under accelerated development by direction of the Administration. This powerful pair would provide first and second-stage boosts for advanced Saturn vehicles which could effect a moon landing and return.

During static firings the F-1 exceeded one million pounds thrus• more than 140 times.

Rocketdyne engines continued to provide the power for practically all of the large ballistic missiles deployed in defense of the free world. These include the Redstone tactical missile, the Jupiter and Thor intermediate-range missiles, and the Atlas, first operational ICBM. Redstone engines provided booster power for the successful launchings of the U. S. astronauts and is scheduled for use in the first orbital flight. New contracts for Atlas and Thor engines extended production through another year.

A contract was received for a compact liquid rocket booster using storable propellants, for the Navy's newest target missile. This engine, the P-4, was successful in its first flight and was expected to become operational in a year. An Air Force contract was received to deliver a flyable .01-pound-thrust ion engine early in 1962, and NASA awarded a contract to study new nozzle concepts, system packaging methods and advanced control techniques.

In the solid propulsion field, the Division had a Navy order for Aeolus solid rocket motors for upper atmosphere weather readings and a solid propellant engine research facility was being constructed near Reno, Nevada.

Other solid-fueled products in production at the Rocketdyne McGregor facility in Texas were gas generators for Tartar/Terrier ship-to-air missiles, and booster rockets for the Navy's Regulus target drone.

Through Flexadyne, North American has made a major advance in solid propellant technology. Because of high tensile strength and good elongation properties, Flexadyne can operate under extreme environmental conditions, permitting launchings under any climatic condition.

Rocketdyne's first Saturn booster, consisting of eight H-1 engines clustered to develop 1,500,000 pounds of thrust, completed static tests and was delivered to Cape Canaveral, where it made its first test flight in October. The initial Saturn vehicle is designed to orbit a three-man capsule or 10 tons of instrumentation.

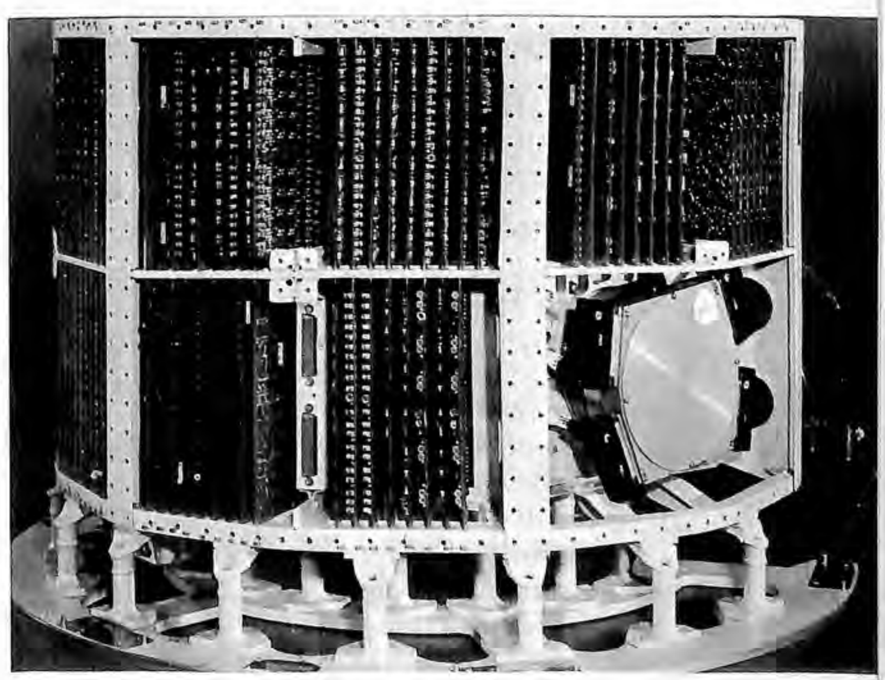
AUTONETICS DIVISION

Autonetics, now the largest of North American's six divisions, continued its growth in 1961 under expanding requirements for its electronic and electromechanical products. Through this division, North American became one of the 10 leading electronics companies in the nation.

The division completed its 1,000th transistorized digital computer and during the year manufactured more inertial instruments for navigation systems than in all the company's previous experience. More than 1,000,000 square feet of facilities were added in 1961.

Computers with capabilities previously unique to the human mind were the object of the bionics research, and through moletronics, scientists will study basic structures of solid conductors which would reduce size and weight of equipment a hundredfold and increase reliability as much as 1000 percent.

Autonetics' leading program was the Minuteman ICBM guidance and flight control system, the largest of all North American programs in terms of total value. It constituted about 49 percent of Autonetics business, and represents about 30 percent of the total Minuteman effort.



Autonetics' solid state digital computer used in the inertial guidance system of the Minuteman ICBM.

Exceptional performance of the guidance and control equipment in the missile's first flights was credited to the intensive reliability program.

The Navy's accelerated program for atomic-powered fleet ballistic missile submarines increased requirements for Autonetics marine navigation equipment.

Deliveries of guidance and flight control systems continued for Hound Dog missiles and bomb-nav systems for A3J airplanes, armament control systems for Air Force F-105 airplanes and F-104 airplanes for Germany, Japan, Belgium and the Netherlands.

Automatic checkout equipment was produced for the Atlas missile, A3J and W2F airplane programs, and a number of computers and data systems were delivered to the Army, Navy and Air Force.

COLUMBUS DIVISION

The Columbus Division increased its activity in development and construction of radomes and large-scale ground antennae for radiotelescopy, satellite tracking, and communications research.

Two radomes over 100 feet in diameter were completed and construction was begun on an antenna to aid in developing large transmitting and receiving equipment required to operate high-capacity satellite relay systems for global communications.

Flight-test evaluation of the Mach 2 A3J carrier-based attack weapon system continued and first units for pilot training were delivered to the Navy at Sanford, Florida, prior to fleet deployment in 1962. The A3J was the company's second largest program in total estimated value.

Columbus Division, prime contractor for the Army's newest supersonic target missile, the Redhead-Roadrunner, was expanding its activities in missilery. The Redhead-Roadrunner, designed to operate at either high or low levels, was successfully test-fired at White Sands.

SPACE AND INFORMATION SYSTEMS DIVISION

A contract for development of the second stage vehicles for 10 advanced Saturn space systems was awarded to the Space and Information Systems Division.

The new stage will use four liquid oxygen-hydrogen engines, delivering a total thrust of 800,000 pounds, which are being built by the Rocketdyne Division under a separate contract. As the second stage for the C-3 version of Saturn, it will be capable of placing a 40-ton spacecraft in a 300-mile Earth orbit.

In September, the division delivered an advanced operational model of the Hound Dog air-to-surface missile to the Strategic Air Command. Launched from B-52 heavy bombers, the 43-foot GAM-77As can deliver a nuclear warhead over a range of several hundred miles.

A thirteen-month study contract to improve satellite observation and prediction techniques was awarded to the Space Division by the Electronic Systems Division of the Air Force Systems Command. The study was under way at the North American Aerospace Laboratories in El Segundo. Purposes of the study are to determine methods of improving techniques for systematic visual observation of faint satellites; to investigate short-cut prediction procedures, and to make observations of approximately six special satellites daily.

More of the company's activities in manned and unmanned space vehicles and in electronic information systems were being concentrated in this division under its expanding fields of operation.

The GAM-77 missile program was one of the Space Division's larger programs and was the third largest current program in total estimated value in the company.

ATOMICS INTERNATIONAL DIVISION

Small nuclear reactors to solve the problem of providing auxiliary electric power to operate the electronic equipment on space vehicles are being developed by Atomics International.

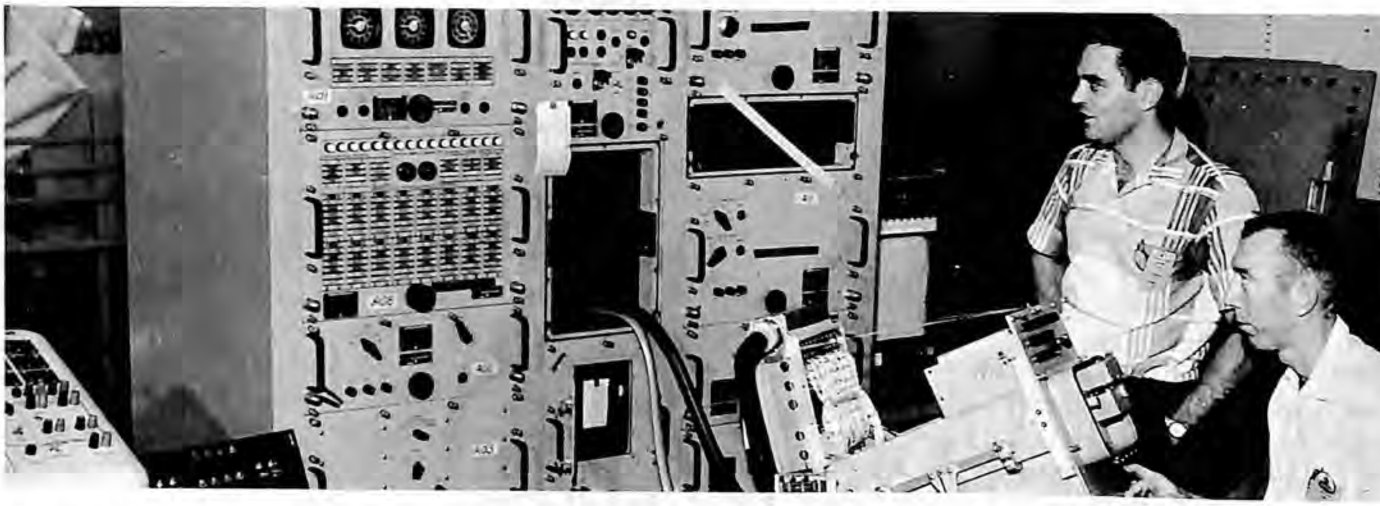
The SNAP 8 (Systems for Nuclear Auxiliary Power) is under high priority development for use as a power source for electrical propulsion applications. In space work, the SNAP unit consists of a nuclear reactor and a power conversion unit to change the reactor's heat into electricity.

During the year, company funds were used to develop and demonstrate a thermionic device that produces electricity directly from heat.

A leading producer of research reactors, the division has designed, fabricated and put into operation more than a dozen reactors in the United States and foreign countries.

Development of compact SNAP reactors, however, utilized about 40 percent of the division's manpower.

Two central station power plants utilizing concepts pioneered by Atomics International for economic production of electricity were to begin operation soon. One of these, a sodium graphite reactor to produce 75,000 kilowatts for the Consumers Public Power District of Hallam, Nebraska, was completed and undergoing operational testing. The other, an 11,400-kilowatt organically cooled and moderated reactor for the City of Piqua, Ohio, neared completion.



Nortronics' Datico system undergoes final acceptance test. Datico is used for monitoring, checkout and launch countdown operations of Polaris missile.

NORTHROP CORPORATION

Emphasis on research and development which enabled Northrop Corporation to anticipate the far-reaching changes that have taken place in the aerospace industry accounted for the company's participation in over 70 advanced aircraft, missile, electronics, optics and communications programs during 1961. Northrop's prime systems management, subsystem and precision component programs during the year were carried out by 16,000 employees—some 4,500 of them engineering, technical and scientific personnel—in three operating divisions and two operating subsidiaries.

In the developing national space program, Northrop directed its efforts to the areas of its greatest competence. These included guidance, control, life sciences, environmental testing, escape and recovery, orbital operations and electronic support systems, as well as research in new fields which are essential to space exploration.

Northrop's emphasis on scientific research also shaped the character of its capital investment program where the greatest part of its new facilities will go to strengthen research capabilities. During the year the company brought to the last stages of completion its new science and research center at Palos Verdes Research Park. An addition to engineering buildings at Norwood, Mass., was completed, construction on a new science building at Anaheim was in progress, ground was broken for the Radioplane Division's new research and manufacturing center at Conejo Valley, and a nuclear research reactor and a high-speed wind tunnel were planned for Hawthorne.

Commercial business interests were extended during 1961, principally in the field of aluminum architectural products. Here, because of the special character of the business, Northrop operated through a wholly owned subsidiary. This subsidiary, formerly the Acme Metal Molding Company, acquired the assets of Arcadia Metal Products in June, 1961, and was re-named Northrop Architectural Systems. In addition, Northrop purchased approximately two-thirds of the outstanding stock of a third smaller company in the same general field, Pacific Curtainwall, Inc. The balance of Northrop's commercial business was in the manufacture of wing and fuselage sections for Boeing Aircraft's 707 and 720 jet airliners.

The Arnold Air Society awarded the 1961 Fairchild trophy to Northrop Corporation for its design, development and production of the T-38 Talon supersonic trainer and for other distinguished contributions to the national defense effort.

The twin-jet supersonic T-38 Talon trainer was flown by aviatrix Jacqueline Cochran in a series of record-breaking flights. In the Northrop-sponsored flights that spanned seven weeks from August 24 to October 12, 1961, Miss Cochran set a series of new speed, altitude and distance world records for women.

NORAIR DIVISION

Research programs at Norair moved ahead significantly during 1961. As part of its continuing study of the problems of hypersonic flight, Norair established plans to install a new wind tunnel at its Hawthorne facilities. It will provide velocities up to 10,000 miles per hour and temperatures up to 3,200 degrees Fahrenheit. The new wind tunnel will be used as a laboratory to study noise and heat problems encountered by space vehicles entering and leaving the earth's atmosphere, as well as problems of missile stability during re-entry.

One of Norair's advanced space programs, development of an engine for spacecraft, led to an experimental plasma engine that was subjected to test operation. Encouraging results spurred continuing research in this new field of magnetogasdynamics—the use of electricity to accelerate ionized gases to tremendous velocities. Designed to propel vehicles on interplanetary voyages, these engines produce comparatively small amounts of thrust for periods of months using very little fuel.

In the field of life sciences, Norair specialists extended their investigation of methods to support the human body in the severe environment that will be encountered in space travel. Activity was focused on the design of the body support couch for astronauts which, together with the pressure suit, helmet and restraining harness, will allow them to be fully effective during periods of extreme accelerations. In addition, Norair scientists continued investigation of methods for sustaining life on prolonged space missions. These studies include experiments with green algae as a possible food supply which could be grown aboard space craft, and irradiation studies of the physiology of small desert animals which can live for long periods with virtually no water or moisture. The growth of cancer cells was being studied to determine the effects of space radiation on living tissues.

Norair physics extended their study of the origins and behavior of the Van Allen radiation belts known to exist in space, and affecting the safety of human space penetration.

Initial preparations were made for the installation at Northrop's Hawthorne plants of a nuclear research reactor where the effects of high-energy radiation on space craft systems will be conducted. In the same field, work moved forward on radiation detection devices and instruments for handling radioactive materials.

One of the most significant research pograms during 1961 concerned Laminar Flow Control. LFC is a Northrop-pioneered method for extending the range of large airplanes without increasing fuel consumption. By reducing the friction drag encountered by the plane as it moves through the air, Laminar Flow Control will enable airplanes to fly approximately twice as far with a given amount of fuel, thereby reducing ton-mile and passenger-mile costs on long flights. Not only does this offer tremendous logistic advantages to the armed forces in the rapid transport of men and materiel over intercontinental distances, it also promises a great expansion in long-haul cargo shipments and air travel. Northrop was assembling two LFC aircraft for the Air Force for the purpose of an "in-flight" demonstration of advantages of LFC. The company was also conducting research into advanced applications of this technique to supersonic aircraft.

New applications of the T-38 family of supersonic aircraft were studied for the purpose of providing additional versions for special training requirements as well as combat-capable configurations suitable for limited war.

Hand in hand with these important research programs were the major production programs carried out by Norair and other divisions of Northrop Corporation during 1961.

Another 144 T-38A Talon supersonic trainers were ordered during 1961 by the Air Force. The contract brought the total of T-38 orders to 357 aircraft. Production rate climbed to 12 aircraft per month in December at Norair plants in Hawthorne and Palmdale, Calif.

New emphasis on limited war capability for U.S. military forces and the need to replace U.S. furnished F-86 and F-84 jets in allied nation inventories prompted intensive interest during the year in Northrop's supersonic N-156, fighter counterpart of the T-38 trainer.

The N-156 is slightly heavier (12,500 pounds) than the T-38 and faster (approximately Mach 1.5 vs. the T-38's 1.27). It can carry external fuel and armament weighting up to 5,500 pounds. Leading edge flaps and a drogue chute give the fighter exceptional short-field capability.

During its 1961 tests, the N-156 became the first supersonic fighter to operate from a sod field. In subsequent operational tests, the N-156 provided its ability to deliver weapons in support of troops and to penetrate deeply into enemy territory on surveillance and reconnaissance missions.

As a subcontractor to the Boeing Company, Norair continued production of outer wing panels and aft fuselage sections for the KC-135 jet tanker and 707 and 720 jet airliners. By September 25, 1961, Northrop had delivered 773 ship sets of outer wing panels and 735 aft fuselage sections on schedule and at one of the lowest per-pound costs in the industry.

The Norcom launch site voice communications system developed by Norair was ordered for the 250-station Norcom network on the first Saturn launch complex at Cape Canaveral. Experience gained from earlier installations at Vandenberg Air Force Base, Calif., and at NASA's Goldstone tracking station, proved the Norcom system applicable on ships, tanks, submarines and even factories.

Norair conducted a continuing search on all fronts for new manufacturing methods and for solutions to the problems presented by forming, shaping, drilling, cutting and welding the exotic new materials required for space age structures.

One of the division's most important materials research programs was the work being done in beryllium, which appears destined to become a prime metal for space ship construction. Northrop pioneered in the technique of making thin-walled extrusions from this metal. Brazing processes in columbium, molybdenum and cobalt alloys were being developed for application to the Air Force's triple-sonic B-70, to a Mach 3 transport, and to an aerospace craft of the Dyna-Soar type.

RADIOPLANE DIVISION

Radioplane's research and production of space recovery systems gained new recognition during 1961 with the successful return to earth from suborbital flights of American astronauts Alan Shepard and Virgil Grissom. The same recovery system proved instrumental in returning NASA Project Mercury instrumented space craft from an orbital space flight in September 1961.

In its return from space, the instrumented Project Mercury vehicle was slowed down from orbital velocity by means of retro-rockets. As the vehicle lost velocity and entered deep into the earth's atmosphere, the Radioplane landing system took over. At 42,000 feet and a speed of approximately Mach 1, the 6-foot diameter conical ribbon drogue parachute was ejected by means of a mortar. Inflating rapidly, the drogue's 'chute stabilized and decelerated the vehicle to a velocity of approximately 160 knots true air speed. Upon reaching an altitude of 10,000 feet, the drogue 'chute disconnected from the spacecraft and deployed the main 63-foot ringsail parachute from its compartment in the top of the vehicle. The spacecraft was then decelerated and lowered to the water at a speed of just under 30 feet per second. To aid in search and location, a cloud of radar reflective metal foil strips called "chaff" was ejected from the spacecraft at 42,000 feet. As a further locating aid, when the main parachute was pulled from its compartment, a SOFAR (Sound Fixing and Ranging) charge was ejected with it. Upon landing, a highly visible marking compound dye was floated on the water to aid in the air search for the spacecraft.

Paradynamic work during the year at Radioplane included the NASA Project Mercury landing system, two contracts for recovery of reconnaissance satellites, and crew escape and survival systems for the F-106 fighter and B-58 "Hustler" bomber. Landing and recovery system research included requirements for the Appollo Lunar Spacecraft and other advanced space vehicles.

Development of an unusual new device to increase radio reflectivity that may revolutionize the field of space communications was launched in 1961. Called ADSAT (for Anomalous Dispersion Spherical Array Target), it should extend the usefulness of passive communications satellites out to 22,300 miles—the 24-hour orbit.

The germ of the ADSAT idea actually came from early X-ray diffraction experiments with ordinary salt crystals which yielded a pattern of intense bright and dark spots. This hint of resonance with the crystal lattice led Northrop researchers to attempt to duplicate this effect at radio frequencies—and the first version of ADSAT looked much like a molecular model, with silver-coated ping-pong balls serving as "atoms." The size of the balls and intervals between them were carefully calculated to resonate with and reinforce the incoming frequencies.

In its basic concept, the ADSAT satellite is a collapsible, spherical network, 100 to 400 feet across, with the resonant balls at each intersection of the network. It is designed to be launched in a small package, and inflated in orbit, much like Echo. The reflected signal, however, can be 1,000 times as strong as that obtained from a simple, Echo-type target of equal size.

The succesful RP-76 recoverable target missile produced by Radioplane continued as the only rocket-powered target missile in operation during 1961. Simulating an enemy aircraft, it attained the record altitude of over 75,000 feet and was hit by a Nike-Hercules air-defense missile at McGregor Range, Fort Bliss, Texas. Under terms of an extended flight program contract, Radioplane continued to be responsible for target air launch, flight control and tracking, and maintenance and repair of targets at McGregor Range.

A supersonic rocket-powered version of the RP-76 target missile was developed and evaluated. The advanced RP-76-X-4 is designed to operate at altitudes in excess of 70,000 feet and speeds up to Mach 2. Total flight endurance is in excess of 20 minutes, including approximately five minutes of powered flight plus glide.

Northrop's Radioplane Division has produced thousands of the OQ-19 type radio-controlled aerial targets for the United States Army, Air Force, Navy and several foreign nations. It was being used extensively as a training target for surface-to-air missiles such as Nike and Terrier and for many years has been the standard target for antiaircraft artillery training all over the world. The OQ-19's rugged construction and simplicity of maintenance permits multiple missions in rapid sequence without major component replacements. OQ-19 type targets are recoverable by parachute.

Quantity production of the SD-1 surveillance drone system continued during the year. Developed in conjunction with the Army Signal Corps, the system has been operational with the Army in Europe, the Far East and United States, performing photographic and reconnaissance missions.

To accommodate Radioplane Division's growing research and production programs, Northrop started construction in mid-1961 on a modern engineering and manufacturing center at Conejo Valley, California. Representing an important part of Northrop's three-year $32,000,000 capital investment program, the new facility will be located in campus-like surroundings at Rancho Conejo. Radioplane research, engineering, manufacturing and administrative activities located at Van Nuys, California, will be moved to the new center.

NORTRONICS DIVISION

Northrop's Nortronics Division gained recognition as one of the nation's leading producers of electronic, mechanical, and optical systems for aerospace requirements. Major strides were made during 1961 in several key programs.

Development and initial production of the advanced star-tracking inertial guidance system for the new Air Force Skybolt missile progressed on schedule at the division's Hawthorne laboratories. Skybolt will be guided to a ballistic trajectory above the atmosphere and race at hypersonic speeds to targets over 1000 miles distant. Nortronics is responsible for development and production of the astro-inertial guidance system that will enable the launch aircraft and the missile to always "know" where they are within the earth's atmosphere and to control the flight of the missile once it has been launched.

More than 4,000,000 engineering hours had been devoted by Northrop to research, design, development and manufacture of astro-inertial guidance systems at the time the Skybolt program was initiated. This included pioneering development and quantity production of the Mark I guidance system for the nation's first intercontinental guided missile, the SM-62 Snark.

In addition to continued research and development on terrestial and space guidance systems, Nortronics was under contract to the NASA Jet Propulsion Laboratory for a healthy portion of the electronic guidance subsystems used in the Ranger and Mariner lunar vehicles. The work included production of autopilot electronics, sun sensors and earth horizon seekers. These instruments are designed to aid in determining vehicle position in space.

The Navy's Polaris Fleet Ballistic Missile System relies on several Northrop products which were provided during the year.

Deliveries of DATICO (for Digital Automatic Tape Intelligence Checkout) systems for Polaris submarines, tenders, Naval Weapons Annex and factory production lines continued at an accelerated pace. DATICO is the electronic system that monitors, checks out and performs the launch countdown sequence for each of the 16 missiles aboard the nuclear-powered submarines.

Nortronics supplied gyroscopes and accelerometers for the Atlas, Bomarc, Nike-Zeus, Falcon and Polaris missiles. An advanced inertial gyro developed by the division neared production status. It will replace the current Nortronics model being used in the Polaris submarine inertial navigation system.

Development and production of the Type-II Periscope for the Polaris submarines was a Nortronics system responsibility. This optical sextant permits celestial navigation while the submarine is submerged and is used to correct drift in the ship's inertial navigation system. A more advanced navigation aid for Polaris submarines, an electronic sextant that receives radio emissions from the sun and moon, was delivered in mid-1961. Called a radiometric sextant it provides all-weather capability, and is difficult to jam.

VIPS, a miniature tape play-back and monitoring system developed by Nortronics to solve the critical inflight warning needs in today's complex high performance aircraft was selected by the Air Force for installation in all operational B-58 bombers. Incorporating a priority network in the event of multiple hazards, VIPS alerts the pilot of inflight emergencies and has the capability to present pre-recorded instructions to cope with the hazard.

A space vehicle "hot nose" that measures angle of attack and side-slip during critical atmosphere exit and entry, originally developed for the NASA X-15 rocket-powered research craft, was adapted for the Saturn S-1 booster. Called "Q-Ball," Nortronics modified the system's electronics for the Saturn. Relative dynamic pressures used to determine attitude angles are sensed through fixed ports in the Saturn nose cone. The X-15 "Q-Ball" incorporated a movable sphere which is servo-mechanized to point into the relative wind at all times.

Two important optical developments were recorded in 1961 by Nortronics. A panoramic rear-projection viewer for interpreting aerial reconnaissance film was produced for the Bureau of Naval Weapons. The new viewer automatically computes ground distances from 70 millimeter panoramic film. The Air Force received the first of six giant 600 millimeter ballistic cameras designed by Nortronics to photograph the flight paths of missiles and space vehicles. Installed throughout the Atlantic Missile Range, the huge instruments can locate lighted objects up to 1500 miles distant with extreme precision.

Engaged in the Army Hawk missile program since its inception in mid-1954, Nortronics had delivered over 40,000 airframe and ground handling system units by the 1961 year-end. Northrop designed the missile airframe, mobile launcher, tracked missile loader and associated ground equipment.

A full-tracked, lightweight amphibious vehicle called Versatrac that can be used as a personnel or weapons carrier, rocket launcher, or multi-purpose engineering vehicle was developed by Nortronics as a derivation of the Hawk missile loader.

A contract covering development of chaff dispensing rockets for use in weather research was awarded to Nortronics. To be tested at the Wallops Island test site, the rocket dispensers are designed to erect a continuous and uniform column of shredded aluminum chaff from the earth's surface to an altitude of 50,000 feet in three to five minutes. Wind velocity will be measured by tracking the chaff with radar.

Another important development in Nortronic's countermeasures and explosive ordnance activities was receipt of a contract for design and production of penetration rocket launchers to be used on the B-52H global ballistic missile bombers of the Strategic Air Command.

NORTHROP INTERNATIONAL

A substantial increase in activities marked Northrop's international operations during 1961. In addition to continued technical assistance by a 12-man management and engineering team assigned to five NATO nations in Europe to support the Hawk air-defense missile program, Northrop established licensing agreements in France and Japan. The agreement in France authorized the manufacture of Northrop-designed Datico automatic checkout systems while the licensing arrangement in Japan called for production of Radioplane Division target drones.

Through its permanent offices in Tokyo and Paris, and representatives in Germany and Italy, Northrop supported intensive evaluations of several major products. These included NATO country evaluation of the T-38 supersonic jet trainer to fill the requirement for an advanced pilot trainer and study of Northrop's automatic checkout systems for application to new weapons which were programmed into free world inventories in Europe and the Far East.

PAGE COMMUNICATIONS ENGINEERS, INC.

Through its subsidiary, Page Communications Engineers, Inc., Northrop started development of an experimental satellite communication relay capable of transmitting messages via passive orbiting satellites. The relay will permit voice and teletype transmissions through 2,000 miles of space between upstate New York and the British West Indies. The system was expected to provide criteria for development of a full-scale satellite communication system for the military.

Another significant new task undertaken by Page includes the design of two long-distance VHF ground-air-ground antenna arrays for the Federal Aviation Agency. They will be used in tropospheric-scatter experiments to determine if this type of communications can be used in long-distance air traffic control and are part of the FAA program to establish a tropospheric "forward scatter" radio communication system on air routes across the North Atlantic. High-frequency communications on these routes are sometimes interrupted for as long as 24 hours by solar disturbances and auroral blackouts. The VHF troposcatter mode is not affected by magnetic and solar disturbances, and will provide direct contact between air traffic control and the pilot.

The new Luzon Microwave Relay Communication System built by Page underwent performance tests before final acceptance by the Signal Corps in mid-year. The system connects three military communications on Luzon in the Philippine Islands and interconnects with the Pacific Scatter Communications which was installed by Page a year earlier.

UNITED STATES UNDERSEAS CABLE CORPORATION

In July, the U.S. Underseas Cable Corporation, jointly operated by Northrop Corporation, Felton & Guilleaume, of Germany, and Phelps Dodge Copper Products Corporation, was awarded a contract to provide a 700-mile cable extension for the U.S. Atlantic Missile Range.

The contract calls for USUCC to design, manufacture and install the extension from Turks Island in the Bahamas to Ramey Air Force Base, Puerto Rico, and thence to Antigua in the Leeward Islands. Submarine cables play a key role in Atlantic Missile Range operations, enabling instantaneous return of missile tracking and telemetry information from down-range stations back to Cape Canaveral.

A 1962 Comanche flies over Piper Aircraft's new $1,000,000 Engineering Center, which houses engineering offices, experimental fabrication, static and flight test operations.

PIASECKI AIRCRAFT CORPORATION

During 1961 Piasecki achieved two major milestones in its Sky Car (aerial jeep) program: Sky Car II, an advanced twin-engine aerial jeep with greatly increased pay load, speed, and range over Sky Car I, reached manufacturing completion and proceeded through the bulk of its flight test program; and, under a Navy contract, Sky Car I was equipped with floats and tested extensively in operations on and over water.

Sky Car I, the development and flight testing of which was completed in 1959 under Army sponsorship, demonstrated the inherent advantages of the Piasecki aerial jeep configuration and proved the feasibility and practicability of this unique vehicle. The operational usefulness of the Sky Car was extended greatly in Sky Car II with the incorporation of two turbine engines for increased range, speed, and pay load coupled with multi-engine safety. It was expected that intensive field demonstrations and operational evaluation of Sky Car II would be performed by the Army at various military installations in early 1962.

The low center of gravity of the Sky Car configuration and the wide tread afforded to its floats give promise of excellent suitability for operations on and over water. Unlike the helicopter, whose rotors must continue to turn to provide stability when the machine is at rest on the water, the engines of the Sky Car can be stopped without impairing its stability in water. This affords greater economy, increased mission range and endurance, and eliminates the interferences of noise with certain military missions. Most importantly, the ability of the Sky Car to land in water during situations where other VTOL craft must hover affords a new rescue capability for aerial vehicles.

In the course of the development of the Sky Cars, Piasecki brought into practical usage the world's first cyclic-controlled ducted rigid rotor-prop. Some of the more important advantages of the Piasecki rigid rotor-prop as compared with the conventional fully articulated rotor, are: (1) improvement in control response characteristics; (2) reduced maintenance; (3) lower initial cost; and (4) significantly lighter weight for small diameter rotors.

During 1961 Piasecki began flight tests on its new ultra-high performance helicopter. Designed for both military and commercial markets, this latest Piasecki craft combines the agility of a helicopter with the speed performance of modern executive aircraft.

Piasecki continued during 1961 to serve as a supplier to the nation's missile and space vehicle program. The company participated in the engineering and fabrication of Discoverer type re-entry airframes of both metallic and high temperature-resistant plastics. In addition to building major elements of missile and space vehicles, the company produced a substantial volume of carriages, mating cradles, and other ground handling equipment. Combined with Piasecki's electronic development and production resources at its Mayfield, Pennsylvania plant, this missile and ground handling equipment capability made Piasecki a significant source of advanced systems technology.

PIPER AIRCRAFT CORPORATION

On January 8, a joint celebration marked the 80th birthday of company founder and president William T. Piper, and dedication of the Vero Beach Plant, new manufacturing division of Piper's Vero Beach, Florida, facility which includes the Development Center, opened in 1957, and a new Electronics Division. More than 5,000 aviation and industrial leaders and private flying enthusiasts paid tribute to President Piper, aviation's "grand old man of private flying", on that occasion.

The Vero Beach Plant was specifically designed for efficient, low-cost production of Piper's newest four-place business, sport and training plane, the Piper Cherokee. The all-metal, advanced design Cherokee is the first low-cost, 4-place aircraft with a modern, low wing. It was designed in the Vero Beach Development Center and went into production at the Vero Beach Plant in January. First production models were retained by the company for evaluation, demonstration and experimental development. Deliveries to the public began in May, and production volume of the brand new aircraft increased steadily as the year progressed.

The two-place Piper Colt, first "compact of the air", which was announced in November of 1960, established new sales records as one of the fastest growing new aircraft ever introduced. The $4,995 Colt is the lowest priced aircraft in its class on the market and was developed as a truly low-cost, all-around aircraft to put private air travel within the reach of thousands of prospective pilots as did the Piper Cub years ago. The Colt's appeal so far exceeded company expectations that production quota for the first year was tripled to meet demand. Because of its gentle flight characteristics and operating economy, the Piper Colt is particularly popular with flying clubs and flight students. In Sweden, after intense competitive trials, the Piper Colt was named the official aircraft for all Swedish Aero Clubs, resulting in an initial order for 30 Colts from various Swedish organizations.

The twin-engine Piper Apache was selected for all multi-engine training of pilots for BOAC, BEA and other Commonwealth airlines by the newly established College of Air Training, Hamble, England. The first five Apaches delivered were flown to England in formation flight. The twin-engine, over-200-mile-an-hour Piper Aztec was chosen for the pilot training program at the Thailand Government's aviation school in Bangkok. Both the Piper Apache and the Piper Aztec were selected after thorough comparison with similar-type aircraft on the world market.

Max Conrad, in a twin-engine Piper Aztec, again made aviation history, flying 25,946.5 miles around the globe in 8 days, 18 hours and 36 minutes for an average speed (total elapsed time versus total distance) of 132.2 mph. The Aztec flight captured two world "class" records and the U.S. National record for Speed Around the World, smashing the previous record which stood at 33.4 mph average speed over a 23,456-mile course covered in 29 days.

Piper facilities were further expanded with completion of a new three-story, 41,500-square foot Engineering Center at the company's headquarters in Lock Haven, Pa. The Engineering Center houses offices, experimental fabrication, and static and flight testing operations, and consolidates projects and personnel formerly housed in three separate locations in the main plant. Work there will be concentrated on twin-engine and higher performance single-engine aircraft, while experimental development of other Piper aircraft will continue at the Vero Beach Development Center.

PRATT & WHITNEY AIRCRAFT DIVISION

UNITED AIRCRAFT CORPORATION

Commercial and military planes using Pratt & Whitney Aircraft JT3D turbofan engines began scheduled operations in 1961, and the company received orders for a variety of such engines. (The turbofan differs from earlier turbojets in having a large fan, powered by the engine turbines, at the front of the engine. This enclosed, many-bladed fan pushes air back past the outside of the engine as well as through it.)

The JT3D boosts the speed of a conventional jet by 40 miles an hour, increases thrust by at least 25 per cent and yet offers from 20 to 25 per cent less fuel consumption at cruise level.

Of the 35 domestic and foreign airlines using or ordering Boeing and Douglas jet transports with Pratt & Whitney Aircraft engines, 24 included turbofan-powered planes.

The new Boeing 707-120B cruises at 640 miles an hour, each of its four JT3D engines developing 17,000 pounds of thrust. The crew of one American Airlines transport flew from New York to San Francisco in May in four hours and 43 minutes, clipping about an hour from conventional jet schedules.

Besides the Boeing 707-120Bs and medium range 720Bs and Douglas DC8-50s, some airlines use the 18,000-pound-thrust JT3D-3 on their intercontinental planes. Douglas also planned to use this engine on its combined cargo and passenger aircraft, the DC-8F Jet Trader. The JT3D-1 was certificated for commercial airline service July 22, 1960. The certificate for the new and more powerful JT3D-3 became effective May 18, 1961.

Pratt & Whitney Aircraft-designed thrust reversers for use on JT3D engines in the Douglas DC-8-50 planes were delivered and flight-tested and gained FAA approval in March. These thrust reversers first entered commercial service on United Air Lines and KLM planes. A Douglas DC-8-50 plane set an unofficial distance record in April by flying 6,900 miles nonstop from Long Beach, Calif., to Rome, Italy, in 11 hours and 17 minutes at an average speed of 612 miles per hour.

The only military airplane flying with turbofans in 1961, the B52H, was powered by P&WA engines. This newest globe-spanning missile bomber made its first flight March 6. Eight TF33 (JT3D) turbofan engines produce 136,000 pounds of thrust, more power than any plane in the free and, probably, the Communist world. Besides new takeoff power and climbing capabilities, range was increased over previous models, including the 10,000-mile-range B52G.

During the year the United States Air Force selected the TF33P-7 (JT3D-8 in the commercial version) turbofan engine, with a rating of 21,000 pounds thrust, to power the new Lockheed C-141 cargo and troop carrier transport. The choice of powerplants followed a billion dollar order for 100 of the four-engine transports to replace slower piston-engined aircraft in service with the Military Air Transport Service.

Test cell operation of the JT8D, a 14,000-pound-thrust turbofan developed entirely at company expense, began in April. This engine will power the new three-engine Boeing 727 short-to-medium range transport. Prototype engines, for airframe testing, were scheduled for delivery to Boeing in 1962, and production engines in the first half of 1963. Eastern Air Lines, United Air Lines, American Airlines, and Lufthansa have ordered a total of 117 of these new planes in the 550-mile-an-hour class.

The Douglas Missileer aircraft program was cancelled, but with Navy support development work continued on the 10,000-pound-thrust TF30 turbofan engine which was to have powered the Missileer. Commercial interest centered on its possible use in a two-engine short-range transport. This engine also has potential application to the Air Force STOL (short takeoff and landing) fighter and Navy close support aircraft. The first of four experimental JTF10s, commercial versions of the TF30, scheduled for delivery to SNECMA, was shipped to France in March. This engine was being used to develop an engine afterburner and thrust reverser combination to meet the performance requirements for a new French military airplane.

A total of 436 JT3D turbofan engines had been delivered to commercial operators of Boeing and Douglas transports by the end of 1961. A total of 827 JT3 (J57 in the military version) straight jet engines had been delivered since 1958, when the U.S. commercial jet age began, and a total of 999 JT4s (J75s in the military version) had been delivered.

Approximately 25,000 jet military and commercial engines have been manufactured by Pratt & Whitney Aircraft since 1948. Total engine hours accumulated as of December 31, 1961, were 23,513,000, of which 6,161,000 were in commercial service.

In August, the JT3 straight jet engine became the first of its kind designed and manufactured in the United States to be permitted to fly 2,200 hours without an overhaul. The FAA granted the TBO to Trans World Airlines. This rise from 800 to 2200 hours TBO was done in less than three years of operation. This means that as the engines complete their TBO spans, each will have flown more than a million miles—a distance equivalent to two round trips to the moon.

The TWA time between overhaul for the JT4, which develops 16,800 pounds of thrust, was 2,000 hours, and the TBO for the JT3D put into service by American Airlines only in March, 1961, was set at 1200 hours a few months later.

The FAA issued a type certificate for the JT3C-12, a straight turbojet engine developing 13,000 pounds of dry thrust. This is a growth version of the 12,000-pound thrust JT3C-7 engine and will power new Boeing 720 models. Like the earlier C-7 series engine, the JT3C-12 is a lightweight commercial version of the famed J57 turbojet engine. The JT3C-12 does not use water injection.

The Navy Bureau of Ships entered into a joint program with the company for the development of a new marine prime mover employing an aircraft jet engine. Under the program, a J75 engine will be modified and mated to a free turbine to produce the desired horsepower. The propulsion unit will be designed to power advanced hydrofoil vessels and could also be used to provide "boost" power in other types of Navy ships. The designation FT4A-2 was given to the power package that will combine the gas generator and the power turbine and accessories.

The division's smallest straight jet engine, the JT12, or J60 in the military version, proved itself in service during the year, accumulating more than 1,000 flights. The Lockheed C140 JetStar utility transport powered by four JT12s, flew nonstop from California to Florida at altitudes up to 42,000 feet. A North American T39 Sabreliner trainer-transport powered by two JT12s, flew the Atlantic Ocean from Madrid, Spain, to New York, a distance of 3,873 miles, in an elapsed flying time of nine hours, 30 minutes. The small rugged engine weighing 436 pounds and developing 3,000 pounds of thrust also powers Canadair's CL41 and the Fairchild SD5 surveillance drone.

New uses for this engine resulted when Lockheed Aircraft Corporation picked the JT12 as the powerplant for its twin-jet Hummingbird, a jet research aircraft designed to rise and descend vertically and hover in the air. The West German government purchased some of the engines to power high altitude research gliders.

JFTD12 free turbine drive engines derived from the JT12 were shipped to Sikorsky for installation in prototype models of the twin-engine Sikorsky S64 Skycrane to be flight-tested later in the year. The JFTD12 weighs only 870 pounds but develops 4,050 horsepower. An industrial version of this engine, designated the FT12, will have a maximum rating of 3,000 horsepower. Prospective uses of the FT12 include primary and boost power for ships, high pressure pumps and compressors, electric power generation, and propulsion for large ground vehicles such as military tanks and earth-moving equipment.

The North American GAM-77 Air Force Hound Dog missile became operational during the year. It is powered by the 8,500-pound-thrust J52. The J52 was performing creditably in the Grumman A2F Intruder, a Navy low-level attack bomber with seeing-eye ability, and will also be used in the Douglas A4D. A J52-powered A4D-5 flew for the first time July 12.

Air Force orders were received for engines to power 30 Boeing C135 jet transports, with deliveries beginning in June. The C135 is a modified version of the KC135 jet tanker used by the Air Force for inflight refueling of jet bombers.

The J57, basic jet engine from which other Pratt & Whitney Aircraft engines have derived, was the powerplant for three of the Century series fighters—the North American F-100, the twin-engined McDonnell F101, and the Convair F102. It was also serving the Navy as the engine for the Chance Vought F8U and Douglas F4D fighters, and the Douglas A3D shipboard attack bomber.

The most powerful turbojet engine in production in the free world is the J75. In its military version, with afterburner and water injection, it produces 26,500 pounds of thrust. The engine was being used in both the Convair F-106 interceptor and the Republic F-105 fighter-bomber.

Development work on the 30,000-pound-thrust-class J58 continued.

Westinghouse Electric Corporation announced in 1960 it was disbanding its aviation gas turbine division. At the Navy's request, Pratt & Whitney Aircraft assumed the service, spare parts, and engineering support for the more than 2,200 Westinghouse J34s still in the Navy's inventory, effective January 1, 1961.

The versatile PT6 free turbine engine developed by Canadian Pratt & Whitney Aircraft for civilian and military markets had its first prototype airframe application in Hiller Aircraft's new helicopter, Model 1099, which began flying July 14. The turboshaft version weighs 225 pounds and develops 450 horsepower. The turboprop version designed for light to medium single and multi-engine aircraft, including VTOL types, weighs 250 pounds and develops 500 horsepower. The PT6 first was airborne in late May in the nose of a Beech 18 converted to a flying test bed. The test bed has since accumulated many hours of high altitude flying and completed a calibration to 24,000 feet, after more than 2,500 hours of development running. The PT6's official 50-hour preflight rating test run to Navy specifications was completed in July.

The LR115 liquid hydrogen rocket engine development program continued at the division's Florida Research and Development Center. The LR115 produces 15,000 pounds of thrust. Two of these engines, harnessed in a pair, will power the Centaur as an upper stage of an Atlas booster. Under original planning this system will be capable of putting a four-ton satellite in a 300-mile-high orbit around the earth, or sending a lighter payload on deeper space probes. NASA also planned to use six LR1115s in an upper stage of the huge Saturn missile atop a cluster of rockets delivering approximately 1,500,000 pounds of thrust, and aimed to lift a heavy payload into orbit. The LR115, the nation's first liquid hydrogen rocket engine, was designed to make multiple starts in space after coasting for hours. Because of these restart capabilities, a satellite could be placed so exactly in orbit that it would remain over a single point on the earth's surface 24 hours a day.

To aid in developing new materials for space, aircraft and industrial powerplants of the future, Pratt & Whitney Aircraft established in September a new Advanced Materials Research and Development Laboratory at the division's North Haven, Conn., plant. The main goal will be development of high-strength materials, alloys for service at extreme temperatures and materials for energy conversion devices.

On March 30, 1961, the Aircraft Nuclear Propulsion program was cancelled at the Connecticut Aircraft Nuclear Engine Laboratory (CANEL) in Middletown, Conn. Part of the ANP work on materials and reactor component development work continued for the Atomic Energy Commission. NASA also awarded a contract for the design and construction by CANEL of a "Space Radiator and Condenser Facility" in Cleveland. A small contract with the Air Force for materials research and development work also was received after cancellation of the basic ANP program.

In March the Army Ordnance Missile Command announced successful firing of an improved high energy, solid propellant rocket motor using a light weight high strength motor case made of titanium. The case was designed jointly by P&WA and Thiokol Chemical Corporation's Redstone division, and was built by Pratt & Whitney Aircraft. The company delivered many Army Pershing rocket motor cases to Thiokol during the year.

In April steel missile cases made by P&WA were used successfully for the first time on a new army missile. A two-stage Pershing ballistic missile was fired at Cape Canaveral, and raced down the Atlantic missile range for an undisclosed distance.

The successful testing of a new high-strength steel rocket motor case, designed and built by Pratt & Whitney Aircraft, also was announced in October. The testing was part of a development program for the Special Projects Office of the Bureau of Naval Weapons.

A large segmented rocket motor case also was completed and delivered to United Technology Corporation, a subsidiary of United Aircraft Corporation, in May, and tested successfully.

Significant development progress was made on fuel cells, which convert chemicals directly into electricity. Most of the research work was done on electrodes. NASA awarded the company a contract for development of this new power system. The fuel cell has potential applications in the space and industrial fields.

The division continued its study and investigation also of a magnetohydrodynamics (MHD) power generator. The basic power concept, which uses high velocity gases through a magnetic field as the power source, appeared to have a good long-term potential for military use and ultimately for central station power generation.

The nation's first jet engine-powered electrical generator to serve homes and industries was being prepared for installation at Hartford, Conn. In this pioneering step, a modified J57 engine—the same powerplant used for modern commercial jet transports and military aircraft—is harnessed to a generator to produce from 8,000 to 10,000 kilowatts. This power package was to be operational in mid-1962 as augmentation for the larger steam-operated plants now used by the Hartford Electric Light Company.

Another modified J57 gas turbine installed near Clementsville, Ky., was powering a compressor pushing 600 million cubic feet of natural gas daily through the long-distance lines of the Columbia Gulf Transmission Company. The unit was developed in cooperation with the Cooper-Bessemer Corporation. Since its installation late in 1960, the 10,000-horsepower unit has accumulated approximately 8,000 hours of operation.

These units are the first industrial adaptations of the P&WA family of aircraft gas turbines. Other power packages were planned by the Industrial Power department in a wide range of horsepower, and were expected to find widespread use in the natural gas, petroleum, and petrochemical industries, in electrical power generating and in marine applications.

Employment at the end of 1961 was approximately 40,000.

RADIO CORPORATION OF AMERICA

DEFENSE ELECTRONIC PRODUCTS

Radio Corporation of America's increasingly important role in space and defense was centered during 1961 in the corporation's Defense Electronic Products activity, comprised of six separate divisions specializing in a variety of areas vital to national defense and expanding space technology.

Astro Electronics Division, outside Princeton, New Jersey, was the center of the majority of space work underway at RCA. This is the Division which designed and developed the successful family of Tiros weather satellites for the National Aeronautics and Space Administration (NASA). NASA designated the AED group to construct the Project Relay experimental satellite to test the feasibility of transoceanic telephone, telegraph, and television communications using an active repeater satellite. Other important projects underway at the Princeton Division included development of the television system which the Ranger space craft will carry in the program to explore the moon, and work on the Nimbus program.

RCA was selected by the Air Force as prime contractor for a research and development program to demonstrate the feasibility of a Satellite Inspection System. This work was centered in its own special project activity at Burlington, Mass.

Key military activities were being performed at the five other Defense Electronic Products Division.

Major Defense Systems Division, Moorestown, New Jersey, was prime contractor for the Air Force's Ballistic Missile Early Warning System (BMEWS), which comprises long-range radar bases in Greenland, Alaska, and England. This huge project involves participation by more than 2,000 subcontractors and all three Service branches. With the Thule, Greenland, and Clear, Alaska, sites already on Automatic Operating Capability, and the Yorkshire, England, site well under construction, the BMEWS program is now entering its maintenance and operational phase.

Moorestown Missile and Surface Radar Division, Moorestown, N. J., was prime contractor for the Downrange Anti-Ballistic Measurement Program (DAMP). Under contract to the Advanced Research Projects Agency (ARPA) and the Army Rocket and Guided Missile Agency (ARGMA), RCA outfitted the U.S.A.S. "American Mariner" with precision radar and other electronic and optical equipment and operated her from 1959 through the present on the Atlantic Missile Range, studying the behavior of ballistic missiles fired from Cape Canaveral, Florida, as they re-enter the atmosphere. The Missile and Surface Radar Division was also working on an Army contract for the development and fabrication of an advanced tracking radar called TRADEX, which will be located on Roi-Namur, an atoll in the Pacific. The program was aimed at development of new concepts and techniques in anti-missile defense. This Moorestown group was also responsible for development of the FPQ-6, a giant new radar capable of tracking space vehicles up to 32,000 miles.

Aerospace Communications and Controls Division, with production and administrative facilities in both Camden, N. J., and Burlington, Mass., was performing on a wide variety of defense contracts. This division was charged with development of a complete communications subsystem for the Dyna-Soar test program, which has as its overall objectives manned orbital flights, manned suborbital flights, and ultimately, a weapon system. RCA's participation with prime contractor Boeing Airplane Company involves development of a tracking network for Dyna-Soar utilizing data link communications techniques. ACCD was also performing on several major data link programs for the Air Force. The Division was responsible for production of DATS, a Dynamic Accuracy Test Set, which automatically checks out the weapon systems of Air Force fighters, and Digital Evaluation Equipment, which performs automatically a comprehensive sequence of tests and checks, isolates defects, and records test results. This equipment successfully checked out selected components of a number of missiles.

Data Systems Division, Van Nuys, Calif., was subcontractor to Convair for development and production of automatic checkout and launch control equipment for the nation's first operational ICBM, Atlas. This equipment reduces the previously tedious countdown from hours to minutes, minimizes launch failures and provides reliability through a rapid test of sub-systems and other components. This division, which, as its name implies, is primarily charged with application of data-handling to defense projects, also developed an advanced, trailerized version of the Atlas Pre-Flight Checkout Equipment (APCHE), known as MAPCHE. This is for use with dispersed "E" Series Atlas Missiles. Data Systems Division also provided the powerful and versatile ground checkout computer system for use in connection with NASA's important Saturn program. An RCA-110 computer comprises the "heart" of the checkout system.

Surface Communications Division, with production facilities in Camden and Cambridge, Ohio, and research laboratories in New York and Tucson, Arizona, was involved in a number of important communications programs for the military. It is this division which was assigned prime responsibility for the Army Signal Corps' Micromodule Program, which produced dramatic advances in the miniaturization of electronic components. Work on this project was continuing. Meanwhile, Surface Communications Division was handling RCA's participation in the long-range planning and improvement of communication systems for the Army and Air Force. Some of the major production contracts being performed on by Surface Communications Division included: ground launch control equipment for the Air Force Minuteman Program (Boeing Airplane Company is prime contractor); communications equipment for Polaris submarines; and Mobile Radio Relay equipment (AN/GRC-50).

REPUBLIC AVIATION CORPORATION

In 1961, Republic Aviation Corporation marked its 30th anniversary by continuation of a strong F-105D Thunderchief production program, highlighted by delivery of the all-weather fighter-bomber to the U.S. Air Forces in Europe; acceleration of space age projects in the newly-dedicated Paul Moore Research and Development Center, and the receipt of new and follow-on contracts in many aerospace areas.

Throughout the year Republic continued scheduled deliveries of the F-105D to the U.S. Air Force. In October, the Air Force announced that it placed a $46,900,000 contract with Republic for additional numbers of the 1,400 mile-per-hour Thunderchief. This followed closely an announcement earlier in the month that more than 60 of the tactical jet fighters had been ferried across the Atlantic to the 36th Tactical Fighter Wing in Bitburg, Germany. The F-105 was first deployed to Europe in May and official acceptance ceremonies were held at the Paris Air Show in June.

The versatile aircraft continued to show examples of the wide range of missions for which it was designed. General Frank Everest, then commander of the Tactical Air Command, which employs the F-105 in the U.S., announced in October that a successful 1,520-mile non-stop mission by an F-105D was performed flying blind at altitudes of from 500 to 1,000 feet. The mission, designed to demonstrate the aircraft's automatic, all-weather capability at levels "underneath" enemy radar detection, also included a simulated low-level nuclear bomb delivery.

At mid-year two examples of the assortment of weapons carried by the Thunderchief were exhibited. Stressing its limited war capability, the F-105 dropped 26 conventional 565-pound bombs on a single flight. It was the largest bomb load ever carried aloft by a single-engine fighter. A month later, the first launching of the Bullpup (GAM-83A) air-to-surface missile from the aircraft was announced, adding to the more than 4,000 variations in conventional weapons that can be carried by the Thunderchief.

Earlier in the year, an F-105 was piloted from Nellis AFB, Las Vegas, Nev. to Langley Field, Va. non-stop in three hours. An average speed of 730 miles-per-hour was maintained over the 2,200 mile run.

In May the Air Force authorized Republic to develop a highly advanced, all-weather, airborne reconnaissance and battlefield surveillance system which will be incorporated in the F-105D. The system will mark the first "marriage" of an all-weather reconnaissance unit to an all-weather weapons system.

Throughout the year the F-105 participated in many military maneuvers designed to test and display the U.S. coordinated deterrent force. Operation Cross-Feed, held at Nellis AFB, provided the U.S. Army command with first-hand information on the ability of the Thunderchief to destroy ground targets and give necessary air support to the advancing infantry and mechanized units under all-weather conditions.

In Operation Solidarity, the F-105 was involved with the combined forces of the Army, Navy, and Air Force, and the military forces of Peru, Colombia and Panama, in a mock attack on the Canal Zone. Flying many 2,000 mile ground support sorties from Puerto Rico and return, the F-105 exemplified the effectiveness of TAC's Composite Air Strike Force (CASF) method of dealing with limited wars at great distances in a matter of hours.

The F-105 continued to serve the Tactical Air Command with the 4th Tactical Fighter Wing and the 4520th Combat Crew Training Wing.

Maintenance and service on Republic's F-84F Thunderstreak and RF-84F Thunderflash was still being provided by Republic Aviation International, wholly-owned subsidiary in Lugano, Switzerland. The 'F' with a primary mission of fighter-bombing and the 'RF' with its mission of photo reconnaissance were in service with 13 allied and NATO nations. The earlier F-84 Thunderjet was in service with seven allied nations.

In May, Thunderflashes, placing first in two of four categories and totaling the highest point score for all types of aircraft competing, played a prominent part in Royal Flush VI, NATO's annual reconnaissance competition.

F-84s and RF-84s assigned to Air National Guard units, took part in Operation Swift Strike, the largest peacetime military maneuver held in the U.S. since World War II.

Working toward the future generation of manned military aircraft, Republic logged its seventh year of investigation in Short Takeoff (STOL) and Vertical Takeoff (VTOL) aircraft. Early in the year, Republic unveiled some 20 VTOL and STOL designs which have been developed, ranging from supersonic fighter-bombers to long-range reconnaissance and transport planes.

Following up on its cost reduction program started in 1959—the initial success of which was reported last year—Republic staged a further meeting with parts and materials suppliers termed "Project Second Wind." Some 70 major subcontractors attended the session designed to reduce cost on the Thunderchief fighter-bomber. It was announced in July that over 90 per cent of the original off-site cost reduction goal (30 per cent) had been accomplished, representing a saving of $30 million. The new target for fiscal 1962 is half again as much or an approximate 40 per cent overall reduction in the major part of the off-site program. If the fiscal year 1962 target goal is met, both in on-site and off-site cost reductions, the cost of each F-105D will be shaved by more than one million dollars each.

The field of Research and Development was highlighted by the official dedication of the Paul Moore Research and Development Center. Named for one of the company's original founders, the $13 million dollar complex—part of a multi-million dollar program implemented for the development of advanced forms of aircraft, missiles, and spacecraft—is unique in that it houses a wide variety of scientific laboratories comprising the most modern equipment in the industry, all under one roof.

At the dedication ceremonies, a man-carrying space ship, identified as forerunner of the type of vehicle to be used to circumnavigate the moon, was unveiled. The full-scale model, 10 feet high and 12 and-a-half feet in diameter, is designed to carry a three-man crew on a 14-day reconnaissance orbit of the moon. It could also be used as an earth orbiting laboratory. The space ship is one of five advanced aeronautical and astronautical projects currently under way in the Research and Development Center. The operational analyses and design studies being performed on the lunar orbiting vehicle, a project supported by company funds, represented the more than 29 new technological areas in which Republic scientists and engineers are conducting investigations.

Throughout the year, work progressed in the field of high temperature hydraulics under the third Air Force contract issued in 1960. Performed by the Fluid Systems Laboratory, the third-phase contract calls for development of a prototype hydraulic aileron power control system capable of operating at temperatures ranging from 20 to 1000 degrees Fahrenheit and for tests and development of leak-proof power systems.

It was announced in September that a research contract leading to the improvement of structural design requirements for aerospace vehicles had been received by the company. Under the contract, a comprehensive investigation will be made not only of vehicle structures, but also of internal components such as piping, electrical harnesses, and equipment supports. The scope of the study will include the period a flight vehicle exists from the earth's atmosphere, its operation in space, and the critical structural phase of atmospheric re-entry.

Work continued under contract with the National Aeronautics and Space Administration for specific orbit determination programs, including lunar orbit studies and planetary missions, and in the space trajectory studies field, under contracts received from the Air Force's Wright Air Development Center and Cambridge Research Center.

Research and development furthered experimentation on projects concerned with the support of life in space including the growth of plants in a moon-like environment and development of a closed ecological system.

Following a previous announcement that a prototype magnetic pinch plasma engine, developed by Republic under contracts from the Office of Naval Research and the Air Force Office of Scientific Research, had been run continuously for more than 118 hours, the company started in March to expand its plasma propulsion activities. It involved the doubling of laboratory personnel and the building of one of the largest electrical propulsion testing facilities in the country.

An Air Force contract for the building of a compact, battery-powered pinch plasma engine was received from Wright Aeronautical Systems Division in July. Prior to the contract award, demonstrations of an experimental model—the third version of the plasma propulsion engine built by the company since 1957—had been made at the electrical and advanced propulsion branch of the Propulsion Laboratory of the Aeronautical Systems Division at Wright Field.

In October, leading members of the nation's press witnessed a special demonstration of the plasma pinch engine. It was the first time Republic's unique electric engine, capable of operating indefinitely by battery and solar cell power, was run before a public group.

The use of the engine has wide-range potentiality to propel and "steer" space ships from planet to planet with pinpoint accuracy, and for other missions that include control for reconnaissance and communication satellites for military and commercial purposes.

During the year, Republic's helicopter division introduced the Lark, the company's version of the Alouette helicopter designed by Sud Aviation of France which Republic continued to assemble and market in North America. The Lark, designed primarily for military use, is a five-place jet-powered helicopter which provides for two internal litters plus an attendant. The aircraft has logged over 400,000 hours of flying time under all climatic and weather conditions, including active military service. The Lark features an adaptability for sea and land-based operations such as observation/reconnaissance, aero-medical evacuation, external cargo carrying, air sea rescue, wire laying, nuclear contamination surveying, and turbine engine training.

The Missile Systems Division earlier in the year received a follow-on order for additional guidance systems for the all-weather version of the Navy's Bullpup missiles.

Three Air Force contracts were let which called for advanced research into space electromagnetics, while three other were received from the Army Signal Corps and the Marine Corps involving qualification tests for the company's subminiature electronic modules and work in the field of surveillance drones.

Completion of a new half-million dollar Manufacturing Research Laboratory, believed to represent the largest installation of advanced research equipment of its kind in private industry, for developing advanced, improved techniques for production of aerospace systems bolstered Republic's rapidly-growing Space Age capabilities.

At the start of the year, it was announced that Republic's Special Products and Services department received follow-on orders for plastic radar reflectors to be used in connection with the Tartar surface-to-air shipboard missile. The reflector contract is the seventh such order received during the past two years. The reflectors are oval-shaped, weigh 326 pounds, and are eight feet in diameter. Made from a Republic-developed and formulated re-inforced plastic, they are designed to withstand a shock load of 160,000 pounds and their completely smooth exterior prevents ice accumulation.

Later in the year, the Special Products and Services department received another follow-on order for additional GAM 83 Bullpup adapter assembly components. The adapter assembly is similar to a wing pylon designed and manufactured by Republic used for carrying the Bullpup air-to-surface missile on the F-105 Thunderchief.

Republic's Manufacturing Research department, in January, received a contract for the development of extrusion processes for titanium metal from the Air Force. The contract covered advance phases of the company's intensive study into new techniques for handling the high-strength, difficult-to-shape metals needed in advanced aircraft and space vehicles.

A study contract for investigation of the use of electrical discharge to form high-strength metals was awarded to the department one month later by the Marshall Space Flight Center, NASA, Huntsville, Ala.

Two basic methods were being compared as to their efficiencies in shaping stainless steel and aluminum alloys. The first involves the deformation of a metal workpiece by shock waves created in a liquid medium. In the second method, known as inductive repulsion forming, an induction coil is placed in close proximity to the workpiece and insulated from it; during the electrical discharge, opposing currents in the coil and metal produce a magnetic force which repels and deforms the metal away from the coil.

In a joint effort of Manufacturing Research and Processes and the Structures Group, a development contract for the design of fasteners—the special rivets, bolts, and other mechanical devices needed in spacecraft construction—that can withstand the stresses of space flight was received from the Air Force. Employing alloys of bolybdenum, columbium and tungsten, engineers will work toward development of fasteners that will hold up in a temperature range of from 2,000 to 4,500 degrees Fahrenheit.

At mid-year it was announced that a possible merger between Republic and ACF Industrices, Inc., under study for some time, was no longer being considered because of a mutual decision that a merger did not offer sufficient advantages to the two companies.

Republic closed the third quarter of 1961 with a backlog amounting to $609,000,000.

For the nine months' period ending September 30, 1961, a net income of $7,532,062 on sales totaling $256,755,599 was reported.

RYAN AERONAUTICAL COMPANY

New dimensions of aerospace mobility were projected by Ryan Aeronautical Company in 1961 with two major projects—the revolutionary new Flex Wing, and the tri-service VTOL military transport.

At the same time, space electronics assumed an increasingly prominent role at Ryan Electronics, which was selected to design, develop and fabricate radar altimeters for the Saturn and Surveyor space vehicles.

Meanwhile, use of the Ryan Firebee jet drone, world's most widely used free-flying target, was further broadened; deliveries of Ryan Electronics' continuous wave Doppler radar automatic navigation systems to U.S. and European military customers were accelerated; and production of giant aft fuselage sections for the Boeing KC-135 jet tanker and the C-135 cargo transport was stepped up to cope with increasing world-wide logistics pressures.

Ryan unveiled its unique Flex Wing flying test bed and immediately launched a flight testing program for the Army Transportation Research Command at Brown Field, near San Diego. The National Aeronautics and Space Administration gave Ryan engineers another assignment—to study means of utilizing the Flex Wing as a paraglider to recover the extremely expensive Saturn booster and return it to a predetermined area for re-use.

And while the flying test bed program continued, the Army Transportation Research Command awarded Ryan a contract to determine the Flex Wing's adaptability as an unmanned towed glider, capable of multiplying sixfold the cargo carrying capacity of Army helicopters and fixed wing aircraft.

Meanwhile, for other agencies, two more Flex Wing contracts were being performed but details were not publicly disclosed.

The flying test bed is described by the Army as the world's first manned, powered version of the basic flexible wing concept originated by Francis M. Rogallo of NASA. In contrast with the conventional wing composed of a rigid skin covering a forming structure, the Ryan Flex Wing consists of a membrance of flexible plastic coated cloth attached to a center keel and two side members.

It is considered a major advance in the field of aerodynamic structures by providing an extremely lightweight, large lift service to give various airborne vehicles maneuverability and extremely slow, controlled flight. Its applications range a wide spectrum.

In partnership with Ling-Temco-Vought of Dallas, Texas and Hiller Aircraft Corp. of Palo Alto, California, Ryan will help develop and build five experimental tilt-wing VTOL military transports in a tri-service program which may exceed $70 million over a four-year period.

The three-company team was selected following a design competition involving nearly 20 major aerospace firms. For Ryan, its participation in this significant new program culminated a long period of VTOL pioneering, highlighted by its development of the world's first all jet VTOL, the Air Force X-13, and the deflected slipstream, propellor-driven VZ-3RY Vertiplane, which has been under test by NASA.

Ryan will design, tool and construct various components of the VTOL, and will provide specialized engineering personnel in the design and ground and flight test program. The transport, designed to take off and land vertically, will cruise at 250 to 300 knots and will have a range of 200 to 300 nautical miles with up to 8,000 pounds payload.

In the space electronics field, Ryan Electronics launched development of a radar altimeter and Doppler velocity sensor equipment for NASA's Surveyor lunar soft landing vehicle in a $2 million contract with Hughes Aircraft Company. NASA's George C. Marshall Space Flight Center, Huntsville, Ala. awarded Ryan Electronics a $450,000 contract to develop a Saturn radar system, weighing only 16 pounds, and capable of recording altitude measurements up to 250 miles.

A fleet of 110 Q-2Cs, latest production model of the famed Firebees, served as the sole targets for "William Tell 1961", the Air Force's World Wide Weapons Meet Oct. 23 to Nov. 3, at Tyndall Air Force Base, Fla., where the speedy drones challenged the top fighter-interceptors of the Air Defense Command, the Alaskan Air Command, the Air Training Command and the Air National Guard.

Replacement of the older model KDA-4 Firebees with Q-2Cs was started by the Navy during 1961, and the first Fleet support mission by a Q-2C set a distance record of 134 miles from the control center at Pt. Mugu, California as the "bird" provided target service for a missile fired from the guided missile cruiser Oklahoma City.

The Army also took delivery of a special configuration of the Q-2C, the Model 124-E, and began test flights at White Sands Missile Range, New Mexico.

Quantity production of the Firebee for the Air Force and Navy was assured through 1962 in additional orders totaling $8 million, including spares.

Effectiveness of Ryan Electronics' automatic navigation systems was dramatically demonstrated when five new Sikorsky HSS-2 helicopters, equipped with AN/APN-130 navigators, set a transcontinental speed record for this type of craft. The squadron flew from Key West, Florida to its permanent base at Ream Field, Imperial Beach, California in 17 hours.

Flight tests with the "second generation" navigation set developed by Ryan Electronics, the Ryanav IV, resulted in major breakthroughs in performance and reliability. Accuracies of better than 1/4 of 1 percent in ground velocity, and better than 3/4 of 1 percent in distance traveled, were recorded. The set also reflects major advances in weight and size reduction, simplification of installation, versatility of application, and system integration.

Ryan's unique Flex Wing flying test bed was unveiled in 1961.

Ryan's explosive forming techniques were used during the year to produce increasingly large parts, including a gore, 15 feet long and eight feet wide at its broadest end. The gore, one section of an elliptical dome which can be used on very large rocket fuel tanks, was shaped on a 40-ton concrete Fiberglas-faced die, one of the largest of its kind in the world.

More than five years' production of pods and pylons, and buildups of 480 jet engines for the DC-8 transport was completed during 1961. The work totaled nearly $100 million.

Ryan activities, which had been distributed among six operating units, were consolidated, for most economic and efficient operations, into three principal plant facilities—the Aerospace plant at Lindbergh Field, San Diego; the Electronics engineering and research facility at Kearny Mesa, San Diego; and the electronics production plant at Torrance, California.

Ryan sold its Pasadena subsidiary, Aerolab Development Company, and its interests in two other subsidiaries, Communications, Inc., of Canoga Park, California, and Transdata, Inc., of San Diego.

Robert C. Jackson was promoted to President of the Ryan Aeronautical Company effective November 1, 1961 and T. Claude Ryan, who had held that position as well as Board Chairman, continued as Chairman and Chief Executive Officer. Jackson previously had been Executive Vice President and Vice Chairman of the Board, posts which were eliminated.

Jackson forecast that Ryan's increasing reliance on its own proprietary items will be demonstrated during the current fiscal year, with approximately 75 per cent of 1961 sales stemming from prime contracting of the company's own electronic products and target systems.

SCHWEIZER AIRCRAFT CORPORATION

Major production items at Schweizer Aircraft during 1961 were the AG-CAT Crop Duster biplanes, and the tail sections and ailerons for the Gulfstream G-159—both for Grumman Aircraft Engineering Corp. Also manufactured were 60 sailplanes and trailers, plus a number of spare parts and tow winches—all for the USAF.

Production of 1-26, 2-22C, and 1-23H sailplanes for the civilian market reached a new high, when by the end of July, the output equalled the entire 1960 total, as sales continued to develop during the remaining five months of 1961. The number of flights at the Schweizer Soaring School exceeded the 1960 figure, as interest in motorless flight continued to grow.

A new, high-performance, all-metal, 2-place sailplane, the 2-32, was under development.

Tooling started on a new order from Sperry Gyroscope Co. Division, for parabolic discs for missile range tracking installations, while another 100 AG-CATS were ordered by Grumman.

SIKORSKY AIRCRAFT

Initial deliveries to operational squadrons of the Navy's twin-turbine HSS-2 helicopter highlighted a productive and eventful year at Sikorsky Aircraft.

Early in September five of the big turbocopters flew across country to the Navy Auxiliary Air Station at Ream Field, San Diego, Calif., to commence crew training for Helicopter Anti-Submarine Squadron 10. Several days later another five HSS-2s arrived at the Naval Air Station at Norfolk, Va., to begin indoctrination work with Helicopter Anti-Submarine Squadron 3. Other deliveries followed. Service with the fleet was expected to begin early in 1962.

The boat-hulled HSS-2, the world's most advanced helicopter weapon system, is the Navy's first helicopter designed to detect, identify, track and destroy enemy submarines while flying a full combat mission. In preparation for fleet duty, the aircraft was put through the most extensive test program ever conducted for a new helicopter.

The HSS-2 also made two successful assaults on world helicopter speed records during the year. On May 17 it flew 192.9 miles an hour over a three-kilometer course at Bradley Field in Windsor Locks, Conn., for the fastest speed ever recorded by a helicopter. On May 24 the HSS-2 was clocked at 174.9 miles an hour over a 100 kilometer course along the Connecticut shore from Milford to Westbrook for a second world mark.

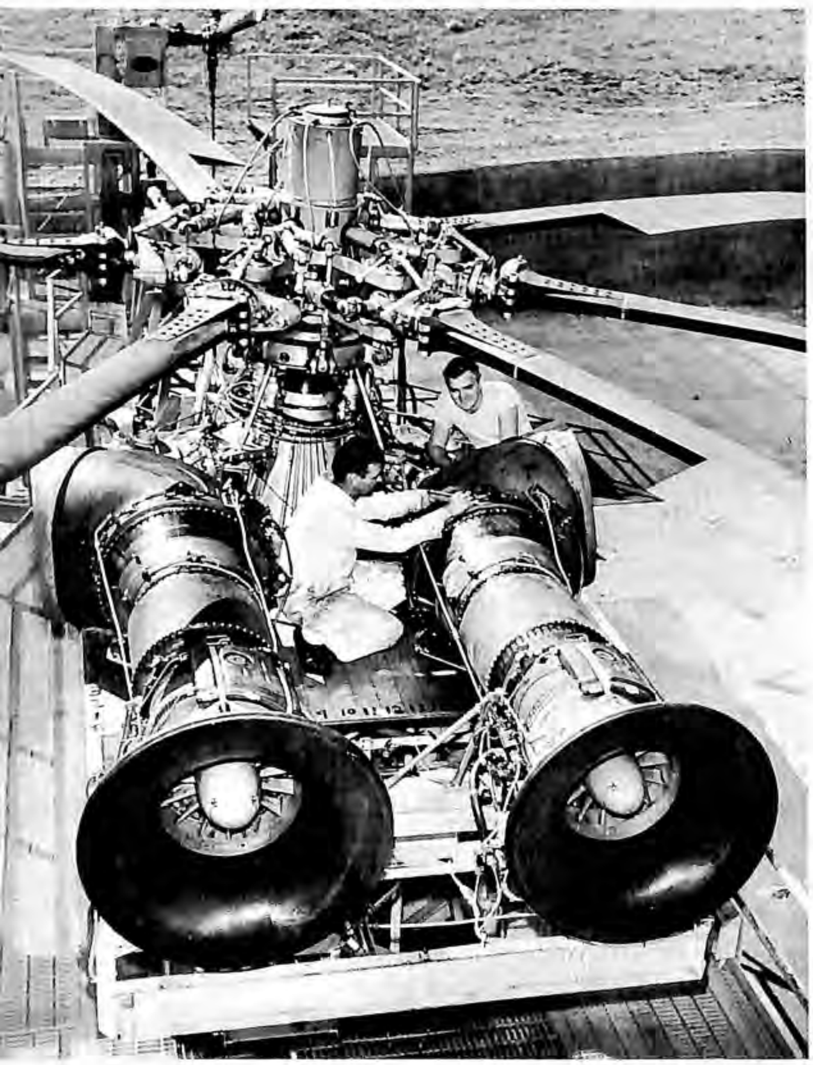
The top helicopter speed attained previously in a sanctioned speed test was 167.09 miles an hour made in a 100 kilometer closed circuit by the Russian Mil-6 Nov. 21, 1959. Sikorsky eclipsed its own mark in the three kilometer class, its Marine Corps HR2S-1 setting the previous record with a speed of 162.7 miles an hour Nov. 11, 1956.

In the first delivery of HSS-2s to the West Coast, the five aircraft flew from Key West, Fla., to Ream Field in 17 flying hours—an average of 150 miles an hour for the coast to coast trip. This was the fastest helicopter crossing of the country in history.

A Sikorsky helicopter carried America's first astronaut on the final leg of his trip back from space. When the capsule carrying Cdr. Alan B. Shepard, Jr., plunked into the Atlantic Ocean May 5, a Marine Sikorsky HUS-1 hoisted the astronaut into the copter cabin, then flew both man and space ship to the deck of a nearby carrier.

The HSS-2, which is now in full production at Sikorsky's plant in Stratford, Conn., passed other milestones during the year. It made notable progress in the Board of Inspection and Survey (BIS) test program at Patuxent River, Maryland. It also came through its carrier suitability trials and Fleet Indoctrination Program (FIP) with high marks.

A derivative of the HSS-2, the S-61L passenger airliner, completed its Federal Aviation Agency certification program late in the year. This made Sikorsky the winner in the race among helicopter manufacturers to develop and produce the world's first twin-engine turbocopter certified for passenger transportation. The 25-28 passenger S-61L was being put into scheduled airline service by both Los Angeles Airways and Chicago Helicopter Airways. The big turbocopter was developed under a multi-million dollar company-sponsored program, and it is the first helicopter designed specifically for airline use and to airline passenger standards.



Dynamic components of the Sikorsky S-64 Skycrane helicopter, including two Pratt & Whitney JFTD-12 turbine engines, are checked out on test bed.

Another boat-hulled Sikorsky turbocopter, the single-turbine S-62, continued to receive expanded utilization.

As the first turbine-powered helicopter certified for airline work, an S-62 was assigned to Los Angeles Airways so the line could accumulate experience with turbocopters prior to the introduction of the S-61L. After concluding a year's work with the S-62, LAA President Clarence M. Belinn said: "I can't recall being exposed to a more dependable and trouble-free machine in 35 years of operating aircraft of all types."

The new San Francisco & Oakland Helicopter Airlines—the fourth helicopter airline in the United States offering a regular schedule of flights—opened service with two S-62s.

Nitto Airlines of Osaka, Japan, put an S-62 into charter work. Other S-62s were flown by Okanagan Helicopters of Vancouver, British Columbia, resupplying the DEW line; Canadian Department of Transport, resupplying and inspection operations for the government's Marine agency along Canada's west coast; Petroleum Helicopters of Lafayette, La., resupplying off-short oil rigs in the Gulf of Mexico with men and supplies; World Wide Helicopters, Ltd., servicing oil rigs in the Persian Gulf, and the India Air Force, resupplying remote outposts at high altitudes in the Himalayas.

Piston-powered helicopters continued to roll off the Sikorsky production line as large orders were placed and filled for the reliable S-58 series. HSS-1Ns were delivered to the Navy for anti-submarine warfare, and HUSs went to the Marine Corps for troop and cargo work. Toward the year's end an order was received for 90 S-58s for the West German Ministry of Defense.

There was no interruption in Presidential helicopter travel during the change of national administrations. President Kennedy took right up where former President Eisenhower left off and made frequent use of the Sikorsky Marine HUS and Sikorsky Army H-34.

In addition to its development work with present flight articles, Sikorsky also reported steady progress on future projects.

Fabrication work on the twin-turbine S-64, latest member of Sikorsky's family of Skycrane helicopters, was more than three-quarters complete at year end. First flight was anticipated early in 1962. Before fabrication started, months of test work with the engines and dynamic components was accomplished on a special test stand.

The S-64 will be powered by two Pratt & Whitney Aircraft JFTD-12 gas turbine engines. The Skycrane will have a gross weight of 38,000 pounds and a useful load of 20,760 pounds. The new aircraft has been proposed to both the U.S. military and the West German Government as an all-purpose transport and flying crane.

Sikorsky announced that it had "in the hardware stage" a new helicopter designed to meet military requirements for a heavy assault transport helicopter. The machine is based on proven, off-the-shelf components and will utilize the six-bladed main rotor, tail rotor and transmission systems of the S-64. The new transport will be able to carry up to nine tons for short distances.

Sikorsky conducted a design study of a high performance helicopter and presented a design capable of speeds up to 224 miles an hour, payloads as high as 7,000 pounds and a ferry range of 2,400 miles with one hour's reserve fuel. The study was conducted under contract with the Army Transportation Research Command, Ft. Eustis, Va.

A break-through in blade manufacturing was one of Sikorsky's top accomplishments during the year. A revolutionary, built-in rotor blade inspection device opened the way to unlimited blade life, cutting two-hour blade inspection to less than a minute. The exclusive Sikorsky development that makes this possible is called BIM—Blade Inspection Method. All Sikorsky rotor blades will be filled at the factory with compressed air. Mounted on each blade will be a gauge that indicates pressure loss due to crack initiation. With BIM, operators can check blade condition during a simple walk around by ground crew and pilots.

The Sikorsky division signed a technical cooperation contract with Sud Aviation of France to provide design, test and construction assistance for Sud's new Super Frelon 3210 helicopter. Sikorsky will be primarily concerned with the detail specifications, design, construction and test of the main and tail rotor system. The Super Frelon, which will have a gross weight of 25,350 pounds, has been proposed by Sud for military operations.

Mitsubishi Heavy Industries, Ltd., of Japan was licensed to manufacture and sell the S-61 and the S-62 in the Far East.

On August 1 military representation at Sikorsky was transferred from the Department of the Air Force to the Department of the Navy. Capt. Murlin W. Alley, USN, was designated Bureau of Naval Weapons Representative at the plant.

Increasingly, as the year progressed, Sikorsky's research and future planning concerned itself with the entire atomosphere-supported V/STOL field, covering the whole spectrum from the pure helicopter to direct-lift jet aircraft.

THIOKOL CHEMICAL CORPORATION

Thiokol Chemical Corporation scored a number of important achievements in both solid and liquid rocket engines during 1961.

Flight test of large solid propellant motors were sustained in key missiles systems including the Minuteman, Nike Zeus and Pershing. With the continued development of solid propellant motor applications, the company's facilities were expanded with larger motor capabilities and exotic fuel research being carried out at Wasatch, Longhorn, Redstone and Elkton Divisions. Important new projects assigned to Thiokol's solid propellant divisions included motors for the Dyna-Soar and Surveyor projects. Thiokol solid propellant engines

Under development by Hamilton Standard is this variable camber propeller, using tandem blades to give the effect of changes in camber for varying flight conditions.

performed successfully in Project Mercury astronaut sub-orbital flights as well as recovery of the Discoverer series of satellites.

Major advancements were made in the liquid rocket engine field by refinements on the XLR 99 engine which set new world speed records of over 4,000 mph and altitude records of over 200,000 feet in the X-15 aircraft. The X-15 program showed such outstanding reliability and performance that future plans included satellite orbiting and training of future astronauts.

Another Thiokol innovation reached the production stage with packaged liquid rocket engines being produced for the Bullpup and Bullpup B systems. This concept permits the instant operation of a liquid rocket engine without on-site loading and with fuels that are impervious to temperatures.

Continued development of nuclear ion plasma and high energy systems are being carried out at Thiokol's facilities.

The company added to its capability during 1961 with the acquisition of Shawnee Industries, Inc., a production capability for large hardware required in the aircraft and missile industries. The acquisition of the Panalyte Industrial Plant in Trenton, N.J., also gave the Company the capability of producing high temperature laminated insulation material.

UNITED AIRCRAFT CORPORATION

United Aircraft Corporation moved ahead at an accelerated pace during 1961 on its broad forward program of research and development and continued to make significant progress in its traditional areas of flight.

All four operating divisions of United—Pratt & Whitney Aircraft, aircraft and rocket engines, industrial and marine powerplants, fuel cells, and space propulsion systems; Hamilton Standard, propellers and modern missile and turbine accessories; Sikorsky Aircraft, helicopters, flying cranes, and other advanced vertical lift vehicles; and Norden, electronic guidance and navigation equipment—continued to broaden their dimensions during the year.

(Because each division functions autonomously, reports of the company's technical and manufacturing activities for 1961 are found under the names of the individual divisions. The activities of United Technology Corporation, a subsidiary working on the design and development of solid and liquid rocket motors and propellants, are also reported separately.)

The corporation's Research Laboratories received a contract from the Aeronautical Systems Division of the Air Force Systems Command for the design, development, and testing of an ion engine. This program constitutes a continuation of the Laboratories' work on the oscillating-electron ion engine for deep space missions. Another Air Force contract was received during the year for continued basic research in the physics of accelerating the particles in an ion beam under neutral conditions. Work in this area was expected to lead to smaller, lighter engines of higher efficiency.

The receipt of two contracts by the corporation's Weather System Center early in the year marked a realignment of responsibility for its activities. Where the center originally conducted a single, unified program as contractor for a new high-speed automatic weather service, in 1961 it was working under separate contracts from the Air Force and Federal Aviation Agency involving two different sets of requirements. Late in the year, the center went into the test phase of its work with the completion of test stations at Hanscom Field and Westover Air Force Base in Massachusetts.

The name of United Aircraft Export Corporation was changed to United Aircraft International, Inc., to define more precisely the subsidiary's activities abroad.

United Aircraft maintained a high level of development and production during 1960. In 1960, the last full year for which figures were available, United Aircraft reported a net income of $13,868,996 on sales totaling $987,879,119. Total current assets at December 31, 1960, amounted to $379,338,384, compared to current liabilities of $117,606,009. Contracts, orders, and government letters of intent amounted to $1,150,000. The corporation's employment as of December 31, 1960, was 57,319.

HAMILTON STANDARD

During 1961, Hamilton Standard continued to make significant progress on its diversification program which has already resulted in over half of the division's business coming from products introduced since 1950.

Continuing its leadership in propellers, Hamilton Standard in 1961 had in production the 54H60 model for the Lockheed C-130B, C-130E and Electra; 53C51 for the Grumman AO-1, and Hydromatics for the deHavilland Caribou, Douglas DC-6 and DC-7, and Lockheed Constellation. A newer model, the 63E60, was successfully flown on a General Electric T-64 powered deHavilland Caribou.

Further advancing the state of the propeller art, Hamilton Standard had several development programs for vertical take-off and landing and short take-off and landing aircraft underway during 1961. Under Navy contracts, programs were carried on to develop a variable camber propeller for the General Electric T-64 (the variable camber propeller mounts blades in tandem which work in pairs to simulate change in camber); an integral gear box propeller which places the gear train on the propeller instead of the engine at a weight saving of approximately 15 per cent; and lightweight blades which feature a fiberglass shell over a steel spar. In addition, under a company-funded program, a reliable redundant propeller control for VTOL aircraft was under development.

In the environmental control field, production continued on systems for the military Boeing B-52H, Douglas A4D-5, Chance Vought F8U-2N, Republic F-105, and Grumman A2F and Convair B-58. For passenger-carrying aircraft, systems for the Convair 880 and Lockheed JetStar were in production. Development continued on the advanced system for the 2000 mile-an-hour North American B-70 and first hardware was delivered during the year.

As an extension of the company's work in the environmental control field, a regenerable carbon dioxide removal system for manned space vehicles was developed during the year and successfully completed a 100 hour endurance test.

Engine control activity during the year centered on the production of fuel controls for military and commercial versions of the Pratt & Whitney Aircraft J52, J57, J58, J60, J75, and JT12; Canadian P&WA PT6; General Electric J79, T58 and T64; and Lycoming T55. Work continued on the development of the air induction control for the North American B-70, following the successful testing of a small scale prototype last year.

Activity in the jet engine starter field continued strong with production of pneumatic and combustion types for aircraft including the Boeing B-52, Convair B-58, Lockheed P3V and Convair F-106.

Hamilton Standard's Electronics Department continued to provide a variety of static power supplies to military and commercial customers during the year and entered the consumer market with a static inverter designed for use on pleasure boats. In the aircraft control field, production of automatic stabilization equipment for the Sikorsky HSS-2 continued. In marine installations, the flap control for Grumman Aircraft's marine hydrofoil was delivered for installation in the vessel and development continued on the stabilization and navigation systems for the Navy PCH hydrofoil being built by Boeing. Temperature controls continued in production for a variety of aircraft including the North American T-39, Grumman AO-1, Grumman A2F, Convair 880, Boeing B-52H, Douglass A45-5 and others.

The Ground Support Equipment Department made significant strides during 1961 and delivered several types of environmental conditioning GSE for use on the Titan I, Titan II and Minuteman missile programs. Also produced were fuel handling equipment for Titan II; mobile control towers for the Air Force; jet engine control test stands; and missile vapor disposal units.

Production of "Americanized" Hamilton-Zeiss electron beam machines started in 1961, less than two years after the purchase of the North American rights to the process from the Carl Zeiss Foundation. During this time, several study programs were conducted on the welding of refractory metals and the use of the machine as an electronic microminiaturization tool. These programs showed that the machine can successfully work all known materials and is capable of welding reliable connections for microminiature electronics.

In the field of solar power, Hamilton Standard in 1961 delivered a multi-cell generator to the Air Force which is designed to provide more current per pound of generator weight than any other available system.

The Missiles & Space Department continued its work on the promising United Aircraft guidance system during the year and undertook several classified study projects for the Services.

NORDEN

Completion of a large scale plant consolidation program and new engineering, development and manufacturing achievements in electronic systems, subsystems, and components highlighted the 1961 activities of United Aircraft Corporation's Norden division.

Early in the year, some 1,200 employees and manufacturing and laboratory equipment were moved from plants in Stamford, Milford, and Bridgeport, Conn., and White Plains, N.Y., to the division's new 350,000-square-foot research-engineering and manufacturing facility in Norwalk, Conn. In November, the Ketay department, located at Commack, Long Island, N.Y., was transferred to the Norwalk plant.

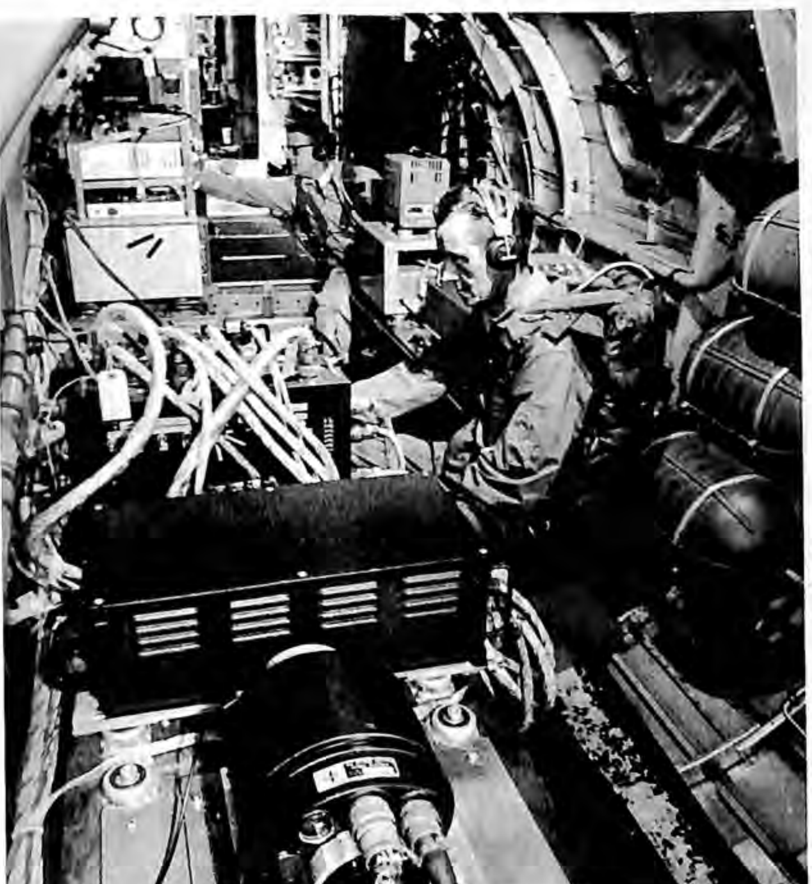
As a result of this consolidation, Norden was operating in these basic areas at the year's end: the design and manufacture of military and commercial electronic systems and components at Norwalk, and the development and production of commercial and industrial control systems and data processing equipment at the Data Systems department at Costa Mesa, Calif. Data Systems occupied its new 50,000-square-foot plant at Costa Mesa late in 1960.

Operations of the former Ketay department were phased in with those at Norwalk; however, the Ketay name, prominent for more than 20 years in the rotating component field, was retained for product identification and separate engineering and manufacturing operations to manufacture this line were established at the Norwalk plant.

Increased emphasis was placed on the research, engineering and development of advanced navigation, guidance and control systems for space vehicles, missiles, aircraft and ships. With the completion of this program, the division strengthened its position as a major avionics prime contractor as well as a manufacturer of a wide variety of components, including inertial platforms, encoders, gas pressure systems, pressure ratio systems, gyros, attitude reaction wheels, accelerometers, synchros, tachometers, servo motors, servo packages, and resolvers.

From its newly-developed, all-attitude inerital platform, which was successfully flight tested early in 1961, new inertial, navigational systems for airborne and shipboard applications were developed. The platform, weighing less than 16 pounds, can be supplied separately with its Norden-built gyros or tied into an advanced computer to form a precise and complete navigation system.

Indicative of the division's progress in systems



During the year, UAC's Norden Division successfully flight tested a new, lightweight, all-attitude inertial platform (foreground).

development was the establishment of production schedules for advanced search radar and terrain clearance systems for new jet aircraft. With this new system, the aircraft is capable of detecting targets completely obscured by night or weather conditions. Despite such conditions, the pilot is able to "see" targets and geographical features by means of two viewing screens within the cockpit which provide a visual representation of the ground and air below and in front of the aircraft.

Also in 1961, deliveries of advanced weapons delivery systems were continued to the Navy for jet bombers.

In the television and computer field, a new contact analog display system was developed for airborne use. This compact system provides a pictorial pathway for the pilot, displaying on a single screen the vehicle's speed, course, altitude, etc. A similar contact analog display system, developed for the Navy's Bureau of Ships, was successfully tested for submarine use at the David Taylor Model Basin and at the year's end was undergoing trials at sea. This system displays on a single screen all pertinent parameters: pitch, roll, heading, speed, surface and bottom positions.

Deliveries also were made of a photographic overlap computer and a television theodolite for the tracking of missiles while in flight. The overlap computer provides an aerial photographer with a view of the terrain within the camera field of view and automatically actuates the shutter to give a predetermined amount of overlap on consecutive photographs.

A study contract for the Maritime Administration was completed, and a new contract awarded for a course computer and steering system for a cargo carrying ship. The study contract was the first step by the Maritime Administration in a long-range program to investigate the possibilities of application of automation to American merchant ships. Under the contract, Norden studied and suggested solutions to problems involved in the instrumentation and mechanization of merchant ships to operate automatically. Such an automated ship must be capable of self-sustained, unmanned operation for at least 30 days without any maintenance, and for at least 90 days with only minor maintenance.

In the data processing and mark sensing field, a second automatic scoring machine was delivered to Educational Testing Service, a nationwide organization of Princeton, N. J., that provides tests and testing service for schools, colleges, and professional associations. Each of the two machines at ETS is capable of grading more than 20 different, randomly-mixed college board entrance examinations at the rate of 6,000 an hour. Other applications for this type of electronic scoring machine are under way at the division.

In this same field, a new electronic vote tallying system, developed by Norden's Data Systems department, was accepted by Los Angeles County and approved for use in the State of California. The new system reads and counts votes on paper ballots at the rate of 600 a minute and is designed to speed up the election results and, at the same time, improve the accuracy of results in cities and counties which use paper ballots in elections.

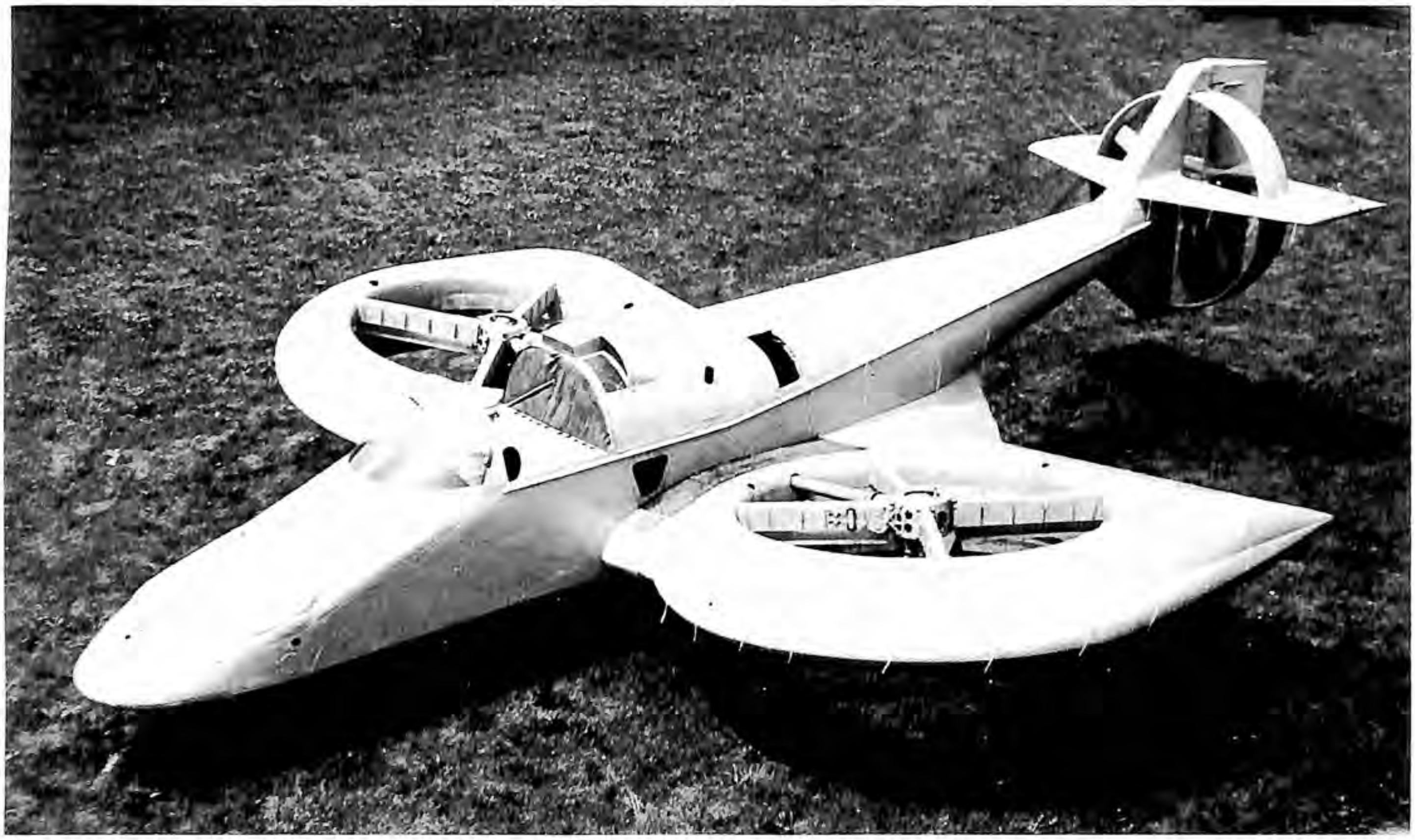
Deliveries were increased of new automatic positioning systems for machine tools. This new concept in numerical control, designed and manufactured by the Data Systems department, utilizes visual displays in modular packages. The units range from simple read-out devices which can be mounted on machines to complex systems capable of reading punched paper tape at fast speeds.

A new applied physics laboratory was established and staffed at the Norwalk plant and at the close of the year several new lines of molecular units were under development. Work was progressing on a new contract for the development of a servo amplifier for a size 8 servo motor utilizing molecular electronics. Many of the new units developed in this laboratory will be utilized in the research and production of Norden systems.

Norden's variety of components was broadened during the year to include two new magnetic encoders and smaller sized synchros and resolvers. Successful results were obtained in a program to incorporate these units into smaller packages, and several new units, designed to withstand ultra high temperatures, were produced.

UNITED TECHNOLOGY CORPORATION

A highly significant advance in solid propulsion development—the successful firing of the nation's first operational prototype of a booster-sized segmented solid propellant rocket motor—was scored by United Technology Corporation during 1961.



Vanguard refined the design of its "Omniplane," a turbine-powered "fan-in-wing" aircraft, and conducted full-scale wind tunnel tests.

The August 5 firing of the giant rocket, which developed nearly a quarter million pounds of thrust, proved the feasibility of developing and producing single segmented solid boosters of 3,000,000 pounds of thrust. By clustering such huge motors, made possible by the "building block" concept inherent in segmented solids, super solid boosters producing 25 million pounds of thrust can now be developed. The test firing of the flight weight solid booster was conducted for the National Aeronautics and Space Administration by UTC. It followed the successful firing of three 15,000 pound thrust segmented solid motors designed by UTC under a NASA feasibility study.

In early April, UTC's multi-million dollar research and engineering center in Sunnyvale, California, and its ultra-modern development center in Coyote, 28 miles to the south, on a 3,200-acre ranch, were formally dedicated.

During 1961, UTC also successfully completed a wide range of advanced development programs. These included an extensive company-funded hybrid engine program and the development of a 6,000 pound thrust solid fuel rocket motor with a light weight fiberglas casing.

A subsidiary of United Aircraft Corp., UTC was carrying out research and development in the fields of rockets, solid and liquid propellants and advanced propulsion systems.

VANGUARD AIR AND MARINE CORP.

During 1961, Vanguard completed the modifications for installation of the T53 shaft turbine engine in its "Omniplane." The modifications were incorporated under an Air Force Systems Command research and development contract. During this modification program, other refinements of this Fan-in-Wing concept were designed and incorporated utilizing Vanguard funding. These included incorporation of a controllable nose fan system to improve control in hover and flaperons giving better STOL capability. After incorporation of these refinements and modifications, the "Omniplane" was returned to Ames Laboratory for additional full-scale tests in the 40 x 80 wind tunnel. Vanguard continued research in the field of Fan-in-Wing and ducted rotor configurations.

Additional investigations were conducted in the field of light-weight drive systems as well as the continuation of improved processes in the metal fabrication field. The Northeast Metals Division of Vanguard increased production of products and components for customers in the electronics, aircraft and missile field.

As part of a diversification program, new products developed by Vanguard during 1961 included an air drive utilizing the ducted fan for use on pleasure boats and the Vancraft pontoon outboard cruiser. This new product development was to be continued during 1962.

WESTERN ELECTRIC COMPANY

During 1961, Western Electric continued its major role in aerospace projects. The armed forces continued to call upon the company to fulfill major national defense responsibilities on the basis of unique abilities developed in manufacturing for the Bell System, and on the strength of Western's past performance in successfully accomplishing highly technical, complex projects covering a broad scope of specialized activities and involving large-scale operations. Among the more recent space projects in the non-military field, a Western Electric led industrial team, in July 1961, turned over the global tracking and ground instrumentation system for Project Mercury to the National Aeronautics and Space Administration for its manned space flight program. This system performed with clock-like precision in September 1961, when NASA launched an unmanned Mercury spacecraft and completed a successful single orbital mission. On November 29, 1961 the global network gave another highly satisfactory performance when NASA launched a Mercury spacecraft carrying "Enos", a 37½ lb. chimpanzee on a successful 2-orbit flight.

The ground communications system for Project Mercury, a specialized portion of this network, is actually a vast data handling system. It provides the following functions: teletypewriter messages between 18 communications and tracking stations, Goddard Space Flight Center, Greenbelt, Maryland, and the Mercury Control Center, at Cape Canaveral, Florida; acquisition information from Goddard to tracking and telemetry stations; commands and instructions from Canaveral to the stations; digital tracking data from the range stations to Goddard; telemetry summary messages between stations and Canaveral; high-speed data transmission between Goddard and Canaveral for computation and display; and voice communications between stations, Goddard and Canaveral.

The system involves about 60,000 route miles of communications facilities. The entire system comprises over 140,000 circuit miles—about 100,000 miles of teletypewriter circuits, 35,000 miles of telephone circuits and more than 5,000 miles of high-speed data circuits.

In the guided missile field, the development of critical system components continued under an advanced research and development program for the U.S. Army's Nike Zeus, the nation's only anti-missile missile system under active, advanced development.

Before this program was authorized, Western Electric Company had anticipated the military demand for precision deposited carbon resistors and had put into operation a plan to develop production equipment to automatically produce resistors in quantity and in quality far in excess of any previous requirements. In 1961, this program, using computer controlled production, started making deposited carbon resistors with extremely high reliability. For a system designed to destroy enemy ballistic missiles traveling at speeds greater than

15,000 miles per hour, such reliability as demonstrated by these components becomes an imperative requirement.

Another Western Electric Company program covered the development of techniques and facilities toward fully automatic or semiautomatic production of millions of ultra-high speed transistors. High speed and complex electronic equipment used in the Zeus System make transistors ideal devices. New production processes under development were expected to produce the mesa transistor at lower cost, higher reliability and more uniform electrical characteristics than hand assembly methods.

For some years, Western Electric Company has been the prime contractor for the Army's Nike guided missile systems. This work began with the Nike Ajax, the nation's first fully operational system, which has been guarding key cities and strategic areas of the nation for more than seven years. Following the Ajax was the Nike Hercules system, operational in many important U.S. defense areas and overseas. During 1961, installation of the improved Nike Hercules system began at existing sites. This system uses advanced radars and a high-power acquisition radar (HIPAR) greatly extending system capabilities.

Active development continued in 1961 on the Nike Zeus anti-missile missile system, the latest member of the Nike defense system. Bell Telephone Laboratories continued with its assigned responsibilities in the research, development and design areas for the Nike Zeus system. Western Electric Company, the manufacturing and supply arm of the American Telephone and Telegraph Company, continued as the prime contractor for research and development on this anti-missile system.

In addition to activity on the Nike missiles during 1961, the company was engaged in a number of important projects for the Army, Navy and Air Force as well as other government agencies. These included data transmission systems, weapons direction equipment, improved ground guidance systems for the advanced Terrier missile as well as ground-based radar and airborne guidance systems for the Titan intercontinental ballistic missile.

Western Electric continued manufacturing and delivering guidance equipment for U.S. Air Force's Titan I ICBM. This missile, during 1961, took a giant stride toward becoming operational when it was successfully launched and guided from operational-type hardened facilities for the first time. The TITAN's accurate command guidance system completed more than 50 successful tests.

During 1961, this guidance system continued to play an important role in space exploration. Having placed the TIROS I into a near-perfect circular

A DEW Line station, "DYE-1," located on the western shore of Greenland. Western Electric was prime contractor for engineering, installation and testing of the DEW East project's electronics and communications services.

orbit, this system was used by NASA for successive weather satellite launchings as well as other "Delta" space projects.

This guidance system also put the "Echo" satellite into a very precise orbit and was used in the first stage of Thor-Agena vehicles for the Air Force's Discoverer satellite program. The command guidance equipment was manufactured by Western Electric at plants in North Carolina. Basic research, development and design of the system was performed at Bell Telephone Laboratories, Whippany, New Jersey.

The Western Electric Company continued to play a key role as prime contractor for the rearward communications system (RCS) for BMEWS (Ballistic Missile Early Warning System). This system, as the name implies, is an electronic system providing detection and early warning of attack from enemy intercontinental ballistic missiles.

In May 1961, the first circuits on a rearward communications route in Alaska for the Ballistic Missile Early Warning System (BMEWS) were made available for limited Air Force use. Circuits were available between the missile detection station at Clear to Colorado Springs.

The new route consists of twenty-four microwave (line-of-sight) and tropospheric scatter (over the horizon) radio stations. It is one of the two rearward routes which, with available commercial circuits, will extend through Alaska, Canada and part of the lower states to link the huge missile detection site at Clear with the North American Air Defense Command (NORAD) at Colorado Springs, Colorado.

The BMEWS project was designed to give North America rapid warning of a ballistic missile attack. Powerful radars in Greenland and England, in addition to those at Clear, will scan polar skies for thousands of miles and will be able to detect enemy missiles soon after they are launched. This information will then be transmitted almost instantaneously to NORAD via data, voice and teletypewriter circuits. NORAD would then alert military and civil defense agencies.

The new RCS route, in addition to providing virtually trouble-free service required for transmitting warning messages, supplements the White Alice system, also built for the Air Force by Western Electric Company, and makes use of the Alaskan Communications System (ACS) stations.

Western Electric also continued to build other defense communications systems for the Air Force in Alaska. It was extending communications westward from DEW Line stations in the Aleutians and in October 1961, completed an eastern radio link between Greenland and Iceland with seven new stations of the Distant Early Warning Line placed in operation. These stations span a 1200 mile corridor of airspace from Baffin Island in Canada, across Greenland to the western coast of Iceland. The new segment, known as DEW EAST, extends the electronic warning network against attack by manned aircraft and air-breathing missiles about half way across the northern reaches of the Atlantic Ocean. Western Electric, as prime industrial contractor, has been responsible for the design engineering and installation of electronics and communications systems with the Army Corps of Engineers doing the building construction for the Air Force.

Initial planning and engineering began in 1961 for a special communications system at Point Arguello, Calif. for the U.S. Air Force.

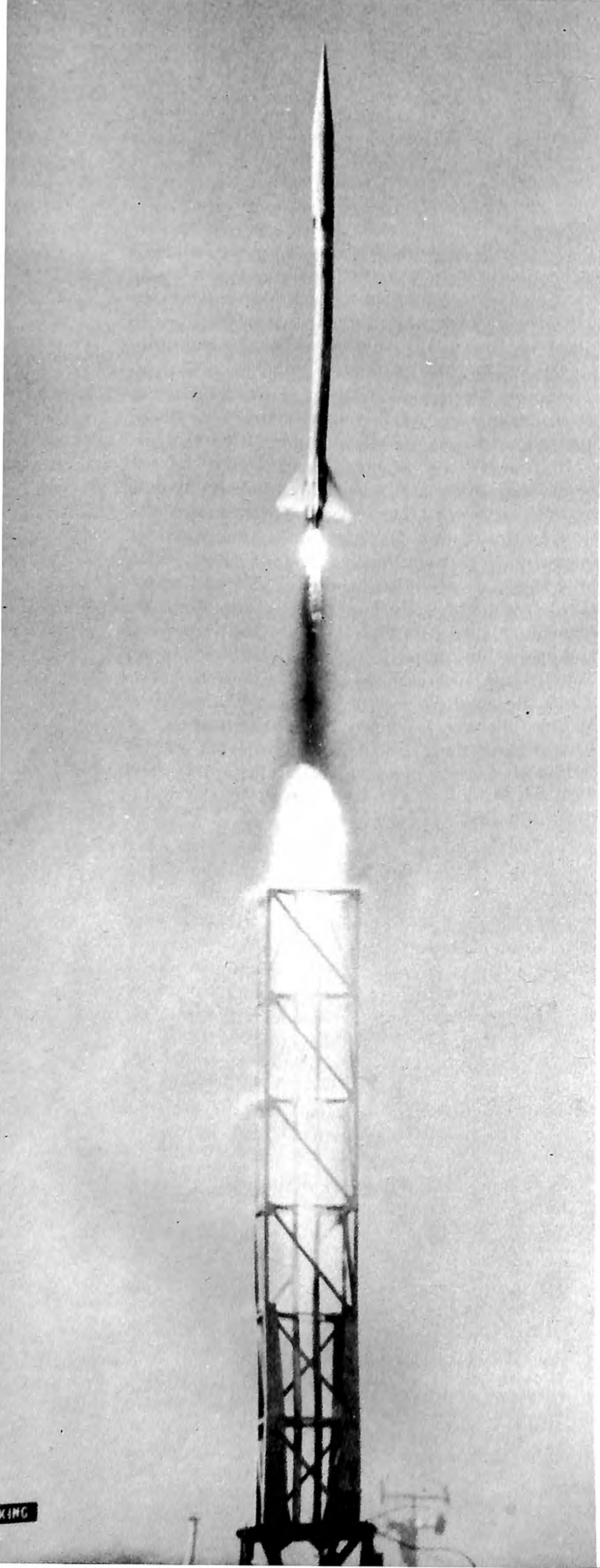
Western Electric Company continued its engineering management service to the Air Force for implementation of the SAGE (Semi-Automatic Ground Environment) System, completing new links in the continental air defense system during 1961. SAGE is a nation-wide complex of interconnected computers, radars, and other electronic devices designed for round-the-clock air surveillance of the continental U.S. and Canada and for directing defense activities in the event of attack by enemy aircraft.

Other communications work in the aerospace field included:

. . . Manufacture and installation at missile ranges of underwater systems for locating the impact point on the ocean's surface of ballistic missiles and other space vehicles.

. . . Manufacture of weapons direction equipment for Navy missile systems.

. . . Provision of field engineering services in support of Western Electric equipment provided to the armed services.



SYSTEMS AND COMPONENTS MANUFACTURERS

Aeronca's "Upstart", new target missile.

AERONCA MANUFACTURING CORPORATION

Expansion and continued improvement marked the steady progress of Aeronca Manufacturing Corporation during 1961. Advancements were made in both the Commercial Products and Defense Products Groups, with particular growth noted in the Aerospace Division of Baltimore, Maryland.

This division greatly expanded its research and development activities with the addition of considerably more floor space obtained when the facilities were moved to Friendship International Airport in Baltimore. Doctorate-level scientific personnel were added also to the Baltimore activity, allowing the division to develop and manufacture more sophisticated components and subsystems for the military agencies. The program was undertaken for the development of a Constant Altitude Plan Position Indicator to be used in the world-wide weather system. The Aerospace Division also developed a proprietary line of reliable, flexible and low-noise RF parametric amplifiers.

The Middletown Division continued as a major producer of stainless steel brazed honeycomb airframe and missile assemblies. Production contracts were received for honeycomb structures with the B-58, A2F, and B-70 systems. Additional contracts and effort were expended for further development of "Thermantic Structures" (proprietary program), exotic materials and ceramics capable of operating in temperature environments up to 4,000° for extended periods of time. A government-funded program for the design, development and production of a new series of "Upstart" training target missiles was received by the Middletown Division. This is a parachute-supported radar and infrared target missile for use at altitudes between 30,000 and 170,000 feet. The Middletown Division continued research and development work, both government-funded and company-funded, in the development of techniques for fabrication of beryllium and in the field of ceramic adhesives. Production continued on major airframe assemblies for B-52H, KC-135 and 707 aircraft for the Boeing Company.

The Aerocal Division continued working with the Boeing Company for production of B-52G and B-52H fuel tanks and pylons. Additional contracts were received for various structural members of the KC-135 and 707 during 1961. Also in 1961, the Aerocal Division received a contract from North American Aviation for the development and production of H-11 structural members on the B-70 program. This contract was a result of the Division's continued research and development and manufacturing methods for high-temperature materials. This year also saw them enter the bonded honeycomb field, with a first contract in this area.

AIRCRAFT RADIO CORPORATION

During 1961, Aircraft Radio Corporation introduced new products to cover a wider range of the aviation market. The company at year-end had three distinct lines of equipment for aircraft ranging from heavy, multi-engine and military jet aircraft to light, single-engine aircraft.

The Starflite I line consists of the Type 21A Automatic Direction Finder, Type 210, 360 channel communications equipment, Type 15F Omni equipment, Course Director, a Marker Beacon Receiver, Glide Slope Receiver and other miscellaneous receivers, transmitters, amplifiers, etc.

Starflite II equipment, a new line, consists of a local-controlled navigation and communication equipment. Equipment currently available in this line includes the Type 318A Automatic Direction Finder and the Type 317A Nav/Com system.

Starflite III, also a new line, is a panel-mounted Nav/Com system of which the Type 501A is presently available. A Nav/Com system for this line and a new single-axis automatic pilot will go into production in the near future.

The Starflite II and Starflite III equipment lines will have additional equipment added during 1962.

The company also expanded its Starflite I line. A new VHF communication receiver having a nominal power output of 30 watts carrying full FAA TSO and FCC compliance will be available in the near future.

The new CD-3 and CD-4 Course Directors made available in 1961 operate from ADF signals as well as from VOR Localizer information. A converter, the B-19A, permits the addition of the RMI type Indicator to the Type 15F Omni system and can also be added to earlier type 15 systems.

ARC had a unique all-transistorized equipment available in the instrument field. It is a Frequency Deviation Meter that makes it possible to compare certain precision oscillations to one part in 10^{10}, which means that two one-megacycle signals can be compared to 1/10,000th of a cycle.

Alcoa forged aluminum front wing spars for the Navy's F4H fighter-interceptor.

ALUMINUM COMPANY OF AMERICA

Aluminium Company of America, during 1961, announced: development of a new heat treatment that virtually eliminates stress corrosion cracking for high-strength wrought aluminum alloy 7075; expansion to meet growing and complex needs of the missile and rocket fields by the Rome Cable Division of Aluminum Company of America; supplying aluminum for a giant "ear" that will help the U.S. tune in the most fantastic radio show in the universe; production of small, precise finned tubes of aluminum powder metallurgy alloys to play a key role in obtaining economical electric power from atomic energy; supplying aluminum to be used as the major structural material in a radically new, super rocket being developed as an upper stage for the Saturn space program; developing ultra-thin, wide aluminum foil for the National Aeronautics and Space Administration's Echo program; supplying structural aluminum for roof components of the world's first missile-launching railroad car; use of aluminum in Ranger I, the nation's first spacecraft capable of landing instruments on the moon; supplying extremely thin, wide foil for development of chemically milled aluminum and plastic laminate for huge inflatable satellites required for advanced programs, such as Rebound, stemming from the Echo experiments; furnishing all aluminum for the Saturn booster which was fired successfully from Cape Canaveral; results of a four-year solid-fuel, rocket motor development program; and production of one of the world's largest closed die forgings, a giant wing spar used in the F4H Phantom II.

A new thermal treatment for high-strength wrought aluminum alloy 7075, developed by Alcoa Research Laboratories, greatly increased the alloy's ability to withstand, without cracking, high sustained surface tension stresses. Such surface forces can combine with corrosive attack to cause stress corrosion cracking. The new temper, designated -T73 was developed for use in applications where alloy 7075 undergoes high sustained surface tension stresses perpendicular to the grain flow. Alloy 7075-T73 withstands stresses equal to 75 percent of its yield strength, without developing stress corrosion cracking.

New electrical production facilities, geared to the growing and complex needs of the missile and rocket industries, were established by Alcoa's Rome Cable Division, East Los Angeles, Calif. Called the Special Products Facility, the new production unit custom was fabricating cables and cable assemblies, and providing users with a source of supply completely integrated from raw material through completed product.

A giant aluminum "ear"—antenna for a super radio receiver—was being readied. The huge saucer-like structure will pick up mystery signals broadcast by unknown sources deep in space and feed them to a powerful receiving unit. Astronomers will use information gathered by the radio telescope, one of the largest precision research instruments ever designed, to chart the heavens as never before. To support the 140-ft-diameter, dish-type antenna, an all-welded, massive aluminum super-structure was fabricated, using 600,000 pounds of aluminum structural components. The telescope was being installed at the National Radio Astronomy Observatory, Green Bank, W. Va., an area remarkably free from man-made radio interference. Radio sources as far away as five billion light years (one light year equals a distance of about six trillion miles) can be detected by the new instrument, compared to a distance of two-billion light years that can be penetrated by the most powerful optical telescope.

Small, precise, finned tubes, fabricated by Alcoa, were playing a key role in the development of economical electric power from atomic energy. The tubes serve as containers for uranium oxide fuel pellets in fuel elements developed by Atomics International, a division of North American Aviation, Inc. Shaped from aluminum powder metallurgy (APM) alloys by the impact extrusion process, the tubes function at temperatures as high as 900°F., far above normal heat limits for aluminum.

Rugged, lightweight aluminum, supplied by Alcoa, was the major structural material in a stage of the Saturn launch vehicle. The new rocket, among the first to use liquid hydrogen as fuel, will be an upper stage—designated the S-IV—in the Saturn. Aluminum's selection for the four-story, 18-foot-diameter structure was based on the metal's unique ability both to maintain high strength, and to resist brittleness at minus 423 degrees F.—liquid hydrogen temperature—and below. Alcoa was supplying aluminum alloy 2014 skin plate for the S-IV, in sections 10 feet wide, 20 feet long, and one-half inch thick. The rocket skin, an integral part of the structure, forms the fuel tank walls. Bulkheads—caps for the cylindrical fuel and oxygen tanks—are made of aluminum sheet and plate. Alcoa forgings and extrusions were also being incorporated into the rocket's structural framework.

Great gleaming balloon satellites that will outshine familiar Echo I were being developed for the National Aeronautics and Space Administration. The giant spheres will be fabricated of Mylar and ultra-thin aluminum foil, produced by Aluminum Company of America. Cooperating with G. T. Schjeldahl Company, Alcoa succeeded in producing exceptionally thin aluminum—.00018 inch thick—at its Davenport (Iowa) works, to be laminated to both sides of a plastic film. The exceedingly tough combination produced a material 20 times more rigid than the 100-foot envelope of Echo I, which was made of Mylar coated with vaporized aluminum.

Lightweight aluminum roof components were installed on the world's first missile-launching railroad cars, the initial complement of a mobile "Minuteman" defense force. Similar in appearance to baggage cars, each missile launcher required approximately 12,000 pounds of aluminum sheet, plate, extrusions, and structural shapes for the roof.

Ranger I was comprised chiefly of aluminum. Basic structural components of the unique craft, developed by Jet Propulsion Laboratory, Pasadena, Calif., were fabricated of aluminum sheet tube, and castings.

A new ultra-lightweight, aluminum and plastic combination may hold the key to a unique space-age, global communications system. An Alcoa foil and plastic laminate that weighs nearly one-third less than material now used has been evaluated for balloon satellites. The vital weight reduction was achieved by chemically milling extremely thin foil, especially produced for the satellite program by Alcoa. The new "skin" was intended for use in massive spheres dwarfing 100-foot-diameter Echo I. Such super balloons are required by NASA for advanced programs stemming from the Echo experiments. One proposed successor—Project Rebound—would be a world-wide communications system employing a network of balloon satellites directing radio waves to all parts of the earth. Weight reduction accomplished by the new "skin" would be extremely important to Rebound, as it proposes to orbit several huge spheres with a single rocket launch. The lacelike Alcoa foil structure, produced by the milling process, was expected to provide sufficient rigidity to maintain a smooth satellite surface—even after escape of the inflation agent through punctures caused by meteoroids.

One of the largest closed die forgings ever made was produced by Alcoa for McDonnell Aircraft Corp's F4H Phantom II. The giant wing spar was forged on a 50,000-ton press at the company's Cleveland works. It measured approximately 17 feet in length, and weighed 707 pounds when it came out of the press. The closed die forging saves 920 hours machining time in the production of the wing spar.

AMERICAN BOSCH ARMA CORPORATION

During 1961, American Bosch Arma reported important achievements as a prime contractor in the Air Force missile program. The major effort was realized at its Arma Division in Garden City, New York, engaged in production of inertial guidance equipment.

The Tele-Dynamics Division in Philadelphia continued development of the data handling and processing center at the Naval Air Test Facility (Ship Installations), Lakehurst NAS, New Jersey. In early 1961, additional contracts were received to enlarge this installation. The NAT Facility was engaged in the evaluation of carrier-type catapult and recovery equipment, utilizing jet-propelled cars and a complex of five test tracks and an 8000-foot runway.

American Bosch Division in Springfield, Mass., was participating in the Air Force TITAN II program as supplier of hydraulic accumulators for launch sites. The American Bosch accumulators will provide stored hydraulic pressure to open and close the 240-ton roof sections of the launch silo. American Bosch accumulators are currently in use on ATLAS, TITAN I and BOMARC missile launch equipment.

A significant achievement in labor relations at Arma Division was the early signing of labor agreements with its major unions representing the more than 5000 employees there. Contracts were signed in February 1961, seven and a half months before the existing contracts expired. The new contracts became effective October 1st, 1961. This was the second time Arma labor/management accord was achieved well in advance of contract termination. In 1957, new contracts were signed in December, more than nine months before existing agreements expired on September 30, 1958.

Sintered metal friction materials such as these produced by American Brake Shoe Co. found increasing application in the braking systems of heavy jet aircraft.

AMERICAN BRAKE SHOE COMPANY

American Brake Shoe Company increased its penetration of important aerospace markets in 1961, and the company's laboratories developed several new products and processes for aicraft and missiles.

Kellogg Division entered full production at its newly-occupied plant in Oxnard, California. The plant is specially equipped for the production of high-reliability airborne hydraulic pumps and system components. Contracts were received for through-shaft pumps for the GAM-77 Hound Dog, and for axial piston pumps for the Boeing 707 and 720 series jets. The division introduced to the aerospace industry its second-generation line of hydraulic pumps in a wide range of capacities. The new pumps achieve more than 50 per cent improvement in power/weight ratios over previous models.

Dynisco Division, acquired by Brake Shoe late in 1960, introduced the PT500 line of solid-state pressure transducers. Unlike other types of solid-state transducers, Dynisco's PT500 line is fully temperature compensated by internal mechanical means. Since no reduction of the output signal is necessary for temperature compensation, the PT500 transducers achieve unusually high output. In many missile applications this achieves a significant weight reduction by eliminating the need for one or more stages of amplification, the transducer output being sufficient to modulate a telemetering signal directly.

American Brakeblok Division received contracts for sintered metallic friction materials for the braking systems of the Boeing 720 and the Republic F105.

The company's Metallurgical Laboratory, in conjunction with its Industrial Castings Group, developed new metallurgical techniques and products for aerospace use. Structural castings in ultra-high-strength steel and in manganese bronze were made for the Pershing and Polaris missiles. The steel castings achieve guaranteed tensile strengths of 260,000 pounds per square inch throughout. The company developed a cast ductile iron launching arm for the Army's LaCrosse missile, replacing a more expensive assembly of 13 separate parts.

The largest vertical Dynapak high-energy forming machine in existence was installed in the Metallurgical Laboratory and was being used for developmental work in forging and extruding tough and refractory metals for aerospace components. Initial success was achieved in the high-energy compacting of sintered metals, and in the extrusion of molybdenum. The Dynapak machine exerts as much as 460,000 foot pounds of energy on the workpiece, causing even extremely tough metals to flow plastically.

At Brake Shoe's Hydrodynamics Research Center and at Raymond Atchley Division work continued in the development of improved servo-valves and electro-hydraulic systems.

In August 1961, Dominion Brake Shoe Company, Ltd., the wholly-owned Canadian subsidiary of Brake Shoe, acquired an interest in Jarry Hydraulics Limited. Jarry is Canada's largest producer of aircraft landing gear, and a major manufacturer of airborne hydraulic system components. Jarry is a designer and producer of landing gear and hydraulic components for major U.S., Canadian and NATO aircraft programs.

THE BG CORPORATION

In the field of high temperature materials, The BG Corporation further developed its ceramic-to-metal brazing techniques to cover the brazing of inorganic materials such as carbon-to-carbon for nuclear application and also developed a new alloy for internal sealing of ceramic-to-metals. This represented an advancement in providing greater reliability in missile terminal and connector applications where high temperatures are prevalent.

During 1961 BG also developed and released four new models of temperature sensors for gas turbine and rocket engines. (BG has specialized in this field for the past 13 years.) Special techniques were developed during 1961 for machining high temperature materials used in the temperature sensors. Investigative work was also done on a means of preventing sublimation in space when using thermoelectric materials as a source for electrical energy. A miniaturized, light weight, compensating resistor type thermocouple harness was also developed for gas turbine applications.

In BG's standard line of aircraft spark plugs, six new platinum electrode models were developed in 1961 to provide long and reliable service in the latest high output piston engines.

THE BENDIX CORPORATION

BENDIX COMPUTER DIVISION

A major contribution to the field of astronautics was made in 1961 by two Bendix G-15 computers associated with the TIROS III project.

A product of Bendix Computer Division, The Bendix Corporation, the general purpose G-15 was instrumental in making photographs from the satellite useful for weather prediction. TIROS III photographed cloud formations from 450 miles altitude in a project aimed at better storm observation which may eventually lead to early anticipation of destructive storms.

Launched by the National Aeronautics and Space Administration, this was the third successful TIROS to be sent aloft for cloud cover pictures, which are transmitted to receiving stations across the country. Photos of remote areas of the globe were stored on magnetic tape and relayed when the satellite was near one of the two principal ground stations located at Wallops Island, Virginia, and Point Mugu, California.

The 35mm negatives were processed within minutes and reproduced for use with a scaled latitude and longitude grid map produced, under G-15 control, by the graph plotter. The resulting cloud picture analyses were sent by facsimile to the National Meteorological Center, Suitland, Maryland, for further dissemination to key points in the United States and abroad.

Though still in the experimental stages, the elapsed time between receipt of satellite signals and the facsimile broadcast of chart renderings was reduced to as little as two hours, making data current enough to have practical weather forecasting value.

The computers were used on a real-time basis, processing information as it is transmitted from the satellite. The G-15s predicted satellite attitude and position at the time of picture-taking, making location of specific meteorological features in the pictures possible. The prediction of satellite attitude is used for control purposes—determining where cameras are aimed and when pictures can be taken.

BENDIX COMPUTING CENTER

Bendix Systems Division has also announced plans to open "the most comprehensive Computing Center in the greater Detroit area" in the spring of 1962. The heart of the Center will be a high-speed Bendix G-20 digital computer system, designed and manufactured by the Bendix Computer Division. The installation, valued at more than $1,000,000, is a true general purpose system—the fastest and most versatile machine in its class available today.

The Bendix Systems G-20 will consist of four memory modules storing 32,768 words and eight magnetic tape units which can simultaneously search for information at the combined speed of almost 2 million characters per second. A control buffer unit permits multiplexed data processing operations. These include off-line or on-line card reading, card punching, and printing capabilities.

The G-20 performs 83,000 additions or subtractions per second, can read or write on magnetic tape at a rate of 240,000 alphanumeric characters per second. Its high speed line printer can operate at up to 1,000 lines per minute, the equivalent of printing a 300 page book in seven minutes.

The first phase of the system was put in operation in November, and is adaptable to the PERT military method of using large computers to control the development schedules of projects such as the Polaris Missile. This initial facility was also being used in the development of advanced computing techniques for the Bendix G-20 Computer.

The Center's facilities will be available to the Corporation's many divisions and to other firms requiring the services of a high-speed computing system. Features of the Computer Center will include security-cleared premises for military projects, and a location convenient to the growing complex of research and industrial organizations in the area.

Under contract to the Air Force Rome Air Development Center, Bendix Systems Division developed an Ultrasonic Light Modulator to improve the quality of infrared strip maps produced from taped video data. Using this device, reconnaissance information can be processed to preserve greater detail and facilitate more rapid interpretation than with previous methods.

The components of the Bendix developed Ultrasonic Light Modulator shown in the schematic are the light source, modulator (ultrasonic cell), beam deflection system, and camera. The principle of operation is that a light beam, passing through the ultrasonic cell, is deflected by a vibrating mirror synchronized with scanning pulses. A camera records the image on film with minimum "spot" size and wide dynamic range. Thus, the image appears brighter and greater clarity is achieved which considerably improves the display quality of the strip map.

Army and Navy contracts totaling more than $23 million were awarded to Bendix Systems Division during the year for the overall development of the communications system for the Advent Satellite Communications Program. Radio repeaters in Advent satellites will serve as relay points for high-capacity voice, radio or teletype military communications on a world-wide, instantaneous basis. An Advent satellite, its orbital speed synchronized with the rotational speed of the earth, will appear to remain stationary in the sky. Three such satellites, spaced around the earth at an altitude of 22,300 miles, will provide direct-line communications to nearly any point in the world.

Bendix Systems Division was assigned responsibility for the design and fabrication of the satellite repeater, special-purpose ground equipment, and checkout equipment, and was also responsible for the communication systems engineering. Bendix Radio Division was designing and constructing ground terminal equipment and was to install and operate the equipment at two ground stations.

The first operating prototype model of the repeater equipment was delivered to the Army Signal Corps for acceptance in September, 1961, approximately one year from date of contract. Six units of the ground checkout equipment were delivered in October.

For the Navy's shipboard terminal, Bendix will perform system engineering and integration of communication equipment with Government-furnished equipment including tracking, telemetry and command units, a gyro compass, and a digital computer. The communications equipment, including receivers, transmitters, and modulation-demodulation equipment is being designed and fabricated by Bendix.

BENDIX FILTER DIVISION

At Bendix Filter Division during the year of 1961, development and engineering programs continued to contribute advancements to the commercial and military fields of fluid filtration and other fields where controlled porosity is needed. These programs encompassed various aspects and products of filtration including: filters for handling aircraft piston engine, jet engine, and missile fuels; filters for hydraulic fluids and lubrication oils used in aircraft and missiles; air filters for carburetor fuel systems, fuel injection systems, and aircraft cabin air conditioning systems; and filter water separators and related equipment.

Bendix Filter Division also designed and produced custom-engineered compressed fiber glass products for a broad range of insulation and isolation applications including that of heat, vibration, shock, and noise.

Among the outstanding developments of Bendix Filter Division in 1961 was the mechanically locked filter element. This element was previously used in development applications, but in 1961 was being installed in a broad range of installations. It has the metallic filter media firmly connected by mechanical crimping to the end caps by mechanical means; no bombing materials are used. The result is a high performance, stronger filter element that is an inherently clean structure with greater fatigue resistance and increased strength. In addition, these elements can be used to higher temperatures. The mechanically locked elements have gained outstanding acceptance from filter users in the critical aircraft, missile and space industries.

Manufacturing, laboratory and cleaning facilities of Bendix Filter Division are among the most up-to-date in the filter industry and were equipped during the year with various new machines and equipment geared to the aerospace industries. These included such things as additional ultrasonic cleaning stands and accessories for cleaning missile products, and special flushing stands for producing high cleanliness levels. All of these new additions were aimed at continuous updating of quality control and product improvement.

The Go-No-Go Cleanliness Gage received excellent response from industry and military groups handling aircraft fuels and was undergoing extended field testing at many different facilities. Preliminary results obtained during the year showed that the concept of full-flow monitoring with a positive shut-off of fuel transfer under excessive water and/or solids contamination conditions was receiving growing acceptance.

Another new product introduced during 1961 was called Pororibbon, an addition to the family of patented wound wire products produced by Bendix Filter Division. Preliminary investigations and development programs were very promising in the field of boundary layer control for high speed aerodynamic surfaces. Other noteworthy products manufactured during the year included elements and assemblies for the following programs: Sidewinder C, Polaris, Mauler, Saturn, and B-70.

BENDIX PRODUCTS AEROSPACE DIVISION

Landing gear, propulsion control systems and rocket motor components were supplied to many of the major airframe, aircraft engine and missile producers in 1961, as in the past. In addition, Bendix Products Aerospace Division continued extensive research and development programs in these and many related fields.

Lightweight fuel control systems for shaft turbine engines up to 1000 horsepower were qualified and placed in production. A Universal Test Control for use in determining optimum turbine engine acceleration and deceleration schedules was furnished to a number of engine manufacturers.

Lightweight aircraft fuel injection systems were certificated for additional applications and production and product improvement continued at an accelerated rate on these as well as on all types of fuel metering systems for large gas turbine engines for both commercial and military aircraft.

Movable nozzles for solid rocket motors were placed in production. These nozzles incorporate a swivel joint that will withstand the high temperatures and highly abrasive exhaust gases produced by the propellants used in high performance guided missiles. Another development of Bendix Products Aerospace Division for the missile age is a Freon Injection System for thrust vector control. Prototype units of this equipment were successfully test fired on advanced models of operational missiles. They provided much more precise control of the weapons.

Development and testing continued in the Ceramic Engineering Department. Microtranspiration was developed as a protective mechanism for rocket nozzle throat materials. Further development was conducted on Chromium Composite for leading edges, fasteners and other aerospace applications where its excellent oxidation resistance and strength in the 2000° F to 3000° F temperature range are exhibited.

In 1961, Bendix wheels and brakes improved their outstanding service record on the Boeing 707 and Douglas DC-8. Bendix equipment also entered service on the Convair 880M and 990.

Research was continued on cooled brakes to provide greatly increased safety and reliability during "hot stops."

Further improvements were also made in the Bendix line of hydroelectrical and hydromechanical aircraft steering systems and landing gear shock struts which were in production for a variety of military and commercial aircraft.

Studies were conducted and equipment was designed for lunar landings and mobility after landing.

The Bendix line of Fluid Power Equipment, formerly produced by the Hamilton Division, was transferred to South Bend to become a part of Bendix Products Aerospace Division. A family of lightweight, high temperature hydraulic pumps, motors and servo valves for aircraft and missile applications were qualified and placed in production.

Production and development continued on hydraulic shock absorbing equipment for the protection of railroad freight. "Cushioned" freight cars have been in use for over a year for commercial purposes and are being specified for transporting aircraft and missile components and assemblies. Similar units were adapted for use on off-shore mooring stations for petroleum tankers, and further developments, stemming from Bendix' hydraulic shock-strut experience, were under way.

BENDIX SYSTEMS DIVISION

The Bendix Corporation undertook a major expansion of the Corporate Space Laboratories located at Bendix Systems Division, Ann Arbor, Michigan during 1961. Completed in the fall of the year, this multi-million-dollar facility is one of the few in the country and the first to be available for the development, assembly, and test of integrated, full-sized spacecraft at a single location and under one roof.

Equipment capable of pre-testing full-scale spacecraft and component assemblies for reliable operation in the space environment is more important than ever. To continue to lead in the growing space effort, Bendix built its corporate system integration and test facility at Bendix Systems Division, the corporate focal point for missile and space systems. The Space Laboratories will be used by all Bendix divisions in the development and test of components, assemblies, and complete space systems, and will be available to other contractors requiring the use of advanced space testing facilities.

The Space Laboratories are fully equipped to test spacecraft operation under the rigorous conditions encountered during launch, and under the extremes of heat, cold, and vacuum in which the vehicle must operate in the space environment. The Laboratories meet the fabrication and test requirements of such space systems as:

*Advent Communications Satellite
*Nimbus Meteorological Satellite
*Orbiting Astronomical Observatory
*Orbiting Geophysical Observatory
*Apollo Manned Spacecraft
*Aeros Meteorological Satellite
*Prospector Mobile Lunar Vehicle
*Military Space Stations

The most significant addition to the Space Laboratories was the Spacecraft Thermal Vacuum Chamber in which the "dress rehearsal" of large satellites can be performed. This chamber, 20 feet in diameter and 27 feet long, is fabricated of ¾-inch highly-polished stainless steel. One end is a full-opening, removal door which allows spacecraft and associated test equipment to be installed. Satellites can be tested in this chamber as if in orbit at an altitude of 800,000 feet. The "hard vacuum" of outer space is achieved by a battery of eight oil-diffusion pumps of the same type used to evacuate large atom smashers. An array of carbon arc and infrared lamps subjects the spacecraft to the intensity of the sun's heat at that altitude. Ultraviolet radiation is introduced through 16 quartz lenses mounted in one end of the chamber. Plates, cooled by liquid nitrogen, then simulate the chill of space darkness when the sun is eclipsed.

Complete spacecraft can also be shaken by a 30,000-lb force vibrator to simulate launch conditions. The boost phase of a trajectory, where a spacecraft is subjected to extreme acceleration, can be simulated by a centrifuge with an arm length of 22 feet, which can produce a force of 50,000 "g" lbs.

A multi-environment laboratory was also built into the Space Laboratories to test spacecraft and space subsystems in the environments encountered before launch or at the launch sites, such as sand and dust, salt and fog, sun and rain, ozone, fungus, and explosion.

ECLIPSE-PIONEER DIVISION

Highlights of the 1961 year at Eclipse-Pioneer Division included continued high level of production activity in the areas of automatic flight controls and instrumentation systems, a greatly increased production activity in major support equipment, and a heavy emphasis on the development of space flight systems and equipment.

In the area of automatic flight controls, the number of domestic and foreign airlines using the division's PB-20 system increased by ten to a total of 45. This was in addition to military versions of the PB-20 in the service of seven branches of the U.S., Canadian and British military and government services. High on the list of new procurements for this equipment was that ordered by TWA for use on its new Caravelle Mark 10A aircraft. The order also specified dual sets of Eclipse-Pioneer Gyro Compass Systems and Flight Director Systems. PB-20 Automatic Flight Controls and Gyro Compass Systems were also specified for the British Aircraft Company's BAC-111 Twin Jet Transport, which during the fall was ordered by Braniff International Airways and was being considered by a number of other domestic lines.

Another significant award was that made by Lockheed—Georgia Company to Eclipse-Pioneer to furnish Three Axis Stabilization Control Systems, a form of autopilot, for the Army's Hummingbird aircraft—a jet powered vertical take-off and landing craft.

During the year, Eclipse-Pioneer in cooperation with Boeing and a number of key airlines operating jet equipment, initiated a long range program directed toward all-weather landings. The program was unveiled during a three-day seminar at the Boeing Aircraft Company's plant in Seattle late in September before a gathering of 74 representatives of 16 airlines, the Air Force and the FAA. In addition to the commercial aspects of this program, Eclipse-Pioneer's work in this field included cooperation with an Air Force program associated with all-weather landing of re-entry vehicles. By year's end the program was in the test stage and included a number of successful fully automatic

The 10-ton head for the Bendix Spacecraft Thermal Vacuum Chamber ran into a tight squeeze at an Ohio Turnpike exit.

approaches, flare out and touchdowns using augmented glide slope techniques and the Division's own Flare Computer.

Important in the area of instrumentation systems was the development of a Propulsion Data System which consisted of a vertical scale type of indicator display panel and a computer utilizing digital techniques that was designed to relieve the flight crew of routine monitoring and computations associated with engine management. The computer continually scans the performance parameters of all engines, decides which engine deviates most from its optimum value and displays the parameter of the worst engine on the appropriate indicator. At year's end delivery of a prototype system was made to the Air Force for evaluation on C-130 type aircraft.

Eclipse-Pioneer's Dead Reckoning Computers which had been used so successfully on the Navy's nuclear weapon-carrying A4D-2N airplane were sold for use on the McDonnell-built F4H Phantom II Navy fighter.

Production of Air Data Computers continued at high level for such aircraft as the Air Force's F-105 and F-106. Further development in this area resulted in a system which offered weight and space advantages over the highly versatile multi package concept.

A new lightweight Compass System, the CB60, was ordered for use on the North American T-39 trainer. A versatile and low cost system, it was designed to cover a broad range of aircraft including those in the commercial transport and executive category.

A tiny 2 inch Attitude Indicator was sold for standby use on the Canadian-built RCAF F-104C aircraft. The indicator was used to replace the more conventionally sized 5 inch indicator.

Heavy emphasis was placed on systems and related products for missile and space flight. Production of inertial guidance and control systems for the Army's Martin-built Pershing continued at a level required to match delivery requirements for the highly successful two-stage solid propellant surface-to-surface weapon.

In the fall of the year, word was received that Eclipse-Pioneer had been selected by NASA to build the Guidance and Control System for the Saturn launch vehicle.

Reaction wheels produced by the Eclipse-Pioneer Division were selected for use on a number of America's upcoming orbiting satellites including OAO (Orbiting Astronautical Observatory), OGO (Orbiting Geophysical Observatory), Advent (Communications Satellite), Nimbus (Meteorological Satellite), and a NASA simulator project.

Other space type instrumentation and control devices developed by Eclipse-Pioneer during the year included a sun sensor which provides a means for locating and locking onto the sun for spacecraft attitude control and orientation, and a star tracker which affords a precise way for locating and using a star for spacecraft navigation. The division also developed a satellite motion simulator as an important part of its laboratory facilities for checking performance of space equipment under simulated flight conditions.

Also in the missile field, Eclipse-Pioneer was awarded a contract during the year to build decoders for the Minuteman missile. The decoder is the final link between the firing command and the missile. Upon receipt of a properly coded message to fire, it automatically positions an arrangement of coded switches to the firing position.

Additional activities in the space field included studies with such institutions of higher learning as the Cornell Aeronautical Laboratory and the Massachusetts Institute of Technology in solving problems relating to re-entry conditions and the development of advanced type gyros for use in missile and space applications.

The development of two new digital computers for space and missile applications was also initiated during 1961. One, designed for use as part of an interplanetary navigation and guidance system, made use of optical techniques for program storage. The other was designed for use as part of a complete guidance system platform star tracker and computer for a long range missile.

Development also continued in the area of hot gas control systems in which rotary and linear actuation, reaction jets, and pneumatic computation were featured. Other systems and equipment applicable to space flight on which the division placed heavy emphasis during the year were self-adaptive controls, spacecraft rendezvous computers and advanced displays.

In the important area of aerospace ground equipment (AGE), the Bendix Support operation at Teterboro placed in production and made scheduled deliveries of a Universal Tester that will be used for check out of the USAF's Douglas-built Skybolt Missile. The tape-operated system has automatic Go, No-Go check out capability for all types of air, land, sea and space systems, and is adaptable to electronic, hydraulic, mechanical and pneumatic devices. There was also considerable continued activity in the area of major support equipment for the B-58 Hustler airplane.

High on the list of new support equipment announced during the year was a Digital Module Universal Test Set. The test set provided a means for making complete, accurate and rapid tests of digital modules or printed circuit cards for magnetic or punched tape data handling and process control systems.

MONTROSE DIVISION

The year 1961 at the Bendix Montrose Division was marked by continued product development within previously established lines which included: aircraft autosyn synchros, pressure and position transmitters and indicators, tachometer generators and indicators, servoed angle-of-attack indicators, a variety of other servoed indicators, variable reluctance type transmitters and indicators, D.C. synchro type indicators, aircraft and missile pressure switches, D.C. motors (under 1/4 h.p.), dynamotors, ordnance lighting and degasser switches.

An important item produced initially during 1961 was a one inch diameter dual concentric integrally lighted indicator utilizing two special D.C. synchros arranged in tandem capable of withstanding extreme environmental conditions.

Development of a miniature 4000 pound pressure measuring system was completed. A significant reduction in the weight and size of the transmitter has been achieved. This transmitter is capable of withstanding temperatures of from −67° F. to 450° F. and can be mounted directly on a jet aircraft engine.

The division was producing a line of high temperature synchros which will withstand temperatures up to and including 800° Fahrenheit. Synchros which will withstand nuclear radiation also can be supplied to meet specific requirements. Since it is known that temperature environments up to 1200° Fahrenheit will be encountered, development of synchros suitable for this high temperature level was also under way.

During 1961, a major plant rearrangement was accomplished facilitating the handling of increased aircraft instrument and synchro manufacturing and assembly operations. In this connection, 12,000 square feet of assembly clean room and temperature-controlled laboratory and manufacturing machine areas were constructed.

PIONEER-CENTRAL DIVISION

Pioneer-Central continued to improve its position in the aerospace field during 1961 by the acquisition of additional facilities, the functional tailoring of the Pioneer-Central organization and the attraction of experienced scientists specializing in various aerospace fields.

The additional facilities included a Cryogenic Development Laboratory which was completed in

September. This laboratory provides for the functional marriage of Pioneer-Central's 18 years experience with liquid oxygen, 42 years experience in the design and manufacture of precision instrumentation and two years experience with liquid hydrogen. The laboratory has one of the finest liquid hydrogen test facilities in the country today.

Pioneer-Central functionally realigned many facets of its organization in order to contribute more efficaciously to the state of many aerospace arts. The Engineering Department, for example, added an electronics group to its advanced engineering staff to compliment the experts in Life Support, Cryogenic Instrumentation, Aerospace Instrumentation and Propellant Control.

The Pioneer-Central engineering climate attracted many well known and experienced scientists to supplement its existing engineering community, thereby forming the nucleus for a concerted aerospace effort.

The year 1961 was also one of hardware development at Pioneer-Central. Some of the newly developed products were a double integrating accelerometer for missile application, a liquid level sensing system for the Saturn space vehicle, a propellant control system for missile application and a miniature impact momentum flowmeter for business and commercial aircraft.

RED BANK DIVISION

During early 1961, the Red Bank Division continued to expand its facilities and products in the three different product groups contained in the divisional structure, namely the Electrical Power Generating Group, the Electron Tube Group and the Semiconductor Group.

In June, this latter group became a separate division of Bendix, known as Bendix Semiconductor Division. This division of Bendix is located in Holmdel, New Jersey.

The Electrical Power Generating Group continued to expand its line of AC brushless generators. Red Bank's family of AC brushless generators included units rated from 10 KW to 80 KW as well as several combination AC/DC brushless generators. All of these units were available with solid-state type regulating and control components to fit complex airborne and ground power equipment. Many of these units were being used in aircraft retrofit programs where they will provide long operating life with little, if any maintenance.

This group further expanded its line of DC equipment to include 30 Volt starter-generators rated from 100 amperes up to 500 amperes. Several

The Bendix Time-of-Flight Mass Spectrometer.

units were being produced to fit the many small gas turbine engines being developed. Here again, all of these DC generators were available with solid-state regulating and control equipment.

In the static power-conversion field, Red Bank continued development and fabrication of static inverters and converters. Several models of these devices were being produced for both aircraft and missile applications.

The Electron Tube Products Group continued its expansion in the microwave field, and in ceramic-metal terminals. The former field included a range of klystrons—from 5 to 35 kmc, a complete family of traveling wave devices—from 40 to 150 kmc, and a group of ferrite devices: phase shifters, Y-circulators and attenuators. These devices were finding their way into many maser and parametric-amplifier applications, and in fast AGC circuits and remote level control applications.

This group registered the trade-mark CERAMETERM to cover its line of ceramic-metal terminals.

These CERAMETERM terminals—which are practically indestructible and provide an extremely high degree of reliability—were offered in myriad configurations to fit transistor bases, relays, capacitors, transformers, and almost any component incorporating terminals which are subjected to extreme environmental conditions.

RESEARCH LABORATORIES DIVISION

During 1961, the Research Laboratories Division completed numerous research and development programs, several of which represented significant advances in the state-of-the-art. Reflecting the diversity of pursuits at the Laboratories, many of its scientists and engineers contributed technical papers to scientific journals and gave presentations of their latest technological findings at engineering and scientific symposiums and conferences.

One of the unique advancements during 1961, was the development of a microwave thickness gauge which instantaneously determines thickness differences in dielectric material to resolutions of less than 50 millionths of an inch. Extremely compact and portable, the instrument may be hand-held like a pistol, and merely pressed against the surface of the material being checked. The instrument will prove especially useful in checking the critical wall thickness of radomes for aircraft and missiles, which normally requires costly and time-consuming methods. Among the many other applications of the microwave gauge is its ability to rapidly and accurately measure the thickness of acrylic (non-conductive) paint used on automobile bodies.

Other investigations in the microwave field resulted in the development of a series of new ultra-miniaturized microwave components, which could be employed with printed circuits for use in various types of aircraft, missile and satellite systems.

In the applied physics field, a new Time-of-Flight Mass Spectrometer was developed for accurately and rapidly measuring pulmonary function in the human respiratory system in closed environments that will be experienced in manned space vehicles. As the first instrument of its type developed for laboratory use, highly miniaturized future models are visualized as capable of continuously monitoring cabin atmosphere during actual manned space flights.

During 1961, continuing development in the dew-point hygrometer field resulted in the fabrication and successful testing of a portable, self-contained unit that was capable of continuously and automatically measuring the dewpoint of a gas sample ducted through the instrument. Operating on the principal of servo-controlling the temperature of a mirror surface to maintain a thin, constant-thickness deposit of dew or frost on the mirror surface, the dewpoint hygrometer could measure dewpoints from 0 to $-100°$ F at pressures from 2.5 psig to 6000 psig, with accuracies better than $\pm 2°$ F and a response time of 2 to 20 seconds.

Ultra-violet detection techniques were further advanced in 1961 through the development of a Model M-308 miniaturized magnetic electron multiplier. As a more sophisticated version of an earlier, larger model, which obtained the first measurements of the sun's low, ultra-violet spectrum, the miniaturized M-308 model was capable of detecting ultra-violet photon, ion or electron currents as low as 10^{-19} amperes. The M-308 unit was similar to, but smaller, than an earlier M-306 model, which was transferred to the Bendix Cincinnati Division for commercial manufacture.

SCINTILLA DIVISION

The Scintilla Division of The Bendix Corporation during 1961 conducted an extensive investigation into the problem of in-flight turbine engine flameout and development of a satisfactory and reliable method of effecting automatic relight. This investigation resulted in development of a pressure rate sensitive switch of a new and unusual type which very rapidly senses flameout through pressure change. The switch immediately and automatically activates the engine's standard ignition system whenever flameout occurs for any reason. This method of detecting flameout and automatically effecting immediate relight is an extremely sensitive, fast acting device that will offer considerable advantage for both commercial and military jet powered aircraft.

Considerable activity was conducted in developing capacitance discharge ignition systems, which Scintilla Division has manufactured for many years, as firing sources for exploding bridge wire ordnance devices.

A portable control center for submarine command and operation is another new activity. This portable control center is packaged in an 18-lb. "suitcase console" that contains all instruments needed for conning information and communications. Initial development of this equipment was accomplished by Portsmouth Naval Shipyard. Further development activity by Scintilla Division produced a similar portable control center which offers many advantages for surface vessels.

An electronic tachometer was developed for single and twin-engine aircraft. This is a dependable, lightweight device that has the outstanding advantage of not requiring a special engine drive pad and mechanical drive cable which are necessary with conventional tachometers. This tachometer operates from electrical impulses in the engine's ignition system and requires only the simplest of connections to be made.

Development of high temperature capacitors proceeded rapidly with Scintilla Division in 1961 offering capacitors for the wide temperature range of −55° C to plus 400° C. These capacitors provide a high order of reliability at voltages from 200 to 3 KV and are designed to meet or exceed the requirements of specification MIL-C-14157. They may be used in AC or DC applications and have excellent radiation resistance.

The Temperature-Vibration Monitor was in use on jet powered aircraft operated by British Overseas Airways Corporation and Air India. This instrument simultaneously presents in bar graph form on a cathode ray tube the exhaust gas temperature and vibration conditions in the four turbine engines powering an aircraft. Any departure from normal operating conditions is apparent at a glance. Up to 48 dial type instruments would be required to accomplish the equivalent of this small unit.

A new development in the field of electrical connectors was the Pygmy PT-SE type which offers the convenience and advantage of using military standard crimp type contacts in standard contact arrangements to accomplish maximum interchangeability and standardization. The PT-SE connector will mate with PT and MIL-C-26482 connectors now in use.

Another interesting connector development was the "Twist/Pull" quick disconnect Pygmy electrical connector for specialized applications. The coupling design assures positive coupling and inter-facial sealing. The uncoupling force, as applied to the coupling nut by means of a lanyard, may be varied to suit the particular application.

In the area of cabling one of the most interesting developments was that of the hydrastatic cable which offers maximum protection against underwater environment. This cable has the ability to withstand extremely high differentials of pressure. It is particularly suitable for such underwater applications as radar detection, well drilling, and camera equipment. Scintilla Division conducted a wide variety of cabling research with the specialized requirements of many applications in view. Extensive production facilities were maintained at both the main plant in Sidney, New York, and a branch plant in Santa Ana, California.

Full evidence of the active program in research, design and development at Scintilla Division was the fact that construction started in 1961 on a 20,000 square foot addition to the engineering building.

A "White Room" for the manufacture of aerospace components requiring the ultimate in temperature controlled, dust free atmosphere was completed and placed in service during 1961. Temperatures are maintained at 70° plus or minus 1° and relative humidity is governed to 40% plus or minus 5%. Incoming air is filtered so that it is 99.97% free of dust particles above .3 micron in size. There is a complete change of air every three minutes.

THE SHEFFIELD CORPORATION

A SUBSIDIARY OF THE BENDIX CORPORATION

The Sheffield Corporation in 1961 introduced the first "Super-Accurate" 5-Axis Numerical Control Measuring and Printout Machine for measuring space age parts to an accuracy never before possible to achieve.

Significant progress in measuring small holes was also recorded. The Dayton, Ohio, manufacturer and developer of precise dimensional control instruments and systems announced the development of an electronic gage to measure holes as small as 0.010″ in diameter on a production basis. A hole ten-thousandths of an inch in diameter is approximately equal to one-quarter the diameter of a typewritten period.

Sheffield's "Super-Accurate" Numerical Control Measuring Machine operates automatically from instructions encoded on a tape. It measures and records simultaneously, millionths-of-an-inch deviations in internal and external dimensions, wall thickness, and other geometrical conditions and relationships of objects of symmetry such as cones, tubes, hemispheres, etc. It measures parts up to 20″ high and 20″ in diameter.

The machine can be used also to determine and print out the dimensions of parts of unknown size.

An example of the machine's time-saving and accuracy is seen in a typical inspection problem in which a point of inspection on a hemispherical part is specified at every two degrees latitude and every 60 degrees of longitude for outside contour, inside contour, and wall thickness. This inspection requires a total of 795 gage readings including 265 mathematical computations for wall thickness.

The Sheffield machine can complete the inspection and provide a printed record of all data in approximately two hours.

The machine has the ability to make and record up to 100,000 readings in a single inch. This permits area or contour inspection with greater detail and accuracy than ever before possible.

The Sheffield 5-Axis Numerical Control Measuring Machine will measure any point or angle within the 20-inch gaging range to an accuracy of one ten-thousandths of an inch (.0001″). Over a range of

Sheffield's Super-Accurate Universal Tape Controlled Measuring Machine.

20", the machine has a repeatability closer than five millionths, plus or minus.

Wall thickness is measured to an accuracy of 50 millionths of an inch (.000050), and is the result of the machine automatically computing the algebraic difference between opposed gage points on the internal and external surfaces.

All slides, vertical and horizontal, operate within 15 millionths of an inch of true position.

All slides including the two vertical slides that weigh approximately 1000 pounds each operate within 15 millionths of an inch of true position.

Accuracy of positioning can be calibrated within ten millionths of an established master.

Several of the Model TC 101 5-Axis Numerical Control Measuring Machines were manufactured during 1961. The machine can be used for rapid, precise measurement of commercial products also.

During the year, Sheffield also completed designs of a 4-Axis Tape Controlled Universal Measuring Machine capable of measuring parts up to 5 feet wide by 3½ feet high by 8 feet long.

YORK DIVISION

During 1961 York Division of The Bendix Corporation continued further advances in the research and development of proximity fuzes for missiles and rockets. These fuzes are compact, high frequency radar systems and are currently utilized on many of the defense programs. The Division participated in the design and development and production of fuzing systems for Sparrow I, Honest John, Little John, LaCrosse, Bomarc, Redstone, Pershing, Geni and GAR 9. In conjunction with these fuzing programs the York Division designed and developed tactical test sets and evaluation test sets for these fuze programs.

Also, the York Division, through engineering programs, continued to improve and produce the tactical test equipment for Talos Missile. Equipment for this purpose was designated as TATTE and provided rapid go-no-go indications and fault isolation of the Talos Missile System. This equipment has been and will be installed on the Navy's new missile cruisers and destroyers that are armed with Talos Missiles.

During the course of the year, the Division was awarded a follow-on contract, by TRECOM, for Project ALARM (Automatic Light Aircraft Readiness Monitor) known as PACER (Portable Aircraft Condition Evaluation Recorder). PACER will provide automatic field maintenance inspection of components and systems within Army Aircraft in conjunction with ALARM. PACER is a portable unit and will determine the condition of components at any specific time whereas ALARM, which is integrated into the aircraft, gives a go-no-go indication to pilots and crew chiefs.

Utilizing advanced development techniques employed in radar fuzes, the Division entered the field of space technology. Among possible applications was the determination of spin-rate and spin-axis of the planet Venus as well as terrain mapping. It was anticipated that an immediate system would be installed in an Aerobee-150 rocket to obtain pulse returns from the earth from an altitude of 250 kilometers. This will be done to obtain correlation with data obtained through use of ground radar systems and to prove the use of radar for ultimate application to space satellites.

Parametric Amplifiers for ADVENT operating on upper or lower side bands in the L-band range have been developed. A Large variety of microwave components and microwave antennas have been fabricated on the ADVENT Satellite. Similar work is in progress for Project BEANSTALK.

Because of its involvement with many of the electronic systems within missiles, the York Division designed and manufactured numerous pieces of test equipment for systems checkout. Included among these pieces of checkout equipment are: Talos Tactical Test Equipment (TATTE- AN/DSM-18); Radar Simulator; Missile Specification Test Programmer; Talos Package Test Set; Universal Pluggable Unit Tester; and many others.

CHANDLER EVANS CORPORATION

During 1961, Chandler Evans Corporation placed renewed emphasis on its program for product diversification and on its capability to produce precision components and assemblies, under subcontract, for the aerospace industry.

At the same time, the company's production facilities were devoted principally to the manufacture of main fuel pumps and unitized fuel control and pumping systems for many of the country's most advanced turbojet and gas turbine aircraft powerplants.

Early in the year, the successful completion of an engineering contract for the development of prototype valves to control water flow in a nuclear environment resulted in a production contract for valves that will be installed in the new General Electric NPR reactor at Atomic Energy Commission's Hanford plant. Delivery of these units was to be completed early in 1962.

In addition, the company was producing nuclear environment water valves for another reactor manufacturer.

In another field, the company designed and successfully tested an anti-icing additive injection system for aircraft jet engine fuel. Capable of handling fuel flow volume up to 10,000 gallons per minute, the Ceco Liquid Ratio Controller can control pre-selected additive injection ratios with great precision. The device can be applied to a wide variety of chemical processes and fluid blending operations.

During the year, Chandler Evans designed and produced a thermostatic-type hot air valve to prevent nacelle icing on the turbofan powered Boeing 707 Jetliner. Ceco fuel pumps were ordered for the Pratt & Whitney turbofan engines that will power Lockheed's new C-141 military transport. Orders likewise were received for a Ceco designed pneumatic control valve system for the Bullpup air-to-surface missile manufactured by the W. L. Maxson Corporation. And the company was producing control valves and pump parts for the Pratt & Whitney liquid hydrogen rocket engine.

As an extension of its broad experience with controls and systems, Chandler Evans continued the design and testing phases of hot gas reaction control systems for spacecraft. Unique experimental facilities completed in 1961, enhanced by precision machining capabilities, carried the company's developments in this area to an advanced state.

Orders on hand at year end for products of a proprietary nature and for subcontract work in the aerospace and industrial fields give promise that business volume would continue at similar levels throughout 1962.

COOK ELECTRIC COMPANY

During 1961, Cook Electric Company's activities again included several new developments in Research and Development of new products for use in missiles, spacecraft and communications.

The Cook Research Laboratories added to its family of rocket vehicles the Chicago III, a new low cost, four-stage vehicle aimed at the growing communications satellite industry. Cook Electric Missile Nose Cone Recovery systems continued to provide successful return of vehicles from outer space. Latest use was the successful recovery of a CREE vehicle on October 10, 1961. The Air Force announced that this recovery was the 200th high altitude sounding rocket launch at the Air Proving Ground Center, Eglin Air Force Base. Developed by Cook Electric Company, the CREE test vehicle took part in the "Ballute" program for the recovery of aerospace equipment operating at high altitudes and supersonic speeds.

Cook Electric Company participated in a space astronomy program through a contract award by NASA and the University of Wisconsin for the design, development and fabrication of the University of Wisconsin experimental package of NASA's Orbiting Astronomical Observatory. The equipment will be borne aloft in an especially designed spacecraft and will be operative for a period of a year. This satellite is one of the series of experiments being conducted by NASA aimed at increasing man's knowledge of the environment of outer space. This particular vehicle will carry five special telescopes, four of them designed to observe the characteristics of stars and the fifth designed to observe nebulae.

The Cinefonics division of Cook Electric Company, in addition to continued production of technical and briefing film reports for government and industry, produced classified films on communications satellites, missile defense systems, air weather reconnaissance and nuclear weapon safety. Technical progress films recently made available for distribution include "Relays to Rockets," "Para Research Programs," and "Hardsite Networks."

Dow extruded aluminum body panels for the Titan missile.

In order to keep up with the changes in the state of the art, Nucledyne division was pioneering in the development of sophisticated environmental test facilities. Under contract to Minneapolis Honeywell Regulator Company, Nucledyne division was designing and building a "Dynamic Analyzer" capsule. This chamber will simulate, simultaneously, such diverse environments as extreme high altitude, solar heating, outer space cold void exposure, three directional vibration, roll, pitch and yaw, buffeting, shock and specimen rotation.

Inland Testing Laboratories in 1961 embarked on a program of "life testing" batteries for space use. This Cook Electric facility works like a "Consumer's Research" operation and tests the space batteries until they fail. A "post mortem" is made to find out why the battery cells go bad. It is expected that the test results will be widely distributed and the data developed will give engineers information about battery life and performance that has not been available before.

Data Stor division of Cook Electric Company continued development and manufacture of digital data handling equipment. Of special interest was a miniature airborne magnetic recording system designed for recording data during the entire flight of Atlas-launched capsules. Other products under manufacture are constantly being refined to perform such vital functions as the loading of target information into Atlas, Titan and Minuteman ICBM missiles and other information data functions in more exotic programs such as "Project Echo," "BMEWS" and future moon landings.

Nucledyne division of Cook Electric Company continued its activities in the environmental equipment field including the design and construction of the most advanced facilities for aerospace environmental simulation relative to missile, satellite and orbital reconnaissance. Nucledyne completed the design and fabrication of two ultra-high vacuum test chamber systems and one roughing pump system for the National Aeronautics and Space Administration. The vacuum chamber is capable of simulating altitudes up to 200 miles and will be used for liquid metal corrosion tests.

THE DOW METAL PRODUCTS COMPANY

DIVISION OF THE DOW CHEMICAL COMPANY

In 1961, as in previous years, aluminum and magnesium mill products produced by The Dow Metal Products Company, Division of The Dow Chemical Company, found major uses in the aerospace industry. Dow's aerospace activities primarily concerned the production of big aluminum extrusions and magnesium sheet, extrusions and forging stock.

Dow, which first became associated with the B-52 program as a supplier of giant extruded aluminum panels for the G model, continued in that role for the new B-52H. The company also continued to supply wide aluminum extrusions for the Titan.

The aerospace industry's use of forgings produced from Dow magnesium forging stock increased substantially. B-52 wheels, Agena support rings and Avco nose cones were outstanding uses. Magnesium forgings also were specified for the series of launching canisters to be used in the Echo A-12 program. Magnesium-thorium mill products were used in the Titan, Talos, Polaris, Agena, Bomarc and Jupiter programs, all of which require lightweight components with good elevated temperature properties in key areas. Conventional magnesium alloys were used for considerable portions of the Minuteman transporter-erector.

GENERAL LABORATORY ASSOCIATES, INC.

During 1961, GLA participated heavily, through design, development, and manufacture, in almost every phase of the missile ordnance field. Equipment being produced by GLA for missile application included direct fuel ignition devices for use on the Pratt & Whitney Aircraft LR-115 upper stage liquid rocket and on the F-1, a 1.5 million pound thrust rocket developed by Rocketdyne Division of North American Aviation. GLA also developed and manufactured high altitude second stage ignition equipment for the gas generator of the Titan missile, and a complete system, including firing impulses for both fuel ignition and stage separation, for the Pershing missile. In addition, GLA was under contract with Douglas Aircraft Company to produce a complete second stage ignition system for the Saturn space vehicle.

GLA also accelerated its pace in the field of civilian aircraft ignition, while continuing to produce ignition systems for use by more than 35 of the major jet airlines in the world and providing service representation and documentation for everything that GLA builds. New projects included the jet engine ignition installations on the Lockheed JetStar, four-engine executive transport, and the Convair 990.

GENERAL PRECISION, INC.

General Precision, Inc., principal operating subsidiary of General Precision Equipment Corporation, a holding company, marked 1961 by moving into its new headquarters building in Tarrytown, N.Y.

The new, two-story, 40,000 square foot building houses the headquarters staffs of the holding company and of General Precision, Inc., which was formed in 1960 by the amalgamation of GPL Division, Pleasantville, N.Y.; Kearfott Division, Little Falls, N.J.; Librascope Division, Glendale, Calif.; and Link Division, Binghamton, N.Y.

In 1961, GP, Inc., and its four divisions operated facilities totaling more than 2,500,000 square feet of floor space and employing more than 16,000 persons. The company was engaged in research, development and production of a wide range of electronic equipment for the military services and civil use.

During 1961, General Precision, Inc., was working on several missile programs. Among products being turned out were gyro reference platforms for the Bomarc, Subroc and Talos missiles and floated gyros for Atlas and Polaris. New programs brought to 33 the number of missile projects in which the company has participated.

Kearfott Division was producing advanced navigation systems for a number of military aircraft, and Kearfott was also turning out synchros for transmitting guidance data in the Polaris missile system.

Librascope Division was producing a variety of special purpose analog and digital computers, fire control equipment and data handling equipment. A highlight of the division's year was the development of a new, lightweight computer for controlling and guiding spacecraft. Weighing only 19 pounds, the L-70 computer uses a thin film of helium to replace the standard metal bearings on which the memory drum spins. This development permits a significant increase in the computer's memory capacity, while reducing overall weight and eliminating mechanical wear in the memory drum unit.

One of the world's smallest digital computers, the L-70 measures 8½ by 8 by 10 inches. It was successfully tested at vibration and shock levels greater than existing space vehicle requirements.

Link Division was engaged during the year in production of a number of types of simulators and training equipment for aircraft, missile, space and submarine applications. A new product was the Link Model 60 trainer designed specifically for the general aviation pilot, who can use it to develop flying skills, navigational techniques and communications procedures. To simulate the flight performance of typical light and executive aircraft, the Link Model 60 utilizes electronic analog computation. Instrument readings and control responses are programmed so that the trainer duplicates the conditions of dynamic stability which the pilot might encounter in flight.

General Precision, Inc. was also engaged in work on the FAA's Data Processing Central and in production of new radar systems for target acquisition detection, missile velocity measurement and fire control.

The company's research activities covered a broad range during 1961. In progress during the year was work in such areas as solid state celestial tracking systems and Doppler space speedometers; optical masers as light detectors and generators for advanced space communications; and optical correlation techniques to determine automatically the position of a vehicle above a planet. GP, Inc. was also researching new, lightweight guidance systems employing new concepts of cryogenic gyros and nuclear gyros making use of the spin of atomic nuclei as gyroscopic reference.

In a top level personnel acquisition during the year, GP, Inc., announced that former FAA deputy administrator James T. Pyle joined the company on December 1 as vice president. Pyle was to be in charge of the company's Washington office, and he was also to serve on various corporate committees relating to the company's aerospace activities.

GEOPHYSICS CORPORATION OF AMERICA

Geophysics Corporation of America acquired Vacuum Specialties, Inc., manufacturers of vacuum processing equipment for industries in the metallurgical, nuclear, electronics, and medical field, in April, 1961. Shortly thereafter, the new GCA subsidiary announced development of the first comprehensive line of standardized cold wall vacuum furnaces for economical and dependable heating of large or small quantities of materials and parts to extremely high temperatures (2500 degrees C) on a production basis.

In several rocket experiments during 1961, GCA scientists conducted the first direct measurement of electron density in the ionosphere traversing a natural electron cloud known as sporadic E. Using Nike-Cajun sounding rockets, the experiments were performed with an electronics technique for probing plasmas adapted for rockets. The experiments confirmed, through the first direct measurement, the presence of a sporadic electron layer in the ionospheric E region. An extremely narrow layer of high electron density was found and charted precisely at a height of 63 miles, and having a thickness of 2,296 feet. A knowledge and understanding of sporadic electron conditions in the ionosphere is of major importance to developing new means for long distance, over-the-horizon radio communication and frequently observed radio communications blackouts.

During 1961, GCA conducted further studies of upper atmosphere wind motions using electrically-operated ground cameras to track tracer gasses (usually sodium) released by sounding rockets at altitudes ranging from 50 to 450 miles. The yellow-glowing clouds, created during periods of twilight, were visible to persons on the ground over the entire eastern seaboard.

These tracer gas experiments provided important stepping stones to three major contracts for high-altitude nuclear explosion detection research which GCA received during 1961. All of the detection research programs were under the overall direction of the Advanced Research Projects Agency, although GCA was working under contract to several different Defense Department agencies and services to perform the studies. The largest of these programs involved studies for Project VELA to develop ground-based optical techniques for detecting high-altitude explosions from observations of sunlight. The spread of debris in space following an explosion causes a scattering of sunlight which can be observed and studied by photometric equipment on earth. GCA was preparing theoretical tabulations

Above: Kearfott facility tests Missile Guidance Inertial System Platform (see p. 179)

Below: Geophysics inspects cameras used to track tracer gases in the upper atmosphere.

of the spectral characteristics which various elements in such debris may be expected to have, and is preparing laboratory cloud "models" to study varying degrees of distribution of uniform and nonuniform particles. Tracking equipment to be developed will be a logical outgrowth of the photometric techniques which the company developed for the tracer gas experiments. Other detection research programs involved studies of theoretical "models" of debris motion for the Defense Atomic Support Agency, and studies to predict and measure the effects of infrared radiation caused by high-altitude explosions.

During 1961, the company received three additional contracts under ARPA's overall ballistic missile defense program. These contracts involved studies of nighttime atmosphere phenomena, infrared radiation, and missile exhaust gasses deposited in the upper atmosphere.

The David W. Mann Company, an instruments division which was acquired in 1959, announced development of the first commercially available photographic exposure repeater for the transistor industry in May, 1961. The instrument operates with positioning accuracies of one micron (.0004 inches) in producing extremely precise photo-masks required in transistor production. Other important new space-age analytical instruments also were developed during the year by the company's Physics Research Division. These include the first airborne mass spectrometer designed to make the first direct measurements of helium concentration in the earth's atmosphere (at altitudes ranging from 60 to 620 miles), and a ceramic photon counter able to detect ultraviolet radiation within narrow bands between 1100 and 1350 angstroms. The counter was designed for use as a laboratory aid in studying light sources, or as equipment aboard rockets or satellites for solar ultraviolet research. The division also announced development of a rugged metal-ceramic ionization gauge able to withstand extreme vibration, acceleration, and thermal shock forces encountered in rocket launchings and still obtain reliable pressure and density measurements even in the atmosphere of the moon. The instrument also will serve as a laboratory aid in controlling or checking out simulated high altitude environments or other high vacuum processing operations.

THE HALLICRAFTERS CO.

Two breakthroughs in aerospace electronics—one accomplished and one potential—highlighted activities of The Hallicrafters Co. in 1961.

The fait accompli was a Wideband High Intercept Probability (WHIP) reconnaissance receiver which provides a sharper "eye" for spy-in-sky satellites. Without tuning, this lightweight device directly identifies multiple radio and radar signals in critical space communications and electronic warfare bandwidths. The WHIP receiver will also detect attempts to jam satellite communications systems.

The "potential" is wrapped up in company efforts to solve the critical communications "blackout" problem encountered by space vehicles as they reenter the earth's atmosphere. The National Inventors Council has designated this as one of the primary problems which must be licked before safe aerospace travel can become a reality. Hallicrafters researchers demonstrated that a properly directed magnetic field will open an "electro-magnetic window," permitting the passage of radio waves through the friction-generated plasma sheath of charged air about the re-entering missile. The company is currently readying prototype hardware for testing during actual re-entry.

Other major Hallicrafters developments in aerospace electronics during the past year included:

(1) An Incremental Microwave Power Spectrum Analyzer (IPSA), which automatically plots and provides a continuous display of power and frequency measurements with laboratory accuracy under stationary, mobile, airborne and shipboard conditions. This makes it possible for the first time to monitor the output of ECM jammers in flight.

(2) A Code Translation Data System (CTDS 2400), for transmitting digital data between widely separated locations (e.g., missile test ranges). It transmits 2400 bits per second—the equivalent of 32 teletypewriters—over a single voice communication channel with a maximum error possibility of 1 bit in 10^5.

(3) A crystal-controlled multi-channel military-type single sideband (SSB) radio communications receiver for the 2.0 to 30-megacycle range with I-F and image rejection better than 70 db and sensitivity of 0.1 microvolt.

(4) A low-cost microwave pulse generator, for radar and electronic warfare applications, which produces millimicrosecond pulses at 1000-megacycle frequencies from conventional radio frequency signal generators. This device costs less than half that of previously available equipment and can also serve as a self-contained traveling-wave-tube amplifier or as a serrodyned amplifier for frequency translation.

Establishment of a new RFI (Radio Frequency Interference) design and consulting service for manufacturers of electronic equipment systems and sub-systems, an area in which design specifications are becoming more stringent.

During the past year, Hallicrafters was awarded military contracts covering production of electronic warfare equipment on military aircraft, support items, electronic penetration systems and an airborne target simulator system for use in testing Nike Zeus anti-missile missiles. The company also teamed with four other national concerns to form a task group for the construction, activation and maintenance of underground missile sites.

Hallicrafters remained a top supplier of airborne electronic warfare equipment. It was the leading Air Force contractor on QRC (Quick Reaction Capability), the continuous red tape-cutting government program calling for quick development of electronic hardware to meet new cold war situations.

Among the new products introduced by Hallicrafters during 1961 were:

—An airborne electronic timing set which permits time correlation of simultaneous recording processes at up to 10 or more separate locations or vehicles with precision within 1 second per day.

—A portable R-F calorimeter which, in field or lab, performs radio-frequency measurements on aircraft antennas to 1,500 watts average power at high accuracy.

—A mobile oil filter system for on-the-spot servicing of hydraulic equipment and heat exchangers on aerospace vehicles, particularly for electronic equipment cooling systems.

—A mobile hydraulic lift for installing heavy electronic gear through hatches onto aircraft.

—A portable electric cable tester for checking out aerospace electronic equipment in the field.

HARVEY ALUMINUM

Accelerated activity in space age programs coupled with vigorous corporate growth spurred the progress of Harvey Aluminum during 1961.

Primary aluminum capacity was increased 25% when additional reduction facilities were put into operation at The Dalles, Oregon. The company completed negotiations with the government for the acquisition of an aluminum wrought products plant in Adrian, Michigan, near Detroit. Installed in the plant was a 16,300 ton hydraulic forging press capable of producing large aluminum parts for aircraft and missiles. When placed in full operation, the facility will have an annual capacity of 25,000 tons.

Increased emphasis was directed to specially designed structural aluminum extrusions for ground support equipment and missile handling. Aluminum skin panels for the Titan and large diameter tubes for missile bodies and components continued in production. Aerospace applications for aluminum forgings, rings, and impact extrusions were plentiful.

In titanium, the company delivered extrusions, forgings, rod and bar, and billet to manufacturers of gas turbine engines and for the B-70 Minuteman, Polaris, Dyna-Soar, and certain NASA projects. High strength, high temperature resisting extrusions were produced in stainless, Inconel, and precipitation hardening steels for bulkhead rings, frames, and other components for such programs as the B-70 and Minuteman. Nuclear-grade titanium tubing was made for the New Plutonium Reactor and special titanium castings for the Polaris missile.

Unusual sizes of Zircaloy tubing, as large as 8 inches and as small as ½ inch in diameter, were extruded for uranium jacketing in nuclear reactors. These seamless tubes were used as the actual fuel element. Large diameter tubing also was produced in columbium for nuclear propulsion systems for aircraft.

A significant step was attained in the ingot conversion of refractory metals for aerospace vehicles during the year. In a joint effort between Harvey Aluminum research engineers and the Materials Central at the Aeronautical Systems Division, Experimental Metallurgical Plant, Dayton, Ohio, developments were accomplished in the extrusion of molybdenum alloys in the range of 4000° F and it was expected that the extrusion success will stimulate design concepts for the utilization of refractory metals in missiles, rockets, hypersonic aircraft, and satellites.

The company's research laboratories in Torrance, California, completed a noteworthy contract for the development of non-ablating re-entry materials utilizing plasma flame deposition.

HUCK MANUFACTURING COMPANY

The year 1961 saw a tremendous increase in the use of patented Huckbolt fasteners in aircraft and missile structural applications. In addition to providing a majority of the structural joint fastenings in the man-launching Redstone, Huckbolt fasteners were in extensive service in the outriggers and other key joints in the Saturn booster, in the Atlas, Titan II, Minuteman, and Polaris.

Huck Research and Development, in the field of fastener design and application, yielded two major new developments for aerospace—the Huck Blind Bolt and the Taper Huckbolt fastener. The main features of the new Huck Blind Bolt are: 1) ease of blind installation; 2) speed of installation; 3) 95,000 psi shear strength; 4) positive mechanical lock that keeps pins from vibrating loose. The major advantage of the Taper Huckbolt fastener is that it offers outstanding structural and sealing characteristics in wet wing applications, full AN bolt shear strength, and swaged-on collar that does not loosen under vibration.

Research in exotic metals, as well as laboratory and field tests to meet higher strength and temperature requirements, also received much of the attention of Huck engineers and metallurgists.

Installation Tool Development kept pace with the announcement of several improvement modifications for fastener installation and a new powerig to operate its line of hydraulic installation tools. Also under study: electric installation tools and remote power sources. The company also reported continuing interest in its precision ground, self-broaching Huckbolt Fastener—a unique design that broaches its own hole to provide leak-proof fastening for LOX tanks as well as other extremely critical applications.

JACK & HEINTZ

A DIVISION OF THE SIEGLER CORPORATION

The year 1961 saw the merger of Jack & Heintz into the Siegler Corporation to strengthen offerings to the aerospace market. Significant progress was made in the company's all electric VSCF generating system, its all electric drive system, rapid expansion of the quick connect coupling line, and continued growth in the commercial and executive aircraft market.

The VSCF, an all electric variable-speed constant-frequency generating system which eliminates the need for a conventional constant speed drive moved along rapidly.

During 1961, 40 KVA breadboard systems of the full rated type utilizing Secsyn brushless solid rotor generators were designed and built in the laboratory and demonstrated to representatives of the Air Force and to aircraft manufacturers.

Based on feasibility studies made in 1960 on an electric drive system for military and commercial vehicles, Jack & Heintz obtained a contract from OTAC in 1961 to equip an M34 truck with an electric drive system. This system replaces the mechanical transmission in the following manner: The vehicle engine drives an electric generator whose output is supplied to frequency changers (one for each powered wheel); the output of the frequency changer supplies an induction motor which is mounted in the wheel assembly. The speed of the wheels and the vehicle is varied by controlling the output of the frequency changer. The engine speed and the wheel speed are independent and controls are provided so that the engine automatically operates at the most economical fuel consumption point for the power demonstrated, regardless of the vehicle speed. The system offers advantages with regard to relative location of engine and wheels, reduced maintenance cost and the capability of using the engine and its generator as a mobile power plant to supply electric power at any frequency desired or supply direct current power.

Jack & Heintz continued its established product line of Quick Connect fluid couplings built around a unique locking pin in lieu of the more conventional ball bearing. This design innovation makes practical a compact coupling with extremely high pressure ratings, and is available in couplings with either rotating or axial moving collars for motivation of the locking mechanism.

The aviation Roto Lock coupling manufactured in aluminum and having a rotating collar was produced in self-sealing series or open series in sizes 1/4″ thru 6″.

The Jack & Heintz Trigger Lock coupling is a quality product line utilizing an axial collar which is triggered into lock position by inserting the nipple half of the coupling into the socket and is cocked for the next operation by an axial pull on the collar which releases the nipple. This coupling available in aluminum or stainless steel is produced in sizes from 1/4″ through 1 1/4″.

The Jack & Heintz GSE line of air handling couplings was being used extensively for connection of hot air to jet engine military aircraft to start the jet engines. From this original application, grew a product line of large diameter air handling couplings for cooling and heating of space vehicles prior to launch wherein the coupling can be disconnected automatically by use of explosive, pneumatic, or electric power.

Jack & Heintz expanded its penetration of the general aviation industry, with equipment on the JetStar, the F27 Friendship, the Grumman Gulfstream and the Aero Commander Executive Transport, and started a program of establishing aviation distributors. It was expected that this network, consisting of three distributors and their branch offices, would be established and operating by the end of 1961.

Kaiser system provides dynamic aerial pathway for pilots.

KAISER AIRCRAFT & ELECTRONICS

DIVISION OF KAISER INDUSTRIES CORPORATION

An increasing percentage of the volume of work at the machining plants of the Kaiser Aircraft & Electronics Division of Kaiser Industries Corporation in 1961 involved fabrication of missile components, primarily for Minuteman and Titan. Machining of large forgings for Boeing continued to comprise the major portion of aircraft component operations. Electronic plants of the Division in 1961 were primarily involved in the design and manufacture of initial quantities of the Kaiser Flite-Path aircraft instrumentation system for the Navy and Grumman Aircraft Engineering Corporation.

The production of rocket hardware, using various metals and plastics, included nozzles, thrust terminators, blast tube liners, rocket motor cases, insulation, aft closures, engine frames, pumps, manifold, and special tanks. In addition, the company also handled profile milling for missiles.

In addition to the Kaiser Flite-Path attitude and guidance instrument for aircraft, the firm was producing semi-automatic ground support equipment for missile and aircraft instrumentation systems, the Kaiser-Aiken thin cathode ray tube, transistorized video monitors, test trailers for ground checkout of turbodriven power supplies, aircraft display equipment using integrated information television readout, automatic universal encoder checkout equipment, and radar display instruments and simulators.

The company operated two electronic plants at Palo Alto, California, and one at Phoenix, Arizona, and machining plants for missile components at Richmond and San Leandro, California.

KOEHLER AIRCRAFT PRODUCTS COMPANY

The Koehler Aircraft Products Company, a subsidiary of New Britain Machine Company, made several major contributions to general aircraft, missiles and space fields during 1961.

The company developed the first high temperature liquid level control valve designed specifically for hydraulic fluids.

The float type valve that forms the basis for the system provides for efficient, single-point filling of oil reservoirs to predetermined levels in any programmed sequence desired. This method of "positive filling" insures delivery of the correct amount of oil every time. Since the filling operation can be completed in the shortest possible time and "full" lubrication or cooling capability is insured, maintenance can be reduced to a minimum. A warning signal indicates when level of fluid drops to danger point.

During the year, Koehler's Fuel-Level Control System was upgraded to handle the requirements of the most advanced aircraft now under development.

This system assures that any number of fuel tanks will be positively filled to the same predetermined level from a single source, on the ground.

In-flight, it also permits the shifting of fuel from tank to tank as required to control the airplane's c.g. It also has the capability of controlling in-flight refueling, and can be prechecked on the ground before operation of the system.

A line of high pressure ball valves was also developed to supplement the low pressure line that has established Koehler's pioneering position in the valve industry. The low pressure series was also expanded.

Initial valves have been utilized in missile ground support equipment delivering fluids at pressures up to 6000 psi.

Line sizes range from ¼" to 2" in high pressure valves and to 10 inches in diameter in the lower pressure versions. These stainless steel valves can operate in ambient temperatures from $-320°$ F to $+160°$F handling a wide range of fluids from gaseous nitrogen and nitrogen tetroxide to UDMH and liquid oxygen.

They can be manually or power operated, as required.

A lightweight flush type toilet was introduced by Koehler to provide business and executive aircraft with the most modern toilet facilities.

The Air-Lav is an extremely compact, lightweight recirculating flush toilet that operates automatically at the press of a button or lever.

LEAR, INCORPORATED

Expansion and development programs of Lear, Incorporated in 1961 were highlighted by a number of major accomplishments including new product development, new production and research facilities, intensified research in new fields and augmentation of Lear's established position as a leader in the aerospace industry.

Substantial improvement in Lear's financial position was indicated at the beginning of the year. Sales and earnings were the highest in the company's history. Working capital had increased more than two million dollars, and in spite of record sales for the previous year, the backlog at the beginning of 1961 had increased by $2-million.

New construction and expansion projects begun in 1961 and scheduled for completion by mid-1962 included a $3.5-million addition to the present Lear Instrument Division facilities at Grand Rapids, Michigan, and a new $1-million commercial hydraulic pump and motor manufacturing plant for the Lear-Romec Division at Elyria, Ohio. The addition to the Instrument Division's facilities was the second phase of a long-range modernization plan for the division. This further expansion will include a 51,000 square-foot addition to the present manufacturing plant and the construction of a new engineering test facility adjacent to the manufacturing building. Although the new Lear-Romec plant will be entirely devoted to the production of commercial gear pumps, the increase of facilities provides a greater overall flexibility in programming production to meet specific industrial and military product requirements.

Lear turned out thumbnail-size electronic amplifiers.

Research and development on microminiaturization through the company's Solid State Physics basic research program was proceeding ahead of schedule, and prototype applications were under test by major U.S. companies. Lear expected this program to make important contributions to the company's rapid expansion in electronic missile and space applications. Undergoing preproduction testing at year-end was a Lear designed and developed automatic vacuum deposition chamber, one of the industry's first high-volume production units for thin film microcircuitry. Coupled with their automatic production methods, the Solid State Physics Laboratory developed reliable techniques for evaporating single crystal semiconductor films and was working out processes to evaporate conventional transistors and diodes. Numerous thin film tunnel emission devices were also developed by the laboratory. This so-called tunnel emission device will be the next step in the evolution of microminiaturization of electronic components and systems.

Lear's lightweight, gas-driven inertial guidance system.

ASTRONICS DIVISION, SANTA MONICA, CALIFORNIA

In June of 1961, Lear and Sud Aviation of France announced that the two firms had signed an agreement for the development of a completely automatic landing system for the Caravelle jetliner. The primary objective of this program will be to lower minimum weather restrictions for aircraft operations and, secondly, to seek a method of providing safe, electronically-controlled, fully automatic landings.

Under development by Lear for several years, the autoland system will use either existing or improved signals for ground equipment which are fed by the landing computer into the autopilot. For this program, the Astronics Division equipped a B-26 type aircraft with a system that will serve as a "test bed" for the Caravelle installations.

First installations of a completely automatic flight control system in commercial passenger carrying helicopters will be made by Lear. A contract received in mid-1961 called for installation of Lear L-5H autopilots and command instrument systems in New York Airways' new fleet of Boeing Vertol V-107 25-passenger helicopters. The Astronics' four axes autopilot and the command instrument system will, for the first time, give helicopters Instrument Flight Rule (IFR) capability and with future system growth, automatic landings.

Also in the field of automatic flight control systems, Astronics' guidance and electrical system components for the DSN-1 drone helicopter successfully completed flight testing in 1961. Undergoing flight test at year-end was the DSN-3 turbine powered drone helicopter. Developed for the Navy's DASH (Drone Anti-Submarine Helicopter) weapon system program, the DSN-1 and DSN-3 will lengthen and strengthen naval capability in anti-submarine warfare.

Of major importance in strengthening Lear's position in the commercial air transport industry was the purchase of Lear L-102 autopilots by United Air Lines. Placed in domestic airline service in mid-year, they were the first installations of a Lear automatic flight control system on a major domestic airline.

Among the other systems in production at Astronics throughout the year were: two-axis stability augmentation system for the Northrop T-38 Talon; modular transistorized command maneuvering system for the Ryan Q-2C, Firebee drone target missile; and pitch dampers for the Fiat G-91, NATO tactical fighter.

INSTRUMENT DIVISION, GRAND RAPIDS, MICHIGAN

The year saw the Instrument Division continue to expand and consolidate its engineering and manufacturing facilities to remain one of the industry's most modern and well equipped manufacturers of precision components and systems for manned and unmanned flight vehicles.

Major 1961 products of the division included: flight indicators, gyro-stabilized platforms and compasses, automatic bombing systems, displacement and rate gyros, synchros and aircraft ground support and checkout equipment.

Continuing production of AJB all-attitude indicating and low-altitude bombing systems for the Navy's A4D-2N and F4H jet fighter-attack aircraft brought the total dollar value of the Instrument Division program to approximately $42-million. More than $1.25-million of an eight million dollar contract received in 1961 will be for AN/AJB system ground support equipment. Programming a low altitude toss or over the shoulder bombing maneuver, the AN/AJB system is unique in that it simultaneously provides the pilot with accurate easy-to-read compass headings, all-attitude information and bomb guidance on a single indicator. This indicator, the instrument panel portion of the system, is similar to the three-axis Lear Astra flight director-attitude indicator presently installed in the X-15, the world's fastest aircraft.

Conducting man/machine research in the relatively new control/display field for the past four years, the Instrument Division received two contracts in 1961 for aero/space design studies.

Under a contract received early in the year, the division's Advanced Engineering Department conducted studies for Project Apollo. Working with its teammates on the project, the division assisted in cockpit design and layout, writing the functional display design specifications and preparing the physical specifications for the vehicles instrumentation.

Initial research for the display portion of an anti-submarine warfare (ASW) data processing system was being carried on for the Naval Air Development Center. A member of a specialized team under the overall management of General Precision, Incorporated, Lear's control/display group will conduct a six months' study leading to the development of the ASW data processing and display system. The study will seek to define the necessary data processing and related display requirements of an airborne display system, requirements which when met, will materially improve detection and kill probability.

In the field of air traffic communications, the Lear Instrument Division received a contract to design and build the cockpit portion of the Federal Aviation Agency's AIDE (Airborne Insertion-Display Equipment). Both incoming and outgoing messages composed of letters and numbers reading from left to right in natural syntax will be presented on a single 4½" x 5½" display panel. The instrument will be capable of displaying 64 separate words and phrases, which coupled with four additional number-and-word readouts, offers an almost infinite number of message variables.

In addition to Lear autopilots entering service on United Airlines and New York Airways, the three largest helicopter airlines in the United States selected the division's Lear Integrated Flight Equipment (L.I.F.E. C.I.S.-100) for their new fleets of turbine-powered helicopters.

To meet the need of high-speed aircraft and space vehicles for a manual control device that can be operated under high "G" forces, the Instrument Division developed a three-axis force controller that

Lear was developing push-button air traffic communications display.

provides complete, reliable control by hand or wrist movements.

Lear's Instrument Division designed and developed, with company funds, a unique low-cost missile guidance system with accuracies comparable to systems costing up to ten times as much. The division was able to slash guidance costs by creating a simply-designed system specifically tailored to meet short-term flight requirements. Using gaspowered gyroscopes, ideal for relatively short trajectories, rather than conventional electrical gyros, Lear engineers have virtually eliminated costly and intricate electronics.

ELECTRO-MECHANICAL DIVISION, GRAND RAPIDS, MICHIGAN

Designing, manufacturing and marketing electric fractional horsepower motors, clutches, electrical, hydraulic and pneumatic actuators and control systems and precision servomechanisms, the E-M Division made numerous new product advances in the aerospace industry during 1961.

Although new products were an important part of the division's development in 1961, an 18-year old Lear electrical cowl flap actuator, used during World War II, received national attention.

Recovered by the Moody Institute of Science from the USAF B-24 bomber, "Lady Be Good," the actuator survived the bomber's crash landing more than 18 years ago in the Lybian Desert. Returned to Lear in mid-year, it was found that, despite exposure to sand, wind and blistering desert heat, the electro-mechanical actuator still meets or exceeds its original operating requirements.

For the missile market the Electro-Mechanical Division developed a clutch type servo actuator weighing less than a pound. The Series 3171 actuator was designed and developed for computer and missile applications which require a high degree of precision with relatively low power. Adaptable to a wide variety of instrument type applications, the servo provides high frequency response, high torque output and proportional torque control. Uses for the new servo actuator range from valve actuation and rocket nozzle control to optical or infra-red tracking devices and computers.

Among the continuing aerospace programs at the Lear Electro-Mechanical Division were contracts for jet engine air-inlet and trailing-edge flap systems for the F-105 fighter-bomber and guidance-fin servo actuators for the Sergeant missile. Contracts for the inlet and flap systems at year-end totaled more than $15-million.

LEAR-ROMEC DIVISION, ELYRIA, OHIO

Development and expansion of its standard product lines which include fuel boost pumps, lube/scavenger pumps for jet engines, pressurization and desiccator assemblies for radar units and servo valves for missile guidance were continued by the Lear-Romec Division in 1961.

Notable in the field of both military and commercial pump development was the perfection of encapsulated pumps for applications requiring submerged operations. Deliveries of such pumps for uses ranging from ground radar cooling systems to aircraft fuel systems were made starting early in the year.

New Lear-Romec miniature servo valves were produced in 1961 for the off-angle tracking radar system of the Navy F8U-2M aircraft.

LEAR SERVICE DIVISION, GRAND RAPIDS, MICHIGAN

Formed in January of 1960, the Service Division in 1961 had personnel stationed in 81 key domestic locations and eight foreign countries.

World-wide service, maintenance and modification contracts were received by the Service Division in August, 1961, from the USAF Air Material Area at Oklahoma City, and the Army Transportation Material Command at St. Louis. Under the terms of the contracts, Lear will, on a world-wide basis, maintain, modify and up-date USAF, Air National Guard and Army aircraft.

LEAR'S EUROPEAN SUBSIDIARIES

Overseas, Lear, Incorporated continued its expansion. In May of 1961, construction was completed on a "clean room" for Lear's wholly owned subsidiary: Lear Electronic, GmbH at Munich, West Germany. The new facility is the largest of its kind in South Germany.

Presently the only manufacturer of ADF's (Automatic Direction Finders) in the Federal Republic of Germany, Lear Electronic also designs, manufactures, repairs and overhauls more than 30 different products.

Another Lear subsidiary, Alliance de Production Electro-Mecanique, S.A. (APEM), is located in Geneva, Switzerland. The Swiss distributor for all Lear products, APEM develops and manufactures miniature electro-mechanical components.

Honeywell's new facility has 16 analog computers and a Honeywell 800 digital data processing system.

MINNEAPOLIS-HONEYWELL

MILITARY PRODUCTS GROUP

Honeywell's Aeronautical Division opened a new $5 million aerospace facility for the development and production of guidance and control systems for space vehicles. The facility was officially dedicated in November by Deputy Secretary of Defense Roswell Gilpatric.

The facility includes:

A space simulator weighing two tons yet so delicately balanced on an air bearing that it is visibly deflected by the weight of a fly landing on it.

An elaborate computer center, manned by a staff of 117 people, which is said to be the only one in industry that can perform scientific work of an analog-digital nature while simultaneously solving business problems.

Machines so accurate they would be thrown off by a half a degree change in temperature in the rooms where they are located. When the operator leaves the room he turns on a tiny heater to compensate for the loss of his body temperature.

In conjunction with the opening, Honeywell took the wraps off two examples of the kind of products that will be made in the new facility—a miniature electrically suspended gyroscope which promises greatly improved accuracy for space vehicle guidance, and a new autopilot that "thinks for itself" to safely steer a human pilot through the dangerous regions at the fringe of space.

The new gyro has only one moving part, a hollow beryllium sphere not much larger than a ping-pong ball. It is held in suspension in a vacuum—inside a ceramic casing—by means of a high voltage electrostatic field. This virtually eliminates friction, which causes gyro inaccuracies.

The sphere is spun up to high speed by a rotating magnetic field which then is cut off, permitting the sphere to spin unassisted for many months.

Honeywell, which is building bigger versions of electrically suspended gyros for use in Polaris submarine navigation, succeeded in miniaturizing the device to the point where it is as small as conventional gyros used in today's space missions.

The new autopilot, termed an adaptive flight control system, has the unique ability to sense the conditions around the vehicle it controls and to automatically adapt the performance of the vehicle to meet those conditions.

Honeywell scientists said the adaptive is the first flight control system capable of blending aerodynamic and reaction controls at the critical time in manned space flight when the craft emerges from the earth's atmosphere where aerodynamic controls become ineffective and reaction controls must provide the necessary control.

Honeywell has been at work on the adaptive flight control system for the past six years. The system has been successfully flight tested for more than 300 hours in jet aircraft and was slated for test in the hypersonic X-15.

The advanced technology required to design and build interplanetary guidance equipment is underscored by the powerful computer center in the new facility, which includes a large-scale Honeywell 800 electronic data processing system and 16 analog computers. The Honeywell 800 can handle information at the rate of two million decimal digits per second.

Honeywell spent $750,000 perfecting its clean rooms technology.

Airborne contamination has been reduced to less than 5,000 particles of over .3 of a micron in size per cubic foot of air (a single particle of cocoa or face powder measures 5 to 10 microns). The air in the halls outside these rooms, normal air, contains nearly a million such particles per cubic foot.

Honeywell's expanding overseas operations made new progress in August when the company announced it had reached agreement with British Aircraft Corporation to form a joint organization to develop, manufacture and market inertial guidance systems for aircraft and missiles in Europe.

The organization is called "Inertial Guidance—Europe" and will headquarter in Paris with a staff of representatives from both companies. The companies will participate jointly in all facets of the program, including marketing, development, design, production and field service.

The Duarte, Calif., engineering facility of Honeywell's Ordnance Division received a significant contract during the year from NASA's Goddard Space Flight Center for the design and construction of a space environment facility at Greenbelt, Maryland.

The contract involves two space chambers to checkout and test large spacecraft. It was believed that the chambers when completed would be the largest in the nation. They were scheduled to be in operation by October 31, 1962.

The Ordnance Division also introduced a family of solid state magnetic core oscillators for which it claimed state-of-the-art advances in accuracy, reliability and miniaturization. The oscillators, or timers, have applications in projectiles, missiles, space vehicles and satellites.

Other work at Honeywell Ordnance included delivery of a $1,000,000 shorebased trainer for the Navy's ASROC anti-submarine weapons system and delivery of a big semi-automatic teletypewriter message distribution system to the Army Signal Corps at Fort Gordon, Georgia.

Some major contracts received by the company during the year included:

Primary and secondary inertial navigation subsystems for the Dyna-Soar maned space glider, work to be done at the Aeronautical Division facility in St. Petersburg, Fla.

The flight control system for Dyna-Soar, work to be done at the Aeronautical Division in Minneapolis.

Inertial guidance system for Saturn, to be developed at St. Petersburg.

Inertial guidance system for the Air Force's Satellite Inspector Program, to be developed at St. Petersburg.

Ground Support Equipment for the Atlas "F" series, to be produced at the Special Systems Division in Pottstown, Pa.

Follow-on production order for Centaur inertial guidance systems, to be built at St. Petersburg.

Other important projects which continued during the year at Honeywell included:

Production of the ASROC missile, an anti-submarine rocket system developed for the Navy's Bureau of Weapons, under technical direction of the Naval Ordnance Test Station. Honeywell's Ordnance Division is prime contractor.

Development of a super-accurate shipboard inertial navigation system for Polaris missile-fiirng submarines, based on Honeywell's new electrically suspended gyroscope. The only moving part in the new gyro is a beryllium sphere machined to accuracies better than 5 millionths of an inch.

Development and construction of an advanced aerospace reconnaissance systems dynamic analyzer for the Aerial Reconnaissance Laboratory of the Wright Air Development Division. The sophisticated device will simultaneously create the heat, cold, vacuum, vibration and roll, pitch and yaw encountered by space vehicles.

Development of a nuclear submarine training center which will electronically simulate full-scale sea battles to train the crews of Polaris-armed and other nuclear submarines in the tactics of underseas warfare. The trainer, utilizing a giant computer and advanced electronic techniques, was being built for the Naval Training Devices Center.

Development and production of miniaturized inertial guidance systems for an Army surveillance drone being built by Fairchild Aircraft and Missiles Division.

Development and production of guidance and stabilization systems for the Scout and Blue Scout multi-purpose space vehicles. Honeywell's system includes new ultra-accurate gyroscopes, servo control systems, a programmer, and hydrogen-peroxide reaction controls.

Development and production of guidance reference systems for the Titan missile. The Titan reference system, an advanced version of the "strap down" concept, provides the electronic brainwork for the first two minutes of flight of the Titan.

Production of inertial guidance platforms for the Polaris missile. Honeywell was teamed with Hughes Aircraft as a second source supplier of this system.

For Project Mercury, Honeywell produced the attitude stabilization and control system for the space capsule, an attitude and rate indicating system, an earth path indicator, ground support equipment and was also responsible for extensive human factors studies.

MOTOROLA INC.

MILITARY ELECTRONICS DIVISION

Motorola Military Electronics Division increased its activity in the aerospace field in 1961. The division's range of interest included missile and space systems instrumentation and controls, military communications systems and equipment, radar and microwave, aircraft navigation and control, electronic warfare, undersea warfare programs and devices, solid state electronics, systems management and studies and research.

Large scale manufacturing of radar, communication, guidance, and control equipment continued, and research and development work in these and other fields continued. Creation of the new Space Technology Group at Western Military Center in addition to Division direction of work in this area reflected the heightened interest. A new clean room was installed at this Center and additional test range facilities were acquired.

Ranger spacecraft rely on the performance of Motorola electronic equipment including a Flight Data Encoder and an all solid state airborne transponder consisting of an extremely narrow band phase-locked receiver and an integrally related transmitter.

Comprehensive measurements of operational and navigational data aboard the Ranger will be assembled for transmission by the Flight Data Encoder. The transponder will generate the telemetry carrier, receive ground commands, and translate carrier frequencies for two-way Doppler velocity measurements.

The NASA Project Mercury spacecraft used Motorola's Command Receivers designed to pick up vital control and emergency signals from earth.

In 1961, transponders were being produced for numerous contractors, all branches of the military service, and NASA. Applications included any stage of any tactical, intermediate, strategic or deep space missile, including the satellite or vehicle itself. Transponders also were developed for aircraft and shipboard installations.

Command receivers, transponders, and telemetry equipment saw failure-free service in many other missiles and space vehicles including Mercury, Polaris, Minuteman, Ranger, Bomarc, Pershing, Skybolt, etc. Motorola equipment for the Pioneer V space probe helped track the vehicle the unprecedented distance of 22,500,000 miles. ADVENT and other forthcoming vehicles will also carry Motorola equipment.

Motorola received a contract to develop and produce high-power C-band pulse transponders for the Air Force Missile Test Center at Patrick AF Base, Florida. An initial quantity of four prototype transponders will be developed by the company's Western Center in Scottsdale, Arizona. The new transponder will have applications for scientific missile and satellite tracking.

Two concurrent contract awards for precision satellite tracking equipment were received by the Military Electronics Division from a prime contractor to the Air Force. The first contract involved a quantity of UHF Doppler tracking receivers to be installed at Air Force tracking stations for gathering critical distance and velocity information from orbiting communications satellites. The second award was for a number of Doppler and Monopulse Tracking Subsystems that will be used to update tracking systems now in service. The receivers employ the principle of "phase-lock" detection to their ability to receive faint signals coming from extremely long distances.

Western Center was also awarded a contract by The Boeing Company for additional equipment used in the Air Force Minuteman missile flight test program. The new contract will provide Boeing with additional units of the Motorola Command Receiver.

Production was underway on the USC/3, a new Army combat communications system, first units of which were scheduled for delivery to the Army Signal Supply Agency late in 1961. The USC/3 Communications Central (formerly AN/MRC-66), a mobile, single side-band system, provides far greater reliability and communications flexibility than conventional telephones. Additional contracts were received for the AN/URC-10 high-powered air-sea rescue set. Motorola was also developing a helmet radio.

The TP3000 Teleprinter was developed at Chicago Center and was being manufactured under contract for the 465L SAC Central System. This non-impact teleprinter features solid state circuitry for high reliability with separate translator and printer for flexibility and economy.

The Systems Research Laboratory in Riverside, California, announced the availability of the first low-cost MIL-E-5400 Broadband VHF Amplifier. Weighing less than six ounces and costing less than $600, the miniature Motorola LPDO1 Amplifier is a rugged, plug-in module that can be readily cascaded for increased gain requirements.

Motorola drew from extensive experience in microwave systems to develop a new militarized radar relay system for the Air Force. The FRQ-11 Data Link System, installed at Bunker Hill AFB, was the first military-approved system of its type.

Similar data links will be installed at a number of military bases throughout the world. Another such system was in operation at Edwards AFB, its uses including X-15 flight data acquisition and relay.

The antenna and subminiaturized r-f circuitry for the tracking seeker for a new Navy air-to-air missile was designed and in production. Model airframe pattern studies were conducted, including studies for jet drone targets to test and evaluate missile systems designed to combat low-flying aircraft.

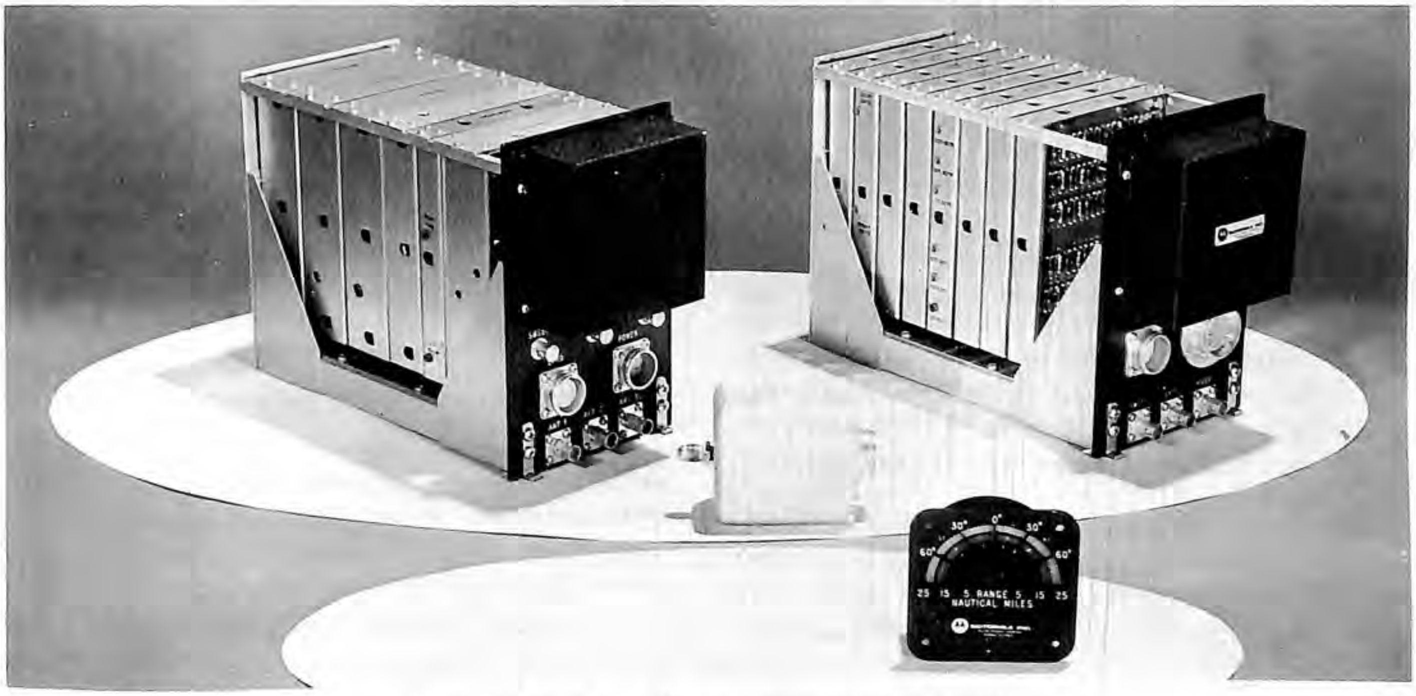
A transistorized 10-inch radar repeater was being developed for the Navy. This indicator, which is completely transistorized except for the display tube, was designed to utilize the advantages offered by solid state circuitry.

A "Velocity Filter" for radar targets was developed under contract with RADC, and Motorola continued this work to produce a complete radar detection, fixing, and tracking system capable of handling thousands of targets simultaneously. Called DECOR, the tracker uses data processing techniques and is being demonstrated for other military organizations.

A long-range surveillance Drone Navigation and Control System was developed by Motorola for the Army Signal Corps R & D Agency. This feasibility program is providing a drone capability with an inherent operational accuracy many times greater than any present system designed for the same mission.

As a sub-contractor to General Dynamics/Fort Worth, Motorola was providing navigational aids, including air-to-air and air-to-ground IFF, for the B-58 weapon system. Motorola's Military Electronics Division was presented a special commendation from GD/FW for "significant contribution" to production of the B-58. Other important programs included ground checkout adaptors for the Skybolt missile and an advanced guidance head for the Sidewinder missile.

Motorola completed development of a Pilot Warning Indicator system and delivered it to the FAA for evaluation. This system is designed to provide a pilot with range and bearing of any aircraft in his vicinity.



Motorola's Proximity Warning Indicator for aircraft.

ACCESS, for AirCraft Communications Electronic Signaling System, was developed by Motorola Chicago Center and General Precision Incorporated and proposed to FAA. A compatible digital system, usable by all types of aircraft, ACCESS provides a system capable of handling the projected increase in air traffic communications, with the fast reaction necessary for higher speed aircraft now beginning to appear.

Motorola's Systems Research Laboratory developed an electronic method for the transduction and digital encoding of altitude information. The system provides digital information in serialized form from aircraft interrogated by a ground station. A pilot model encoder was tested to an altitude of 60,000 feet.

The Motorola digital command system developed for the Gyrodyne DSN-3 helicopter was successfully demonstrated. Delivery of deck and CIC controllers, encoders, and airborne decoders is in process.

Motorola delivered to the Navy a number of AN/URS-1 surface equipments of a tracking system designed to provide a real time ink-plot of a target drone flight path. With the aid of this plot and telemetered data on altitude, a drone controller can fly drone aircraft to out-of-sight regions. A production run of the AN/DRT-1 airborne equipments is currently underway.

Motorola's Aviation Electronics, Inc., opened its new Culver City facility January 27th. Aviation Electronics introduced the ADFT-12, a miniaturized airborne direction finder featuring all solid state circuitry. ADF-12 equipment has logged more hours than all other direction finders.

The M-135 Navigation/Communication system featuring reliability, versatility, and add-ability, was improved by extensive redesign to furnish a clear signal over extended range.

The Motorola L-2 autopilot was certified for the Aero-Commander 680-F. Announced in September was the new M-4 automatic flight control system.

A complete system of passive detection antennas was developed and placed in production for the A3J supersonic military aircraft. This system consists of several antenna assemblies for flush mounted installation.

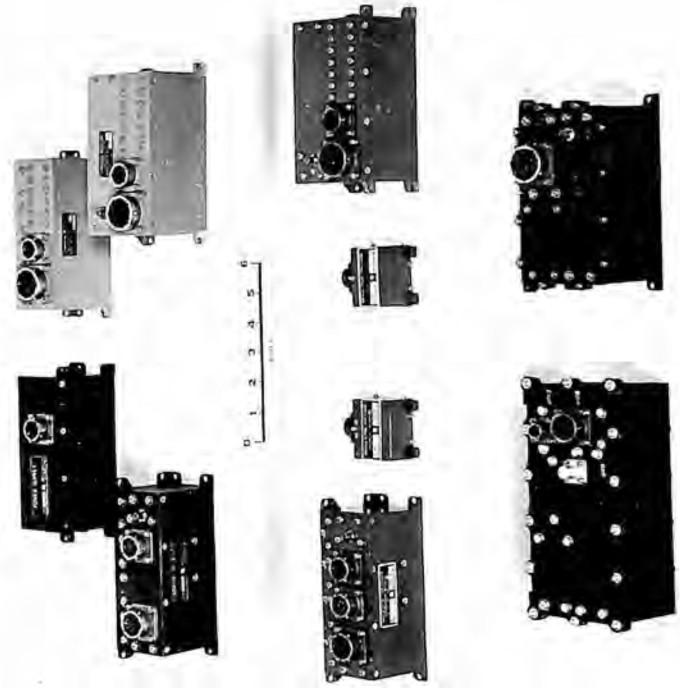
Production of tracker-jammer equipment on a follow-on basis was being carried out, along with manufacture of the ALQ-17 deception equipment. Manpack deception equipment was developed for the Signal Corps.

Sonobuoy antisubmarine devices were in production, and development work was underway on other sophisticated systems in the undersea warfare classification. In September, Motorola received a $6.5 million dollar follow-on contract for the Sonobuoy.

Motorola's Solid State Electronics Department was engaged in technical and product support for items to meet specific military program requirements and for industrial use. Contributions included special isolators, circulators, switching circulators and switches, and parametric and tunnel diode low-noise amplifiers. A significant recent accomplishment was the development of a high-speed, high-power, multi-element, switching matrix.

Motorola engineers were developing extremely reliable instrumentation and control systems that will, for the first time, take full advantage of the latest solid state material, device and circuit advances.

Multiaperture ferrite logic cores were developed



Motorola Command Receivers and associated equipment.

by the Solid State Electronics Departments and new logic techniques implemented. Thin-film electronics research led to development of practical circuits such as two-stage amplifiers and stairstep generators.

A new and versatile bismuth magnetoresistive device developed by the Solid State Electronics Department Integrated Circuits Laboratory can be used as a resistor, analog multiplier, voltage chopper; or a nonmoving-contact potentiometer. Other advances include positive-temperature-coefficient thermistors, and spiral air-core inductors.

Motorola joined forces with the Douglas Aircraft Company in a joint study to establish next-generation design criteria and maintenance philosophy for Air Force weapons systems.

A $1.5 million dollar R & D contract for integrated circuit techniques was received from the Air Force. This advanced work will be done jointly by Motorola Solid State Electronics Department and Semiconductor Division. Other research contracts include thermal design studies for the Navy.

The Motorola Data Systems Laboratory was awarded a follow-on contract related to the prediction of the remaining life in electronic equipment. In the final report on the original contract, Motorola delineated a life prediction concept featuring computer-analysis of accurate data on equipment failure mechanisms. Under the new contract, Motorola will conduct a field test program to prove out the effectiveness of the life prediction concept.

The Solid State Integrated Circuits Laboratory under contract to BuShips will study new approaches to the development of thin-film and ferrite inductors on ferrite substrates and to put thin-film inductors on glass substrates. Goals for the first month of the program included review of available ferrite substrate materials, formation of inductor coils on ferrite material and on glass substrates, and calculation of inductance values that would be compatible with the required substrate form factor.

A study to establish evaluation techniques and methods for latest thermal design advances in airborne electronic equipment was in progress at the Military Electronics Division under contract to the Navy Bureau of Weapons.

The Radar Systems Laboratory at Motorola's Western Military Center established a formal program of circuit technique investigation. The studies will concentrate initially on radar transponders, small missile systems, and antennas, and those showing promising results will be applied to the Laboratory's future development programs.

MOTOROLA WESTERN CENTER

During early 1961, Motorola Western Center was expediting development of the Mission and Traffic Control Subsystem AN/ASQ-43 and associated Aerospace Ground Equipment (AGE) for the B-70 Weapon System. In the role of system manager for the AN/ASQ-43, they were responsible for development and control of the various functions; i.e., Short and Long Distance Communications, Instrument Landing System (ILS), Radio Navigation Aids, Rendezvous Beacon, IFF and Integrated Controls and Displays, whether the functions were an in-house or subcontracted effort.

The M&TC Subsystem design was considerably sophisticated, highly transistorized, utilized modular construction and incorporated the very latest techniques known to the CNI (Communication, Navigation and Identification) field. The AN/ASQ-43 was to be truly the forerunner of tomorrow's generation of aerospace CNI systems as it would meet the requirements of present and all foreseeable aerospace vehicle applications.

Until 1958, the integrated subsystem approach to development of CNI systems had never been implemented. Motorola Western Center was first to use this approach, coupled with advanced systems management techniques, to design and develop an integrated subsystem tailored in the aspects of volume, size, weight, power and cooling into the aerospace vehicle in an optimized design providing required functions with high reliability and at minimum cost.

The associated AGE was of the automatic type, compatible with the Programmer-Comparator AN/GJQ-9, and comprehensive enough to satisfy all requirements for flight line, shop and depot maintenance.

Even though the B-70 Weapon System was reoriented to an experimental program and the M&TC subsystem program was cancelled in the first half of 1961, Motorola continued to monitor the B-70 program, its progress and changes in philosophy.

SEMICONDUCTOR PRODUCTS DIVISION

Research, expansion and diversification marked significant milestones in the history of Motorola's Semiconductor Products Division, located in Phoenix, Arizona, during 1961.

Already a leading manufacturer of semiconductor devices towards the end of 1960, Motorola SPD entered the New Year as the first concern to develop practical production methods for the epitaxial growth process (a technique which had been proposed earlier by Bell Laboratories). This new process for semiconductor fabrication, called one of the outstanding new developments in the electronics field, not only has resulted in improved transistor performance, but paves the way for the production of far more complex electronic devices such as integrated circuits. During the year, Motorola turned to the epitaxial process for the fabrication of all its silicon transistors and was in the process of converting its high-frequency germanium transistor line as well.

In May, Motorola received a $1.5 million Air Force contract for the development of integrated circuits. This led to additional progress in the epitaxial field and resulted in the ability to grow multiplayer crystal films. Additional research into new methods of encapsulating semiconductor devices by application of advanced surface passivation techniques has yielded practical results.

By October 1961, Motorola announced that it had developed several practical integrated circuit devices for both military and commercial applications. These devices were unique in the industry in that they could be used to replace conventional circuits in existing equipment rather than forcing the design of new equipmet conforming to the requirements of the integrated circuits.

With a view towards optimizing transistor performance, the company, during the year, completed an investigation into the effects of moisture on transistor parameters. Results showed that a controlled amount of moisture within a transistor can actually improve device performance. Incorporation of the resulting concepts in some of the company's power transistor lines yielded transistor power gain improvement of 3 to 4 db while substantially reducing low-voltage saturation current.

In the area of semiconductor production, Motorola, in 1961, greatly expanded its production facilities. Special emphasis placed on a mesa mechanization program achieved its projected goal of a production capability in excess of one unit per second. A significant factor in reaching this goal was the development of an automatic tester, MASCOT (Motorola Automatic Sequential Computer Operated Tester), capable of completing the entire job of testing, selecting and sorting 28,000 transistors in a single unit. The tester not only checks DC transistor parameters, but is capable of dynamic tests involving frequencies as high as 300 megacycles and switching speeds as low as a few nanoseconds. The unit automatically tests up to 40 transistor parameters and separates the tested units into as many as 38 different classifications to meet individual customer requirements.

To handle its expanding research and production facilities, Motorola's Semiconductor Products Division, in May, expanded its plant through the addition of a 315,000 square foot area which more than doubled its previous size.

THE NEW YORK AIR BRAKE COMPANY

WATERTOWN DIVISION

The state of the art in hydraulic jet engine starters was advanced significantly and a new high in reliability and compactness of hydrostatic transmissions for a variety of ground support equipment was achieved during 1961 by the Watertown Division of The New York Air Brake Company.

The tiny starter, the first ever designed to a Navy MIL specification, went on qualification tests in mid-year. By the year's end, it had shown immediate and repeated starts of the T-58 GE engine, and of the T-62 Solar and Airesearch GTP30 auxiliary power units, even under the stringent conditions of −65° F. The units being tested were operational models.

The starter can be supplied as a self-contained system, if required, permitting in-flight restarting in case of engine flame-out. Unlimited starts also are feasible, and costs are competitive with pneumatic, electric, or combustion starting.

The DYNAPOWER hydrostatic transmission system, introduced early in the year attracted the attention of a wide variety of potential users. Its capability of applying stepless, precisely controlled power in either direction over a broad speed range, and of producing maximum torque at low engine speeds—even while idling—made it most attractive to manufacturers of any equipment embodying such torque and speed characteristics as operational essentials.

Watertown introduced new Dynapower hydrostatic transmission.

Interest in DYNAPOWER was so active and widespread that models both larger and smaller than the one first introduced were in development stages at the end of the year. At least one was scheduled for 1962 announcement.

PACIFIC AIRMOTIVE CORPORATION

Turbine engine overhaul production at Pacific Airmotive Corporation's main plant in Burbank, California, trebled during the closing months of 1961, compared with the monthly average for the first seven months. Principal reason for the increase in volume was the addition of two new engines to the company's overhaul workload on Pratt & Whitney turbojet and Rolls-Royce Dart turboprop engines.

Under contract with Western Air Lines, PAC began overhaul of P&WA JT3D turbofan engines for Boeing 720B transports in July. The steady buildup of production volume on the engine paralleled this carrier's activation of additional new aircraft and supplemented overhaul of JT3C turbojet engines for Western's Boeing 707s.

The only franchised agency in North America authorized to overhaul and test Rolls-Royce Tyne turboprop engines, PAC began work on this 5700-horsepower engine late in May. Production schedules called for the overhaul of 10 Tyne engines a month by year-end in order to support the first five Canadair CL-44 aircraft placed in operation by Flying Tigers in 1961. This volume was to accelerate as this carrier accepts delivery of the additional five aircraft presently on order.

Production was expected to begin early in January 1962 under a contract to overhaul Tyne engines for Slick Airways. Two of the four CL-44s this carrier had on order were scheduled for delivery late in 1961.

During 1961, PAC realized the highest engine overhaul production volume since 1952, and all of the contract work was for commercial customers. In addition to JT3C turbojet overhaul for Continental Air Lines' 707s, the company continued to overhaul in excess of 40 piston engines a month. More than half of this work was for foreign airlines which are now operating piston-powered aircraft released by U. S. carriers as jet planes were placed in service.

Rework and modification began on Pratt & Whitney's J52 turbojet engine for the Hound Dog missile. Additional volume was represented by rework of P&WA's JT12 turbojet for the Lockheed Jet Star.

Five Convair 440 aircraft were converted to the Allison turboprop engine configuration under contract with the Federal Aviation Agency. Four of these planes were delivered from 20 to 5 days ahead of schedule and the fifth airplane was delivered exactly on schedule. FAA will use their converted Convairs in monitoring intermediate altitude navigation systems. Two Allison-Convair conversions were also delivered to corporate customers during the year.

PAC was supplying "Spraymat" electro-thermal, anti-icing systems for engine inlet ducts on Lockheed F-104G Starfighters being built for Italy, West Germany and the Netherlands under the NATO program. Valued at approximately $1 million, these new orders supplemented a half-million dollar backlog of similar equipment for F-104s being built by Lockheed and Canadair.

European deliveries were to be made to the Fiat company in Torino for the Italian-produced F-104s and to Westfalische Metall Industrie, Lippstadt, Germany, suppliers of Focke-Wulf, Bremen, Germany, and Siebelwerke, Donauworth, Germany.

In addition to Spraymat production, PAC's Flight Support Division in Culver City, California, continued to build specialized hydraulic, pneumatic and electrical test equipment for testing aircraft engines and systems. A major assignment was the complete installation of a large fuel facility at Tinker Air Force Base, Oklahoma City. Non-military customers included U. S. and foreign airlines and components and aircraft manufacturers.

The company's distribution activities increased approximately 20 percent over 1960. Provisioning of United Air Lines' Caravelle fleet represented a major program at one location. New distributor agreements were signed with the South Wind Division of Stewart-Warner Corp. and with Jack & Heinz, Inc.

Sales to the general aviation market increased appreciably at mid-year. A joint program with aircraft component manufacturers resulted in the establishment of the Aviation Quality Council program to eliminate the use of bogus parts and jerry-built service in the maintenance of private and business aircraft. Within the first eight months, 39 manufacturers and 94 associate distributors or dealers had joined with PAC in the Quality Council program.

In August, PAC established the International Division to handle the company's aircraft, engine and parts supply activities in foreign markets. This new division absorbed the activities and personnel of Pacair, Inc., a wholly owned subsidiary of PAC since 1955. To augment the coverage of agents and representatives in 30 countries, regional managers were appointed for South America, Europe and the Far East.

REEVES INSTRUMENT CORPORATION

The year 1961 again saw a marked increase in radar systems development and production at Reeves Instrument Corporation. Particularly significant was an improved design of the VERLORT (Very Long Range Tracking) radars originally developed for the Discoverer satellite program. The newly designed system is capable of tracking to ranges beyond 5000 miles, and employs wide-band parametric amplifiers capable of covering the entire operating spectrum without tuning. The reflector and scanner of the radar are mounted on a high precision two-axis pedestal which has a tracking accuracy of 0.1 milliradians.

In addition to the VERLORT radars, Reeves was also producing a large number of radar bomb scoring systems, as well as radar drone control systems.

Reeves in 1961 had under development a miniaturized three-axis stable platform whose outer gimbal measures only six inches in diameter. Designed for use in coordinate transformation systems, the platforms employ size 5 pancake resolvers of special design. The resolvers are mounted directly to the gimbal structures, thereby eliminating the need for additional shafting or gearing. Gimbal drive is provided by integrally mounted d.c. torquer motors. This type of motor design conserves both weight and space, and also requires no gear trains. The platform uses Reeves' designed 12IG gyros. These gyros, which measure only 1.2 inches in diameter and weigh under six ounces, have a trimmed drift rate of 0.1 degrees/hour.

Reeves also developed an extremely accurate gyro rate package, utilizing the Reeves' D30S gyro, which was used in the inertial reference packages of the Discoverer satellites. This rate package is used in the NIMBUS weather satellite. The servo loop around the gyro consists of a preamplifier and a power amplifier, both of which are fully transistorized and encapsulated; a noise filter between the preamplifier and power amplifier; and a demodulator for feeding the d.c. control winding of the torque motor. A separate proportional temperature control amplifier for regulating the temperature of the gyro heater block is also supplied.

Other designs in the inertial gyro field include a permanent magnet torquer version of the Reeves Zero-One gyro, which has a trimmed drift rate of 0.01 degrees/hour. An inertial reference package consisting of three Zero-One gyros and two size 12 accelerometers, with d.c. torque motor drive, has been developed for use in Schuler-tuned systems.

Reeves had in production a number of new resolver designs for specialized and highly accurate applications. Two of the designs, housed in standard size 23 cases, include a compensated unit for computing applications which has an accuracy of 0.01%; and a data transmission unit with 20 second accuracy. In 1961, Reeves also put into production a series of pancake resolvers with beryllium housings. These resolvers are extremely accurate; and, because of their beryllium housings, extremely stable over a wide range of ambient temperatures. One resolver in this series, designed for high accuracy computed chain applications, has a functional accuracy of 0.005%. The rotor of this unit includes an integral Class III precision gear, thereby simplifying its installation into a chain.

During the year, Reeves placed in operation a very high precision specialized machine shop area. The area is completely enclosed, and dust-filtered and air-conditioned. The 2800 square foot area was established to meet Reeves' production requirements for exteremely high precision parts for its inertial gyros and specialized resolver developments. Equipment is available for performing all types of machining operations, to tolerances of 15 millionths and better. In addition to the conventional metals, beryllium, titanium, and other exotic metals can be machined to the same exacting tolerances. An adjacent inspection area has equipment for performing roundness, perpendicularity and concentricity checks to accuracies better than 4 millionths. The facilities of this shop are available to the industry on a job basis.

Reeves systems and components are being used in most of the major missile and satellite programs, including Discoverer, Mercury, Midas, Atlas, and Titan.

THE ROHR CORPORATION

During 1961 Rohr put into operation several new processes and machines resulting from research and development programs initiated in previous years. These new developments reflected the company's greater diversification, as well as the continuing effort to maintain technical skills at a level compatible with advancements throughout the industry.

While emphasis on production of missile and spacecraft components continued to increase, Rohr's production volume on conventional aircraft components remained high.

Accelerated production of military airlift was reflected in Rohr's order files, with a contract for production of turbofan engine pods and pylons for the new Lockheed C-141 logistics transport as well as follow-on orders for pods and other components for the Boeing C-135 and the Lockheed C-130. Other military production included manufacture of pods, struts, stabilizers and other components for the Boeing KC-135 jet tanker, pods and struts for the Boeing B-52H and propjet power packs for the Navy's new P3V propjet anti-submarine aircraft. Further refinements in the manufacture of brazed stainless steel honeycomb sandwich structures were applied to manufacture of these high strength, heat resistant panels for the McDonnell F4H Navy fighter-interceptor, the Convair B-58 Hustler and the North American B-70.

Rohr designed and built new numerically controlled filament winding machine.

Commercial production during the year included manufacture of pods, struts, stabilizers, aft sections, sound suppressors and thrust reversers for the Boeing family of turbojet and turbofan airliners; pods and struts for the Convair 880 airliner and twin turbojet pods and thrust reversers for the Lockheed JetStar executive-military transport. Preliminary work also started during the year on components for the new Boeing 727 short-to-medium range airliner.

In the rocket, missile and space component fields, Rohr participated in a number of new programs during the year. The company produced filament wound components for the Lockheed Polaris missile and heat shields for the Lockheed Agena satellite. For Atlantic Research Corporation Rohr manufactured fins for the Iris and Arcas sounding rockets, employing both adhesive bonding and conventional structure.

Production was completed during the year on the company's first large antenna structure—a 60-foot reflector manufactured by Rohr as a subcontractor to the Hufford Division of the Siegler Corporation, El Segundo, California. Rohr research efforts in this field led to a number of design improvements now incorporated in pending antenna proposals.

The company accomplished a major advancement in the art of filament winding during the year, designing, building and putting into production a numerically controlled filament winding machine capable of producing engine cases for the largest intercontinental missiles.

Substantial advancements also were made in the field of high energy forming. Electrical discharge forming was developed into a usable production method. Production of stainless steel honeycomb core was improved through utilization of additional Rohr-developed core making machines.

In cooperation with the Remington Rand Univac Division of Sperry Rand Corporation, Rohr developed a numerical control programming system for machine tools suitable for use with small to medium scale computers. This programming system, introduced in September, is expected to make numerical control benefits available to a much larger segment of the machine tool industry. Development of this programming system was accompanied by other refinements in the utilization of numerically controlled equipment.

At the end of the fiscal year, Rohr's production facilities covered 2,060,193 square feet in manufacturing plants at Chula Vista and Riverside, California, and in assembly plants at Auburn, Washington, and Winder, Georgia.

SOLAR

A SUBSIDIARY OF INTERNATIONAL HARVESTER COMPANY

Since becoming a subsidiary of International Harvester Company in early 1960, Solar continued to make progress and diversify its activities in the aerospace field. During the year, Solar intensified its research and development program and made significant achievements in the areas of high temperature brazing and space age metallurgy. Production was increased in auxiliary power units and the manufacture of aircraft components. Additionally, a new gas turbine was introduced and adapted to aircraft ground support.

In 1961 Solar's experience in metallurgy and brazing techniques moved the company further into the space age through a contract to design, develop and fabricate frontal sections for a space re-entry vehicle. Design requirements of the components called for them to withstand temperatures of 4500 to 5500 degrees Fahrenheit for prolonged periods with a re-entry velocity of 35,000 ft per second. Proposed basic structure of the components is of tungsten, tantalum, or alloys of these two materials, with a ceramic oxide coating to provide a protective shield against the atmospheres in which they will travel.

Emphasis at Solar was on research and development and the mobilization of skills in new areas such as refractory material used in space vehicles, nozzles, aircraft ground suppressors and components for nuclear power applications. During 1961, the company was experimenting with tungsten nozzles and lithium cooled rocket nozzles, in addition to producing precision honeycomb structures.

Another exotic engineering program underway at Solar was the development of a prototype radiator condenser for a space nuclear power plant. Ducting components for an advanced space vehicle was still another intriguing project occupying the attention of the company's engineers.

Orders increased during the year for boundary layer controls systems for the Navy's crack F4H Phantom II fighter. The Solar manufactured components make possible lower speed landings for the jets. The company was also awarded a contract to develop a prototype of the hot gas eductor system for an Army aircraft that will have vertical take off and landing characteristics. Still another contract called for components for the Minuteman missile.

Besides supplying ducting and other components for a variety of aircraft, Solar was developing components for the Mach III B-70 bomber. Made of high strength Inconel X in thicknesses from .008 to .016 of an inch, the ducting system will total approximately 200 linear ft. It will withstand pressures up to 450 psi and temperatures up to 1200 degrees F. Total weight of the system is less than 300 lbs. The system will extract air from the jet's engines for cabin heating, de-icing, keeping the windshield clear of rain and ice, and for operating other penumatic systems.

During the year Solar stepped up production of its versatile Titan gas turbine-powered auxiliary power units following increased orders by the Army. The airborne units were ordered for the Army's "Chinook" transport helicopter. The 80 horsepower Titan engine drives a hydraulic pump to start the helicopter's main gas turbine engine and provides power for ground service requirements. Similar units provide electrical power for engine starting and power for ground operations in other military aircraft. Cabin heating can also be supplied, allowing aircraft capability in Arctic conditions. In addition, a Titan gas turbine APU was tested with the Army's "Caribou" transport aircraft.

In 1961, Solar introduced a new product: a gas turbine engine mounted in the rear of an International Harvester panel truck for jet starting and aircraft support applications. Heart of the unit is Solar's newest production line gas turbine engine, the T-350, which in this application delivers 350 hp. The unit provides enough air bleed support to start any size aircraft, military and commercial. Electrical power is provided through two ac power taps, each capable of delivering 120 kva. The new unit provides compressed air for starting, heat and power for de-icing, and power for hydraulic and air-conditioning systems. It can provide electrical power alone or air bleed capability alone. A unique feature is a remote control system which allows for pilot operation if desired.

In the field of ground support equipment, Solar intensified its study of a concept for a mobile missile launcher. Under the plan, Solar would provide specialized launching equipment, lightweight carriage components, electronic launching and tracking facilities, and gas turbine auxiliary power units. International Harvester would provide the mobile wheeled vehicle: truck, chassis, heavy equipment and any reciprocating engines involved in the project. The combined facilities, capabilities and experience of the two companies offer unique advantages in ground support.

In the closing months of the year, Solar completed construction of a cluster of new test cells used to check out projects in expanding turbomachinery and aerospace programs. The added test facilities and the new 62,000 sq ft engineering and research center completed earlier, emphasized the company's continued efforts in research and development.

Vickers' two-ton space vehicle simulator.

SPERRY RAND CORPORATION

Guidance and control equipment from such divisions as Sperry Gyroscope, Ford Instrument and Sperry Utah; computers from Remington Rand; hydraulics from Vickers—all reflected Sperry Rand's new stature in America's space-oriented defense economy.

Broad skills available throughout the operating divisions of the Corporation were integrated by the newly-established Sperry Rand Systems Group, a cadre of engineering and planning people charged with the responsibility of bringing these skills to bear on specific problems. The Group employed the services of a new Sperry central marketing organization in a departure from a wholly divisional approach to defense systems contracting.

A large Air Force award to convert two troop transports into mobile missile tracking stations for the Atlantic Missile Range was one of the first fruits of the Systems Group effort. Reaching toward the moon, Sperry also combined the space guidance and communications capabilities of a number of divisions toward participation in such space programs as the Prospector-Apollo lunar probes.

SPERRY GYROSCOPE COMPANY

Commissioning of the Ethan Allen late in 1961 put to sea the first of five new Polaris submarines to be guided by Sperry's Ship's Inertial Navigation Systems. Manager of Polaris navigation systems since 1959, Sperry has supervised development, production and installation of complex and interdependent equipment which provides a very high order or accuracy in determining the submarine's position anywhere beneath the surface of the sea.

Sperry's contribution to the Polaris missile itself was made public recently with the announcement of a contract for production of tiny prototype accelerometers for a new, lightweight and more accurate missile guidance system which may help to increase Polaris range from 1,200 to 2,500 miles.

Surface ships earned added protection as work continued at Sperry on multi-million dollar Navy contracts for Talos and Terrier surface-to-air missile guidance radars and weapon direction equipment. These missiles were being installed on new classes of cruisers and aircraft carriers.

The third, fourth and fifth giant Sperry search radars for the nation's SAGE air defense network were turned over to the Air Force during 1961. The antennas for the massive FPS-35 systems are half the length of a football field and stand 40 feet high atop 85-foot concrete towers.

Development continued on the target track and discrimination radar transmitters for the Nike Zeus anti-missile system, with efforts pointed toward system tests in 1962 against missiles fired down the Pacific Missile Range. A 100-million watt power supply was installed at Sperry to test the amplifier tubes for the Zeus transmitters.

Deeper into space, microwave engineers in Sperry's Surface Armament Division revealed details of the first method for receiving "action" television from space vehicles hundreds of millions of miles from earth. The new system opens the way to advances in space communications and navigation between planets.

Sperry's Air Armament Division in 1961 was given the go-ahead to develop and manufacture a gyro platform that will furnish precise reference data to the Strategic Air Command's proposed B-70 trisonic intercontinental jet bomber.

Complementing production of bombing-navigation systems for USAF's B-58 supersonic jet bomber, Sperry designed, produced and delivered ground checkout systems that reduced bomb-nav checkouts from days to hours. Completely automated, the new system vastly improved the hour-to-hour combat readiness of the SAC bomber.

Sperry's new infrared-optics group began work toward the application of laser research to practical optical systems. One of the first developments announced by the group was a device to modulate light at microwave frequencies, and aid to both communication and space navigation.

Aerospace flight research in 1961 saw new speed and altitude records being set almost monthly by NASA's X-15 rocket plane. Sperry's inertial flight data system guided X-15 pilots from the moment of launch through the hypersonic acceleration phase of each flight and provided them with information to control re-entry into the earth's atmosphere.

Air Armament engineers continued to advance aerospace technology with development of SPIRAL, a lightweight airborne inertial-radar altimeter with long-time accuracies to within hundreds of feet, even at 200 miles above the earth.

Inertial guidance instruments and computers also were reduced to miniature proportions while sacrificing none of the fantastic performance and long life demanded by space applications:

Tiny navigation gyros less than three inches long were marketed with drift rates so low that a rocket employing the guidance devices on a flight to the moon would land less than a mile from its programmed target. And gyros were developed with spinning masses of liquid replacing conventional rotating wheels—offering near-perfect stability for balancing space platforms carrying extremely delicate instruments.

A miniature memory drum that can spin indefinitely and store an unprecedented amount of information for a parent space system computer also was developed by Sperry, along with the first digital computer to employ magnetic cores in every circuit.

In an area cloaked by military secrecy, Sperry's countermeasures scientists devised new methods for jamming enemy radars, employing special, high-level noise sources for a low cost, high power transmitter. Another Sperry system was undergoing Air Force tests at Eglin AFB, Fla., and the service awarded Sperry a study contract to determine what new countermeasures techniques may further ensure that U.S. missiles can penetrate enemy radar defenses.

Sperry also was active in aircraft collision prevention, putting under FAA tests an antenna designed as the heart of an airborne pilot warning system. The system would alert the pilot well in advance of a collision from any direction and prescribe a proper escape maneuver. This information also could be fed directly into the plane's automatic pilot which would then call for execution of the escape maneuver.

A data processing cost and production control system devised at Sperry resulted in increased managerial efficiency and a saving of $2 million last year. Under the PACC (product administration and contract control) system, nine data processing people perform functions previously handled by more than 200. Covering engineering, design, sales, cost accounting, payroll, publications, spares, production control, reliability and estimating, PACC is utilized by six major product groups at Sperry.

REMINGTON RAND UNIVAC

Early in 1961 the Univac Division announced major scientific achievements leading to three new computer systems. After several years of intensive research, scientists perfected thin magnetic film memory, the fastest form of computer memory yet developed.

In this kind of memory, information is stored in the form of magnetism imposed upon extremely thin dots of a special material. Up to now, the shortest time required to retrieve information from memories has been rated in millionths of seconds. Magnetic thin-film makes possible speeds of billionths of a second.

To meet the needs of the government for a computer that can solve problems virtually as soon as they are posed, or in "real time," Remington Rand developed the UNIVAC 1206 Military Real-Time Computer. It is an especially rugged and compact package that can record all the information sent from a rocket and transmit guidance signals back to the rocket.

Remington Rand Univac's Military Department delivered its first Nike Zeus target intercept computer to the Army's White Sands Missile Range. The computer is designed to help guide the Zeus missile on its flight to destroy enemy warheads approaching the United States.

Univac also stepped up deliveries of Athena ground guidance computers for the Titan missile program.

After several years of secret research, it was revealed that Univac has been involved in NTDS (Naval Tactical Data System). During the year, the Navy awarded a contract for NTDS computer systems, each composed of a series of consoles which display schematic pictures showing targets, their type and movements and the defensive and offensive postures of friendly ships and aircraft. Thus, from the control center in the command ship, it is possible to deploy a whole task force as easily as a single vessel.

FORD INSTRUMENT COMPANY

Ford Instrument Company, under contract with the Air Force, developed an inertial guidance system for aircraft or missiles which does away with the conventional stable platform. In this system, the inertial components (gyros and accelerometers) are "strapped down" on the frame of the vehicle, and digital computers translate the inputs into information similar to the outputs of the conventional stable platform.

Also developed by Ford Instrument was a new, high-accuracy air-bearing gyroscope known as the FG-100. Only 2.5 inches in diameter and weighing less than 1.5 pounds, this gyro surpasses the AB-9 and AB-7 in basic reliability, reduced drift and minimized requirements for auxiliary equipment.

One of the most promising sources for auxiliary power in space craft is the thermionic energy converter. Ford Instrument Company was performing extensive research and development work on low-temperature converters based on the low-voltage arc, metal-ceramic techniques and related problems. The company delivered prototype equipment to the Air Force for evaluation.

Sperry Farragut Company was building inertial guidance equipment for the Saturn program as well as having furnished key guidance components used in the first two successful Mercury-Redstone shots.

VICKERS INCORPORATED

Vickers hydraulic equipment has played a role in almost every major U.S. missile program. The division entered the field of fluid and vapor temperature control with a new line of products for the cooling of electronic equipment in radars, aircraft and missiles. This field takes on increasing importance as overall electronic power packages shrink in size while advancing in power. Cooling by direct liquid contact rather than by air becomes a necessity in many cases.

Under a NASA contract, Vickers began research on a jet exhaust system to stabilize and position space vehicles in free flight. Vickers designed and built a space vehicle simulator for this project. Although it weighs two tons, the simulator can be set in motion with the light touch of one finger.

The company also invested in study and development of cryogenic power systems for driving pumps, alternators, temperature and atmospheric control systems for space vehicles.

Active in the Polaris program, Vickers supplied nuclear reactor controls which monitor the power plants of the atomic-powered submarines. Vickers hydraulic control valves also were abroad the Polaris submarines.

Many of the devices that handle and launch the Polaris missiles embody Vickers components, and the special motor-pump that drives the main hydraulic system of the Polaris missile's first and second stages is made by Vickers.

A sub-miniature vane pump cartridge offering a new flexibility to designers of fluid handling systems in 1961 earned a certificate of excellence in a national miniaturization awards competition. The unique, long-life device weighs only an ounce and is ¾ inch in diameter.

Another Vickers development was a servo motor package for missile and aircraft control systems. It is believed to be the first time that a rotary hydraulic motor and servo valve have been combined in a single compact unit of this type.

SPERRY UTAH COMPANY

Continuing in its role as prime contractor for the Army's Sergeant ballistic missile system, Sperry Utah in 1961 stepped up production of the 85-mile, surface-to-surface tactical missile with the announcement of new multi-million dollar awards from the Army. The solid-fueled Sergeant was scheduled to replace the Corporal, deployed with American and NATO forces throughout the world.

Research and development firings were completed late in 1961, even as production moved ahead. The Army's Ordnance Missile Command reported that all test objectives were met by the missile system.

Highly mobile and easy to operate, the inertially-guided Sergeant approaches conventional artillery in speed of emplacement and displacement. It can be set up for firing on its transportable erector-launcher by a small crew in a matter of minutes.

Sperry graduated the first Ordnance direct support detachment from its equipment training school. This is one of the initial steps in providing the Army with a completely operational system—including trained operators.

SPERRY PHOENIX COMPANY

Early in 1961, the Air Force awarded Sperry Phoenix a multi-million dollar contract for automatic flight control systems for B-52 strategic bombers and C-130 turbo-prop transports. Classed among Sperry's most successful flight control systems, the MA-4 provides SAC's B-52 with precision automatic control on long flights to distant global targets. The E-4 system offers comparable automation to the C-130 Hercules.

Sperry also announced development of a unique automatic flight control system for second generation jet transports such as the Boeing 727. Called the SP-50, the system will offer high reliability in all environments, resulting in substantial savings in aircraft flight time and fuel.

Miniature radio beacons to aid in recovery of space capsules, air search and rescue and for accurate radio-navigation in remote regions were in production at Phoenix. The tiny beacons—two-inch electronic cubes weighing only a few ounces—are so tough that they can be air-dropped without damage.

The FAA approved a Sperry-designed automatic flight system for the new Lockheed JetStar compact transport. The SP-40 system was ticketed by the FAA for the JetStar while the aircraft itself was undergoing final approval flights. Unique to the SP-40 is the 75-pound weight at which it affords complete push-button control of the jet with "coupling" to radio beams for automatic enroute flying and instrument landing approaches. Performance of the SP-40, which was designed for small, turbo-jet and prop-jet transports, is comparable to that of Sperry's famed SP-30 automatic flight control system now in service aboard the larger airline jets.

Sperry gyro is assembled under dust-free hood.

The company also continued volume production of the SP-3 system for private and business aircraft—single engine planes and light-to-medium twins. The SP-3 equipment, which affords a unique "building block" approach to automatic flight, may be installed in varying combinations to give users any desired degree of airborne automation.

SPERRY ELECTRONIC TUBE DIVISION

Sperry's Tube Division, with facilities at Gainesville, Fla., and Great Neck, N.Y., announced development of a number of new amplifiers for space communication systems and radars, and continued research in circuitry, plasma and lasers.

A new liquid-cooled helix traveling wave tube will hike the power of airborne radar-jamming systems by 60 times, while a counter-development promises ground defense radars an amplifier capable of putting out more than a million watts of power over a very broad frequency range to escape the jamming signals of enemy aircraft or missiles.

Late in the year, the division placed on the market a miniature amplifier for space satellite communication systems. The tube, only nine inches long and weighing but a pound, can provide a new high in power for signals between satellites tens of thousands of miles apart.

Employing a unique adaptation of a circuit designed for speeding electrons in atom smashers, Sperry expected to multiply klystron amplifier output by four times while doubling a communication system's message carrying capacity. Called "extended interaction klystrons," the tubes will hike power by accelerating electrons along "standing waves" generated by a series of circuits inside the tubes. The new tubes—whose development may inaugurate a whole new family of power amplifiers—also were expected to increase the effectiveness of satellite tracking systems or radar astronomy systems mapping stars or the surface of the moon.

Sperry also announced production of a new family of two-cavity oscillators for parametric amplifier pumping and doppler radar applications.

SPERRY SEMICONDUCTOR DIVISION

A series of integrated components called SEMI-NETS were being developed and manufactured by Sperry Semiconductor for computer and missile applications. SEMI-NETS offer a technical superiority over conventional circuitry, and provide an electronic equipment manufacturer with complete packaged circuits which previously had to be assembled by the equipment maker. The high density devices eliminate 75 per cent of conventional connections, and assure weight and volume reduction over conventional miniature components between 100 and 1,000 to 1.

SPERRY RAND RESEARCH CENTER

Scientists at the new Sperry Rand Research Center at Sudbury, Mass., initiated basic research in a variety of fields, including solid state physics, plasma, the effects of extreme temperatures and pressures upon materials, applied mathematics, theoretical physics, microwaves, infrared optics, earth and life sciences and novel way of generating power. They were looking a decade and more ahead, building up a backlog of basic knowledge that will serve as a foundation for the creative engineering of the future.

INTERNATIONAL

The Sperry Europe Continental Company was formed in 1961 to handle sales and service of Sperry equipment in Western Europe. The new organization, with headquarters in Paris, represents Sperry in the negotiation of patents, licenses and contracts throughout the European nations where Sperry has increasing commitments with government, commercial and industrial customers.

Sperry was supplying C2G Gyrosyn compass systems for European-built or purchased Lockheed F-104G jet fighters. European airlines flying jet transports were supplied with SP-30 automatic flight control systems, C-11 Gyrosyn compass systems and integrated instrument systems.

STANDARD KOLLSMAN INDUSTRIES

KOLLSMAN INSTRUMENT CORPORATION—SUBSIDIARY

In keeping with its growth philosophy of planned expansion, Kollsman Instrument Corporation strengthened its position in the aerospace industry in 1961 by broad participation in the nation's space effort.

For one major space program, NASA's Orbiting Astronomical Observatory (OAO), Kollsman was chosen to provide astro trackers for the critical mission of vehicle stabilization. This important subcontract was awarded to Kollsman by the Missile and Space Vehicle Division of the General Electric Company under contract to Grumman Aircraft Engineering Corporation.

Late in 1961, Kollsman was awarded a prime contract from NASA for the research and development of optical and electronic equipment for the Goddard Experimental Package, an important segment of the OAO Project. The prime objective of this equipment is the gathering of scientific information on the radiation content in outer space.

Other Kollsman equipment, specifically three specially designed space instruments for Project Mercury, was playing an important role in the nation's space program. American astronauts Shepard and Grissom wore wrist-watch type pressure indicators, and the Mercury capsules were equipped with a Kollsman altimeter and cabin pressure indicator.

Although the major portion of 1961 sales resulted

Kollsman's "bookshelf-type" instrument indicators.

from quantity production of the company's well-known family of astronavigation instruments and systems for missiles and manned bombers, Kollsman, through the efforts of its Research Division, broadened its capabilities through scientific investigations in the fields of solid-state physics and materials; light generation, modulation, detection and projection; electronic circuitry; medical physics and bionics; inertialess gyroscopy; pattern recognition; an microminiature highly accurate digital encoding.

From these and other studies two important new product lines were developed. One new product was an electronic visual display system developed for military command control centers. This fast-time, electronic compilation and data processing device also had commercial application. Kollsman received its first order for this equipment from the Navy late in 1961.

A complete line of portable optical lasers were also developed and offered to the commercial market as laboratory instruments. Other activities included the development of artificial lungs and hearts. This equipment was undergoing tests in New York City hospitals.

From Kollsman's product engineering group came a new photo-electric setting device for converting barometric readings to digital information for use in the world's first unattended nuclear weather station, developed by the Nuclear Division of the Martin Company. The weather station will be located North of the Canadian mainland where year-round observations will be made and information transmitted over distances up to 1,500 miles.

In the field of advanced aircraft instrumentation display, Kollsman developed, under an Air Force contract, the first "bookshelf" type vertical scale indicators. Late in 1961, the company received its first order for the new modular VSI indicators.

In commercial aviation, Kollsman continued to produce quantities of its Integrated Flight Instrument System (KIFIS) for the Boeing 707, Douglas DC-8 and Convair 880. Toward the end of 1961, an advance system (KIFIS II) was being made available to the industry. Initial orders were placed by Douglas Aircraft Company.

During the year Kollsman initiated a number of major company moves. An important physical move was the relocation of the Standard Kollsman subsidiary, Kollstan Semiconductor Elements, from Golden, Colorado, to Westbury, Long Island, where it became a division of Kollsman. The activities of Kollsman Instrument's Research Division were closely coordinated with Kollstan.

Important management appointments during the year included the election of Arthur S. Flood as vice president of Administration and Jack G. Anderson as vice president for Marketing.

Late in 1961 Kollsman strengthened its European operations with the formation of Kollsman Instrument Limited in London. This division was set up to service the British Air Ministry, airframe manufacturers and other aerospace industries with the full scope of Kollsman's technical capabilities in the astro compass, instrumentation and navigational system fields.

Kollsman's facility in Munich, Germany—Kollsman Luftfahrt Instrumente G.m.b.H.—continued as a major supplier of aerospace instruments to the NATO nations.

The company's other two subsidiaries, Kollsman Motor and Richardson-Allen, provided a concentrated capability in the respective development and manufacture of special purpose miniature motors and DC power supplies.

SUNDSTRAND CORPORATION

On July 1, 1961, Sundstrand established its new Hydrostatic Division. This division, originally a part of Sundstrand Aviation—Rockford, will handle the engineering, development, and manufacture of all commercial hydrostatic transmissions. The hydrostatic transmission which has proven so efficient in commercial and military aircraft constant speed drive programs will now be applied through this division's efforts to wheeled and tracked vehicles.

SUNDSTRAND AVIATION—ROCKFORD

On June 30, 1961, Sundstrand Aviation received engineering acceptance and qualification from the Aeronautical Systems Division at Wright-Patterson AFB on the Cartridge/Pneumatic Starter Model

CPS-01 (F-100D/F) and CPS-02 (B-52H). The CPS-01 unit has been flight tested extensively on the F-100 at McClellan and Nellis AFB. The CPS-02 unit is now undergoing endurance testing at Edwards AFB and environmental testing at Eglin AFB on B-52Hs. Both of these units were being manufactured in production quantities under Air Force contract. To offer increased aircraft mobility and comply with the "alert" concept, Sundstrand was studying further applications on the KC-135, B-52B-G, RF-101, F-104, F-105, F4H, and various commercial jet aircraft.

Commercial jet aircraft utilizing the Sundstrand constant speed drives amassed an impressive performance record. To date over 5,200,000 in-flight hours of drive operation have been logged on these aircraft with increased reliability and time between overhaul. Such drive programs as the starter drive unit for the Boeing 727 and the secondary power generating system for the B-70 were in the final stages of development.

SUNDSTRAND AVIATION—DENVER

Sundstrand Aviation–Denver was very active in such missile and space projects as Dyna-Soar, Polaris, Saturn, Centaur, and Atlas. This division was developing a 15 KW solar dynamic space power generation system, a hydrazine monopropellant APS, a 300 hour–5 KW CRYHOCYCLE (hydrogen oxygen APS), a photogalvanic power generation system, and an advanced torpedo and underwater vehicle propulsion system. In addition, research was being undertaken involving thermal energy storage systems, liquid metal lubricated journal bearings, advanced turbine designs, and a rocket motor scaling program.

THOMPSON RAMO WOOLDRIDGE INC.

Thompson Ramo Wooldridge Inc. (TRW) contributed to the aircraft, missile, and space fields during 1961 in the areas of systems engineering and technical assistance of missile and satellite programs, research and development of subsystems and components, study contracts on a variety of aerospace projects, and continuing production of components for manned aircraft engine programs.

TRW provided systems engineering and technical assistance through its subsidiary Space Technology Laboratories, Inc. (STL) for the highly successful launch of the first Minuteman ICBM in February and for subsequent launches during the year as part of its continuing contract through STL with the U.S. Air Force for systems engineering and technical assistance on the entire ICBM program including Minuteman, Atlas and Titan. TRW also produced ultra-high reliability silicon computer diodes through its subsidiary Pacific Semiconductors, Inc. for use in the Minuteman inertial guidance and flight control systems. TRW also produced third stage propulsion nozzles for the Minuteman program.

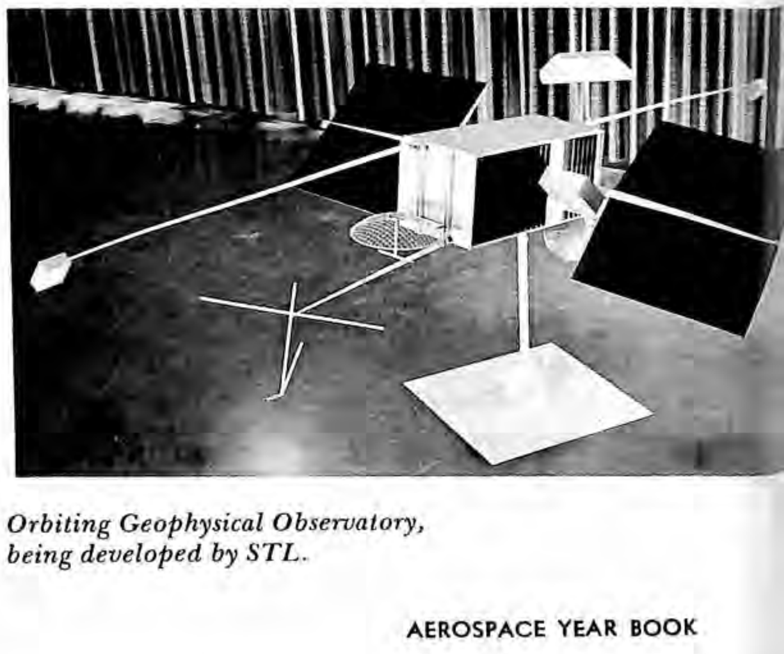
Project Mercury astronauts Shepard and Grissom were fitted with TRW-developed miniaturized, transistorized medical amplifiers which enabled doctors on the ground to monitor the astronauts' physical reactions in the environment of space. The amplifiers, each weighing less than three ounces, amplified and telemetered to earth signals from instruments which measured the astronaut's heart beat and body temperature, and the oxygen content of the atmosphere he breathes.

A research and development contract was received during the year for the reaction control power unit to be used on the Air Force Dyna-Soar maneuverable manned space glider. The unit will stabilize and control the glider during flight through space or when the aerodynamic controls are not completely effective.

A TRW command destruct receiver was specified for the Skybolt air-launched ballistic missile program.

TRW's subsidiary Space Technology Laboratories, Inc. received a NASA contract during the year for Project Relay, a communication satellite program. The contract calls for overall coordination between satellite vehicle and ground tracking stations, specifications for the satellite, launch and tracking operations programming, systems studies, and special test station integration. Two launches were scheduled for 1962.

Sunflower I, a solar auxiliary power system for space craft designed to generate 3000 watts of elec-



Orbiting Geophysical Observatory, being developed by STL.

trical energy continually for one year, was being developed under a continuing TRW-NASA contract. Reinforced plastic expansion cone liners were being supplied by TRW for use in the third-stage nozzle of the Scout missile used in NASA's Apache communication satellite program.

Development of the Orbiting Geophysical Observatory (OGO), the nation's first production satellite, was continuing under an initial STL-NASA contract calling for delivery of three spacecraft during the next three years. Other NASA contracts awarded to TRW's subsidiary Space Technology Laboratories, Inc. during 1961 included study contracts to determine costs, assembly techniques and stability control of Saturn and Nova class vehicles, and to determine the payload capabilities of current U.S. medium space vehicles.

Systems engineering, technical assistance, guidance, tracking, and orbit determination were provided by TRW through STL for the continuing Transit communication satellite program which included three successful launches during 1961. TRW was also awarded a significant contract to provide four of its AN/UYK-1 computers for a high accuracy navigational control system for Transit.

Other contracts in the aerospace field received during the year by TRW's subsidiary Space Technology Laboratories, Inc. included work on the Advanced Research Projects Agency's Environmental Test Satellite (ARENTS) to determine radiation damage in the space environment; systems engineering and technical assistance for Atlas and Titan ICBM boosters which will be utilized by the U.S. Air Force in support of the Nike-Zeus target program; and systems engineering and technical assistance on the Army's Advent program to determine the feasibility of a multi-channel microwave space communication system for strengthening military communications.

A solid state telemetry transmitter, a major breakthrough in the design of solid component microwave power generators, was designed and fabricated jointly by two of TRW's subsidiaries, Space Technology Laboratories, Inc. and Pacific Semiconductors, Inc. The transmitter can operate from a standard 28 volt power supply in missiles and space vehicles, without the need of a converter. The power output of 2½ watts at 2.25 kMc is the highest at this frequency for solid state yet announced.

Development and production of a substantial number of tactical prototypes of the transporter-erector-launcher (TEL) for the Pershing missile were completed, and the TRW developed auxiliary power system for the Advanced Bomarc B missile was phased into production. Pilot production and qualification testing of the miniature auxiliary power supply (MINIAPS) was continuing.

Fundamental and applied research was conducted during 1961 in the areas of turbo electric power conversion, magnetohydrodynamics, ion propulsion, fuel cells, auxiliary power supplies, oxygen regeneration systems, thermionic conversion systems, and particle acceleration.

WESTINGHOUSE ELECTRIC CORPORATION

Scientists at the Westinghouse Research Laboratories achieved in September, 1961, one of the most sought-for goals of modern science: development of the first super-strength superconducting magnet. For its size, weight, and energy consumption it is by far the most powerful magnet ever built. Until a year or two ago it was considered theoretically impossible to construct.

The size of a doughnut and only a pound in weight, the Westinghouse super magnet creates a magnetic field twice as strong as that from a conventional iron-core electromagnet weighing 40,000 pounds, and operated to saturation of the iron.

Such a conventional iron-core magnet needs its own power plant to continuously supply the 100,000 watts or more of power to run it. In contrast, the new super magnet runs from an ordinary automobile storage battery. The only power the battery continuously supplies is a few watts to overcome the small losses in the wires leading to the magnet.

Such magnets enhance considerably chances for the direct, large scale generation of electric power. It makes possible a whole new generation of powerful atom smashers. It increases the possibility of a magnetic 'bottle' in which the vast energy of the hydrogen bomb reaction can be harnessed for useful power. It makes more feasible some of the far out methods proposed for long distance travel in space.

In another area, Westinghouse scientists can now "see" the structure of solid matter as easily as the physician looks at the insides of a human being. They developed a new electronic system that brightens a thousandfold the X-ray images from which the atomic architecture of crystals is revealed. The new system makes visible to the naked eye X-ray patterns that were formerly obtained only through photographs. Such information is used to calculate the precise arrangements of atoms in metals, semiconductors and other crystalline substances.

A new group of high-temperature thermoelectric materials which permit the direct conversion of heat into electricity at temperatures considerably above the melting point of copper, was also developed by Westinghouse scientists. The new thermoelectric materials are varieties of two compounds, samarium sulfide and cerium sulfide. The new compounds are refractory materials and have excellent high-temperature stability and good thermoelectric efficiencies at temperatures as high as 2000 degrees F.

The new materials resulted from a continuing research and development program, under sponsorship of the Bureau of Ships, U.S. Navy, for the discovery and practical development of advanced thermoelectric materials.

Ceramics, rather than iron and steel, may be the key materials for building the electric power generators of the future. Westinghouse scientists have shown them to be the best substances so far discovered for holding in check the white-hot stream of gases from which electric power is obtained in magnetohydrodynamic (MHD) generators.

Using ceramics, Westinghouse scientists operated an experimental MHD generator continuously for record periods of time up to 50 minutes. The usual operating period for such generators is only a few seconds. Studies of the operating performance of the materials were carried out in an experimental 10-kw MHD generator.

A machine with the potential capability to supply a stream of gas at temperatures as high as 20,000 degrees F and pressures as great as 15,000 psi was devised by Westinghouse engineers. The machine, an electric arc heater, can operate for sustained periods of time and at an extremely low level of gas contamination. The arc heater has immediate application in a wind tunnel for missile testing. Also, it holds promise as a chemical synthesizer and as a furnace for processing metals with ultrahigh melting points. A prototype model of the machine was operated at a power input of 1700 kilowatts, but a high of 30,000 kilowatts was planned by the company.

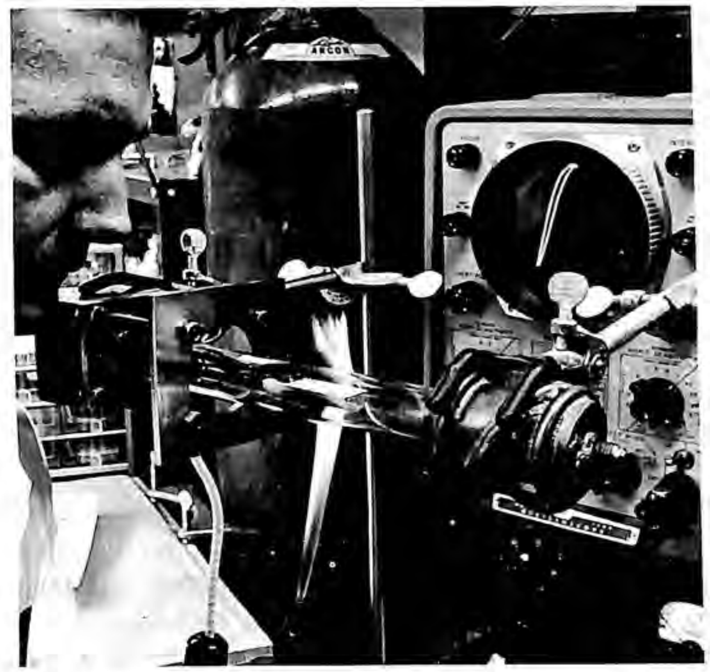
A high vacuum demountable system, developed for experimental work in electron optics, was installed in the cathode ray laboratories of the electronic tube division. Its purpose is to aid in making better electron tubes possible. The instrument consists of a four-and-one-half by one-and-one-half-foot bell jar, adjustable tube parts, and a vacuum system featuring a large ion pump.

The instrument's usefulness comes from its ability to: 1. provide space in vacuum for large scaled models of electron guns; 2. evacuate the bell jar to a pressure of one millionth of a millimeter of mercury; and 3. adjust the built in experimental tube parts.

A nuclear thermoelectric power system for space, moon and other uses requiring long lived, maintenance free operation was demonstrated by the Westinghouse Aerospace Department.

The system uses the spontaneous decay of a radioisotope to produce heat which is converted into electricity by thermoelectric principles. It is designed to produce 50 to 60 watts for three months' life on the moon's surface.

Scientists at the Westinghouse Research Laboratories demonstrated a unique electronic device that might best be described as a "molecular slide rule." The tiny device electronically performs multiplication and division by a process similar to that used



Transistor under high-temperature test at Westinghouse.

in the familiar mechanical slide rule so widely used for mathematical calculations. Yet the new multiplier-divider has no conventional electronic components or circuitry. It is simply a solid slice of silicon about the size of the head of a thumbtack and as thick as a few sheets of paper.

A new photoemissive material reported by the company's Electronic Tube Division maintains a high level of sensitivity over many hours of operation at 250 degrees F. Developed under a research contract with the Bureau of Ships, the new material is expected to be most useful in such devices as imaging and photomultiplier tubes, in which photosurfaces convert radiant energy into electrical energy. Availability of the new material will permit operation of these photosurfaces at temperatures well above 140 degrees F, the temperature at which the operating life of conventional materials has generally been inadequate. In addition to its exceptional thermal stability, the new material has a second useful characteristic in that "dark current"—a residual current produced in total darkness—is less than one percent of that for conventional materials.

The vision of a young Westinghouse engineer 17 years earlier became a reality on September 11 when upwards of 1,000,000 students began receiving televised instruction from an airplane circling at 23,000 feet over central Indiana.

The historic flight of a specially equipped airplane on May 15 represented the practical application of an airborne television system known as Stratovision, which was conceived and developed by engineers of the company's Air Arm Division. On this mission, the plane brought educational television broadcasts to school and college youth throughout a six-state Midwest region.

The Stratovision plane making the first flight was one of two DC-6 A/B craft equipped by Westinghouse for the Midwest Program on Airborne Educational Television. Six tons of special broadcasting facilities installed in each craft are capable of transmitting pretaped programs on channels 72 and 76, both in the ultrahigh-frequency range. While one plane is in flight, the other serves on a stand-by basis.

The range of the Stratovision broadcasts is 175 to 200 miles in every direction, approximately 16 times the area covered by a conventional TV transmitting tower on the ground.

A self-contained air conditioned suit which can keep the wearer comfortable in outside temperatures ranging from 40 degrees below zero to 135 degrees F was developed by scientists of Westinghouse and the Naval Supply Research and Development Facility.

The suit is an experimental model for testing the possibility of air conditioned attire for military personnel.

Heating or cooling of the experimental garment is done by thermoelectricity—a refrigeration technique that eliminates the need for conventional moving apparatus. Cooling is accomplished simply by passing an electric current through thermoelectric couples made of semiconductor materials. Reversing the current causes the materials to heat instead of cool. The heating or cooling is done automatically, and a temperature of about 80 degrees F is maintained inside the garment.

Completely airtight, the suit is made of an insulated aluminum-coated fabric. Air for breathing is supplied through a face mask connected to the side of the suit helmet, where incoming air is heated or cooled by a small heat exchanger.

The only moving parts in the suit's entire air conditioning system are two small fans which circulate and distribute the conditioned air around the wearer. Batteries permit the suit to be independent of any other power source for one hour.

A new lightweight nuclear generator which converts heat directly into electrical power is undergoing performance testing at the Air Research and Development Command's Air Force Special Weapons Center in Albuquerque, N. M. It was developed under Air Force contract to provide a reliable and long-life power source for facilities such as small, unmanned surface radio beacons and weather stations. The completely portable nuclear auxiliary power device, which weighs less than 40 pounds, was designed and constructed by the company's new products laboratories. The generator produces approximately 150 watts of electrical power and was designed for one year of continuous unattended operation. It uses radioactive isotopes, such as Curium 242, as its heat source.

A new high-speed, word-organized, electrically alterable random-access memory developed by the company's Air Arm Division employs multiaperture ferrite cores and fully transistorized circuitry. It is capable of non-destructive readout and non-volatile storage and so does not lose stored information either during readout or as a consequence of power shutdown or failure.

The design techniques employed are expected to

Westinghouse tested new air-conditioned suit.

be significant in military control applications such as high-speed radar data processing and communications, in various memory and programmer functions of space systems, and in special applications to industrial control. A 1024-word prototype model has been operated at an 0.6 microsecond cycle time with an access time of 0.20 microsecond. The model and its memory core stack, drivers, switches, timing circuitry, and sense amplifiers has been successfully operated over wide temperature excursions.

The fact that stored program information can be altered by electrically writing new information into the memory is an important aspect of the development since this permits a new instruction or an entirely new program to be written into memory under control of a tape reader or other input devices. The process of writing information into the memory cores is done by the conventional, coincident-current writing technique. A molecularized computer, one-tenth the size and weight of a transistorized computer and with the same capabilities, is now under development at the Westinghouse Electric Corporation's Air Arm Division.

The new device, called "Mol-E-Com" (for "molecular computer"), will have greater pay load capabilities for American rockets through the use of the promising new approach to electronic systems—molecular electronics. Mol-E-Com will weigh less than 15 pounds and occupy less than one-third of a cubic foot instead of the 175 pounds and three cubic feet required by a similar conventional transistorized computer. More important than the 10 to 1 size and weight reduction, however, is the anticipated reliability of the molecular blocks that make up the "brain" of the computer. Methods of decreasing size and weight have been progressing rapidly, and this trend has made it increasingly difficult to measure reliability. Such measurements, however, are now underway at Westinghouse in the field of molecular electronics.

"Sweat-cooling" of rocket nozzles became a practical possibility with the development by the company's Micarta division, of heat-resistant plastic structures that can be made with controllable porosity.

Porosity of such nozzle walls is not only controllable but can be varied from section to section of a nozzle so that greater cooling can be provided in the nozzle throat than in the divergent section.

Although utilization of evaporation effect in transpiration cooling is not a new concept of heat control, development of a practical rocket nozzle to test transpiration theory has not previously been successful. Lack of control of porosity has frustrated former proposals to make nozzles of porous graphite or sintered metal.

The cooling method consists basically in forcing a fluid into a nozzle through porous walls. A cooling effect is produced by rapid evaporation of the fluid on inside surfaces in contact with exhaust flame.

The porous material developed by Micarta can be made of glass, leached glass, or quartz fabric with a high-temperature phenolic resin binder. It has the additional fail-safe feature of ablating if the coolant system failed. Thus catastrophic failure of the nozzle is minimized.

The company's Electronics Division received a contract from the Johns Hopkins University Applied Physics Laboratory for the Navy's Transit satellite navigation system. This follows a study contract under which the company designed the components of the receiver set.

The Transit receiver set provides a link between the satellite and the navigation computer. The receiver consists of a separate low-noise preamplifier, the main receiver, a stable frequency generator, modulation decoder, and operational test equipment.

The company's Aerospace Department was awarded a study contract for a 4000-watt solar power system suitable for use in earth orbiting satellites. The $50,000 contract was awarded by the Aeronautical Systems Division (Wright-Patterson Air Force Base) of the Air Force Systems Command.

Energy for such a power system would be drawn from the sun and converted into electrical energy by use of solar cells. The system is intended to provide a minimum of one year and a maximum of five years life for the electronic equipment of an orbiting satellite. Requirements for the power system necessitate the highest possible reliability and the lowest possible weight.

In such a system, electrical energy from an array of solar cells is fed into the necessary electronic equipment to derive the required voltages and frequencies for operation of the satellite's communications equipment. A 4000-watt power system would be substantially larger than any yet developed for this type of satellite. The study was scheduled to be completed in January, 1962.

A unique radio receiver whose main working parts are molecular electronic functional blocks was demonstrated by the Electronics Technology Laboratory of the Wright Air Development Division, U.S. Air Force.

The Westinghouse Air Arm Division designed the experimental unit to test the feasibility of constructing complicated military electronic systems through the use of molecular electronics—a concept in which an entire subsystem function is performed within a single block of material.

The receiver contains no tubes, no transistors and no traditional electronic circuits. Its main parts are six silicon functional electronic blocks about the size of a dime, and about one-fourth as thick, each of which performs some function (amplification, detection, etc.) required for radio reception. By connecting the blocks together, the total function of radio reception is achieved.

The receiver tunes in stations all across the standard broadcast band. Such a set typically requires some 50 individual electronic components (capacitors, coils, resistors and the like) which must be wired together by about 150 soldered connections.

Westinghouse Electric Corporation announced the formation of a new department for the development, manufacture and marketing of molecular electronics functional blocks.

The company Air Arm Division completed construction of a new Astroelectronics Laboratory 40 miles northwest of Los Angeles. The new facilities will be devoted to defense projects with special emphasis on the development of advanced electronic techniques for application in the missile and space fields. Totaling 25,000 square feet, the facilities will consist of an administration building and an adjoining laboratory.

The Westinghouse Sunnyvale division more than doubled its Polaris launcher manufacturing facilities to keep pace with stepped up production of the Navy's Fleet Ballistic Missile. The division held the prime Navy contract for Polaris missile launching and handling equipment. The 103,000 square feet of refurbished floor space, spread through seven buildings, augments Polaris launcher research, development and manufacturing conducted at the plant.

The Sunnyvale work on Polaris moved to the hardware phase but research and development of more advanced launching and handling systems for future Polaris submarines, and surface ships continued.

In addition to the launching and handling equipment, developed at Sunnyvale, the Westinghouse electronics division developed an "electronic brain" for Polaris submarines. This device senses the action of the sea and advises the fire control officer of the sea conditions at the instant of launch.

The nation's newest nuclear submarine—John Marshall, designed to fire the fleet ballistic missile Polaris—was launched on July 1st at the Newport News Shipbuilding and Dry Dock Company in Newport News, Va.

The John Marshall will have a reactor power plant similar to the one in the USS Skipjack, which enabled her to set new speed records for submarines.

The reactor plant for the John Marshall was designed and developed by Westinghouse under the direction of and in technical cooperation with the Naval Reactors Branch of the U. S. Atomic Energy Commission.

The 410-foot-long John Marshall, which will displace 6900 tons, was designed from the keel up for firing the Polaris missile from either a submerged or surfaced position. The John Marshall will carry 16 of the solid fueled missiles.

The nuclear reactor powering the John Marshall will allow the submarine to operate for prolonged periods anywhere in the world's oceans without refueling, thereby making the ship a major deterrent against aggression.

The aircraft carrier Enterprise will have a nuclear propulsion plant capable of driving this largest ship ever built at a speed of over 25 knots. The Enterprise's propulsion system will use eight reactors to supply the power to drive four propellers, each the height of a two-story house.

The atomic reactors were developed and designed by Westinghouse under the direction of and in technical cooperation with the Naval Reactors Branch of the Atomic Energy Commission.

The eight reactors will run the Enterprise for years without refueling. It is estimated that nuclear power will multiply by some 20 times the distance the Enterprise can travel at full speed without refueling as compared with the conventional oil fired carriers. Dependence on far-flung bases and auxiliary ships is thus minimized.

The seam turbine propulsion units were manufactured by the company's Steam Division.

Heavy jet bombers and fighters aboard the Enterprise will be ferried to the flight decks by elevators supplied by the company's Elevator Division.

Hydraulically powered, the elevator platforms weigh about 210,000 pounds each and have an area of almost 4000 square feet. Each of the four giant deck-edge elevators will be capable of lifting a 45-ton bomber from hangar to flight deck in 15 seconds. Thus, the four elevators combined can ferry four planes every minute to the flight deck, Pilots aboard the carrier will also be speeded to their planes by two Westinghouse passenger elevators.

Glenn T. Seaborg, Chairman of the Atomic Energy Commission and James E. Webb, Administrator of the National Aeronautics and Space Administration, announced on July 28 that a contract

Westinghouse developed first super-strength superconducting magnet.

had been executed with the Aerojet-General Corporation for the first phase development of the NERVA nuclear rocket engine. In addition, a subcontract was negotiated between Aerojet-General and the Westinghouse Electric Corporation under which Westinghouse will have responsibility for the nuclear portion of the work.

The cost of this six-months first-phase contract was estimated at approximately $6,300,000. The work involved is: preliminary design of the NERVA engine, performance of the work responsive to the needs of the Los Almos Scientific Laboratory and the conduct of reactor tests; assistance in the design of certain test facilities; preparation of a development plan; and research and development tasks, including work on the engine pumping systems, control systems, nozzle, mechanical tests of core components, bearings and seals, and examination of systems which are designed to assure safe operations.

Additional production of the radar portion of the air missile control system for the Navy's McDonnell F4H-1 fighter plane—holder of the world's closed-course speed record—was authorized in a contract for $8.3 million awarded to Westinghouse Air Arm Division where the radar system was developed for the Navy.

The radar is a missile armament control system for the Navy's F4H-1 carrier based jet interceptor. It is designed to "lock on" to enemy aircraft; then, either fire the aircraft's armament automatically or permit the pilot to fire at will.

The radar is used on the F4H-1 Phantom II carrier-based interceptor aircraft. Development of the radar was begun in 1957 with production following in 1958. This is the third production order, the last having been awarded in October, 1959.

An aircraft electrical system developed by the company's Aerospace Department was selected for the new Vickers VC-10 jet-powered transoceanic airliner. The 160-kva system weighs 400 pounds and has compiled an excellent service record on the Boeing 707. The four-channel parallel layout system includes a-c brushless generators, control panels and voltage regulators.

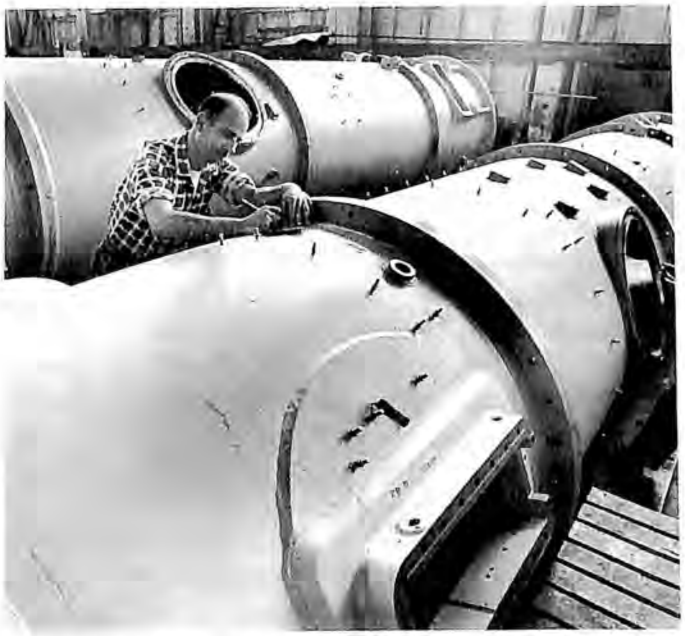
British Overseas Airways Corporation purchased 35 of the 150-passenger VC-10 planes. The $450,000 Westinghouse order covers equipment for the first ten of these planes. A Westinghouse licensee, Plessey Company, Ltd. of Ilford, Essex, will manufacture the remaining systems for BOAC, which has an option on 20 additional VC-10s.

An additional $4 million order for electric power systems to equip the U. S. Navy's A3J-1 Vigilante, a twin-jet attack bomber capable of flying at twice the speed of sound, was received by the company's Aerospace Department.

Westinghouse bookings for the program at year-end totaled approximately $12 million under a contract with the Columbus Division of North American Aviation, Inc., which is building the planes.

Westinghouse will provide oil-cooled, brushless generators together with voltage regulators, control panels, and other components for the electrical systems of the Navy planes.

Electrical systems under an initial contract amounting to $1,000,000 were ordered from the company's Aerospace Department for the Boeing 727 jet transports. This initial order will provide



Polaris launcher tubes undergo final inspection at Sunnyvale.

electrical systems for the first forty of the new jet aircraft to be built by the Boeing Airplane Company.

The Westinghouse equipment includes a starter-generator system that will function first as a motor to start up the jet engines, and then as an alternating-current brushless generator to supply power for the craft's operation.

A major subcontract for work on the Dynasoar manned space glider was awarded by The Boeing Company to the Westinghouse Aerospace Department. The subcontract is in excess of $1,000,000.

The company will develop a generator and control unit for the delta-winged, rocket-boosted Air Force space glider.

The unit will consist of a 400-cycle, three-phase brushless generator and will include a voltage regulator, control panel, circuit breakers and current transformer. It will be the source of the glider's electric power and will be mounted on the accessory power unit.

A $947,000 subcontract for specialized microwave tubes to be used in the U.S. Navy's new "Typhon" weapon system was awarded to the company's Electronic Tube Division, which will have responsibility for final design of the microwave amplifier tubes that will serve as power output elements in this system.

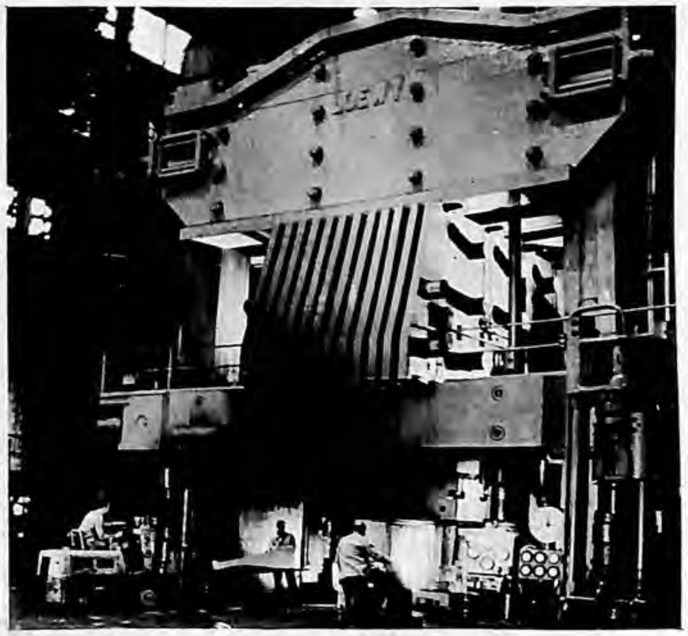
In addition, a contract for $7.3 million for development and production of the weapon direction equipment for the Navy's Typhon weapon system was awarded to Westinghouse Electronics Division.

The contract covers the first integrated shipboard radar and armament control system to be produced for the Navy by a single company. Armament control, computer, and weapon direction subsystems for Typhon will all be produced in an integrated design under the direction of the Electronics Division's weapon control department. This plan is expected to contribute important advantages in coordinated design, cost reduction through weight reduction, and savings in time.

WYMAN-GORDON COMPANY

Wyman-Gordon Company, Worcester, Mass., was engaged during the year in forging components for major missile, rocket and space vehicle programs in the United States from virtually every metal and alloy known including the high temperature super-nickel alloys and refractory metals.

With large plants in three locations in the east and mid-west the company was increasing employment and intensifying production to meet the soaring requirements of top contractors in an industry rapidly expanding into space. In 1961, a special



Wyman-Gordon operated world's largest closed die forging press.

Research Center apart from production was established to experiment with new materials and processes with a view to production possibilities.

Originally designed for aluminum and light metal applications, the Heavy Press program at the USAF-leased plant in North Grafton, Mass., with equipment including 18,000, 35,000 and 50,000 ton closed die forging presses, was forging columbium, beryllium, tungsten, tantalum and titanium components among other materials in a vastly accelerated program. Machining facilities for customer work and vacuum melting of certain alloys were expanded.

Ring-rolling at the Worcester plant, considered auxiliary to closed die and hammer press work only two years ago, assumed independent status as a vital contribution to space programs with one result that Astroloy, Rene 41, Inconel 109, Waspaloy, molybdenum, titanium, stainless steel and aluminum rings were rolled in production quantities.

Although major production at the Ingalls-Shepard Division, Harvey, Ill., continued to be in the production of automotive forgings an increased amount of production was started there in missile, rocket, and space vehicle work.

Configurations were increasingly varied and complex with forging techniques designed to minimize the amount of machining required on finished forgings. While major production of components went into government aerospace programs much work was being done in commercial areas especially in those related to gas turbine, nucleonic and electronic fields.

MILITARY AEROSPACE OPERATIONS

DEPARTMENT OF DEFENSE

IN THE early part of 1961, the Department of Defense rounded out its team of civilian secretaries assisting Defense Secretary Robert S. McNamara and Deputy Secretary Roswell L. Gilpatric.

Named to be service secretaries were Eugene M. Zuckert, Secretary of the Air Force; John B. Connally, Secretary of the Navy; and Elvis J. Stahr, Jr., Secretary of the Army. Joseph V. Charyk was appointed Under Secretary of the Air Force; Paul B. Fay, Jr., Under Secretary of the Navy; and Stephen Ailes, Under Secretary of the Army.

Other top-level defense aides in the civilian secretariat included: Dr. Harold Brown, Director, Defense Research and Engineering; John H. Rubel, Deputy Director, Defense Research and Engineering; Charles J. Hitch, Comptroller; Paul H. Nitze, Assistant Secretary of Defense for International Security Affairs; Carlisle P. Runge, Assistant Secretary for Manpower; Thomas Morris, Assistant Secretary for Installations and Logistics; Arthur Sylvester, Assistant Secretary for Public Affairs; Cyrus R. Vance, General Counsel; and Steuart L. Pittman, Assistant Secretary for Civil Defense.

Total military strength of DOD in September was 2,514,579, up approximately 30,000 from the previous year. The Army had 869,871 personnel, a slight decline of about 6,000 from the previous year. The Navy was up 14,000, to a 1961 total of 635,787. The Air Force was up 13,000, to 826,793, and the Marine Corps gained almost 9,000 to a 1961 strength figure of 182,128.

Civilian personnel strength averaged about 1,050,000 during the year, and was expected to remain at that figure throughout fiscal year 1962. The following is a breakdown of civilian personnel: Army, 394,000; Navy, 350,000; Air Force, 304,000; Office of the Secretary of Defense, 2000.

During the year, there were several changes in the structure of the Department of Defense. In February, DOD created a new Office of Organization and Management Planning within the Office of the General Counsel. Solis Horwitz was named director of the office, set up to conduct research and provide solutions to Defense management and organizational problems.

In August, DOD announced a new Defense Intelligence Agency (DIA) to combine a number of intelligence functions previously carried out by the separate military departments. DIA was set up to report to the Secretary through the Joint Chiefs of Staff. Selected to head the new agency was Lt. Gen. Joseph F. Carroll, formerly Inspector General of the USAF.

On August 31, there was created within DOD a new Department of Defense Supply Agency, to "manage, procure and distribute common supplies and related services. Lt. Gen. Andrew T. McNamara, formerly deputy commanding general of the Eighth Army, was named head of the agency.

In October, DOD formed a new U.S. Strike Command, a unified command involving the Strategic Army Corps and elements of the Tactical Air Command. Objective of the new command was to "provide combat ready land and tactical air forces which can be rapidly moved when required to augment U.S. forces already deployed or to carry out such other contingency missions as may be assigned by the Secretary of Defense or the Joint Chiefs of Staff."

Temporary headquarters were set up at MacDill Air Force Base, Tampa, Fla., with a permanent headquarters to be set up after a study which would take into consideration the mission and the location of the forces comprising the command. General Paul D. Adams, USA, was named Commander of the U.S. Strike Command and Lt. Gen. Bruce K. Holloway, USAF, was appointed Chief of Staff. The new command was expected to be operational by year-end.

From the operational standpoint, 1961 was a year of heightened activity for the service elements of DOD. Their independent summaries follow. ■

ARMY

The Army's year was marked by a further increase in the number of operational missiles, particularly in the air defense category, and by a slight increase in the aircraft inventory.

At year-end, the Army was operating slightly more than 5,600 planes. This compared with 5,500 at the end of the previous year and 5,200 at the end of 1959.

In keeping with the program established early in 1961 to reduce the number of types of aircraft in the Army inventory, the Army took steps to select a new single light observation helicopter to replace the L-19, H-13 and H-23 aircraft performing observation functions. The Army held a Light Observation Helicopter design competition and selected three winning designs. These designs were to be developed through the flying prototype phase prior to selection of a single final design for the observation role.

During the year, a research program was initiated to develop an integrated Vertical Take-Off and Landing propulsion-airframe system to replace the AO-1 Mohawk in the 1970-80 time span. Two propulsion systems under investigation were the ejection-thrust augmentation system and the lift-fan.

In 1961, the Army also became an active participant in the Tri-Service VTOL Prototype Transport Aircraft Program aimed at providing an operational VTOL vehicle of advanced design.

At the end of fiscal year 1961, the Army force structure included more than two hundred and fifty NIKE batteries committed to continental air defense and more than half a hundred committed in other areas. These figures included operational sites manned by the Active Army involving both Nike-Hercules and Nike-Ajax sites plus 76 Nike-Ajax sites manned by the Army National Guard. These sites were deployed in defense of 30 vital areas consisting of more than three hundred communities in 30 States of the Union.

Also at the end of fiscal 1961, the conversion of Nike-Ajax to Nike-Hercules was progressing in accordance with established programs and was scheduled for completion early in 1962.

New developments increased the effectiveness of the Nike-Hercules. Its mobility was improved by the adoption of a new "Ready Round" transporter. Also, an improved radar considerably increased the

Martin-Orlando's "Ejectijet," experimental Army air car.

The Hiller HO-5, a finalist in the Army's LOH competition.

system's effectiveness in combating smaller and faster targets. On June 1, 1960, under test conditions, the Nike-Hercules intercepted and destroyed a Corporal ballistic missile flying at more than 1,000 miles an hour. Subsequently, the Nike-Hercules intercepted and destroyed a target at an altitude in excess of 100,000 feet. These accomplishments clearly demonstrated Nike-Hercules capability to intercept and destroy any known operational type aircraft and air breathing cruise type missile in existence.

By adding Hawk missile units to Nike-Hercules defenses, a capability to destroy aircraft from tree top level to altitudes in excess of 100,000 feet exists. Hawk missiles joined the Army in new quantities during the year.

Other missiles in the Army's arsenal at the end of 1961 included the Corporal, a short-range ballistic weapon in service for several years; the Redstone, a 250-mile weapon deployed overseas since 1958; Lacrosse, a 20-mile range missile with pin-point accuracy for close support use, and Honest John and Little John, also close support missiles. In development status was the Pershing, a two-stage selective range missile; Sergeant, a replacement for the Corporal; Redeye, a bazooka-type missile for use by individual troops; Mauler, a highly-mobile air defense missile; and Nike-Zeus, the nuclear-tipped anti-missile missile. ■

NAVY

The Fiftieth Anniversary of Naval Aviation was celebrated in 1961. In 1911, the Navy purchased its first airplane and designated its first aviator. In 1961, there were 6,748 Navy aircraft and 184,638 officers and men assigned to aviation activities. To start the next 50 years, Congress authorized the Navy to spend $1.84 billion for 783 new aircraft in fiscal year 1962.

In 1911, a pilot took off and landed from a specially built platform on the armored cruiser *Pennsylvania*. In 1961, the Navy added to the fleet the carriers *Kitty Hawk, Constellation,* and the nuclear powered *Enterprise*.

As part of a buildup of all services in 1961, 18 naval reserve patrol and antisubmarine squadrons were recalled to active duty.

It was announced that USS *Lexington* would be retained in the fleet as an attack aircraft carrier rather than being converted to antisubmarine carrier as was originally planned.

USS *Antietam,* a carrier operated specifically to train student pilots at Pensacola, was to be brought to full status as an antisubmarine carrier.

Naval Aviation in 1961 added a number of new records:

On May 17, a Sikorsky twin-turbined antisubmarine helicopter, the HSS-2, set a new world record by flying a three-kilometer straightaway course at an average speed of 192.9 miles per hour. A week later it was flown over a 100 kilometer course at a record 174.9 miles per hour.

On May 24, four McDonnell-built F4H-1 Phantom II all weather fighters took off from Los Angeles, bound for New York, competing in the Bendix Trophy Race. The best time, a new transcontinental record, was 2 hours and 47 minutes for an average speed of 879 miles per hour.

Earlier in the month, on May 5, two Navy balloonists took off from the aircraft carrier *Antietam* in the Gulf of Mexico and went to an altitude of 113,733 feet, a new world's altitude record for manned balloon flight.

On August 28, a Phantom II was flown four times over an exacting three-kilometer course at low level at an average speed of 902.8 miles per hour for another world record.

Delivery of the record-breaking F4H to the fleet began early in the year; delivery of the HSS-2, in mid-1961.

Other models introduced in the fleet during 1961 included:

A3J-1, Vigilante, an all-weather, supersonic, carrier based heavy attack aircraft.

GV-1, an aerial refueler and assault transport version of the C-130B Hercules delivered to the Marines.

C-130BL, a ski-equipped version of the C-130B, for cold weather operation from ice and snow.

HU2K-1, a carrier-based search and rescue helicopter powered by a single turbine engine with greater range and increased lifting ability.

In addition to these new models, the Navy continued to receive the F8U-2N, and the S2F-3, both significantly improved versions of the basic aircraft.

The principal fighter aircraft flying from Navy carriers during the year were the F8U Crusader, F3H Demon and F4D Skyray. The A4D Skyhawk was the principal light attack airplane and the A3D Skywarrior for heavy attack.

The newest modification of the Skyhawk, designated A4D-5, with a more powerful engine and additional weapon stations was flight tested in 1961.

The first flights of the A2F-1 Intruder, equipped with sophisticated navigation bombing and all weather flight equipment, were made during the year.

For AEW missions, the WF-2 Tracer was flown from carriers and the WV-2 Constellation from land bases.

Marine Corps pilots flew most of the types of aircraft utilized by the Navy and in addition used the HUS-1 helicopter to transport assault forces in the "vertical envelopment" concept of. amphibious operations.

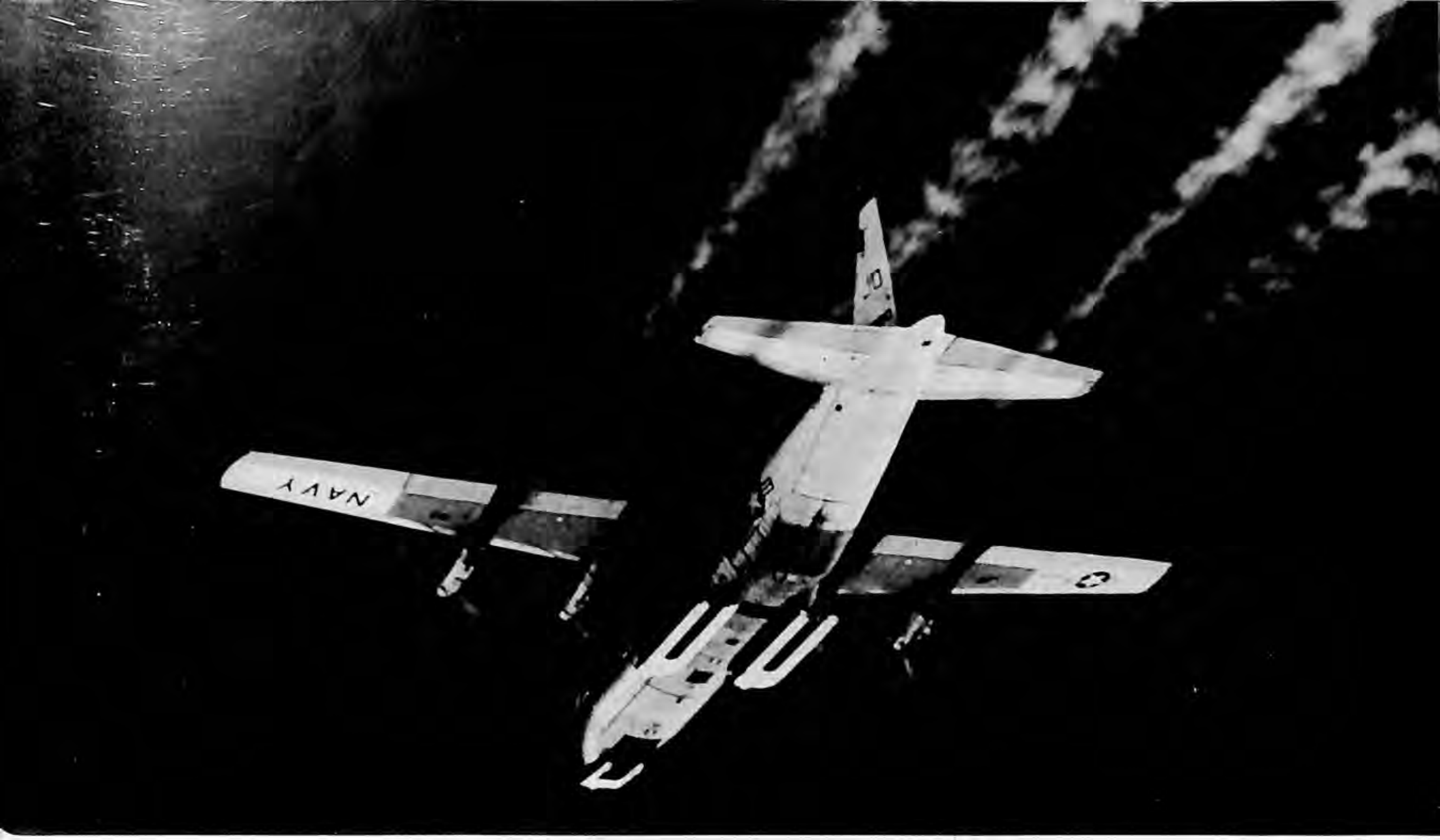
The P2V-7 Neptune was still the mainstay of the land-based antisubmarine warfare planes, combining with carrier based S2F-2 and S2F-3 Trackers and HSS-1 sonar-carrying helicopters to dull the edge of enemy submarine attacks.

The first production model of the P2V's successor, the P3V Orion, was completed and turned over to the Navy. Powered by four turbo-prop engines, it has a cruising speed of more than 400 mph and will carry the latest antisubmarine detection equipment and armament.

The Navy's lighter-than-air program was terminated in 1961. A shortage of funds and personnel combined with the increasing capability of helicopters and fixed wing aircraft to perform the missions of the blimps caused the end of a program that started in 1916.

The Navy's arsenal of missiles was impressive.

The first space triple-payload: the Navy's Transit IVA, Injun and Greb.



The Navy's Lockheed C-130BL Ski Hercules, in service with Deep Freeze 61 task force on the Antarctic ice cap.

The most important strike missile, Polaris, was operational as Polaris submarines were on station throughout the year.

The Polaris sub tender, *Proteus,* was deployed to Holy Loch in March.

The first firing of a second-generation Polaris, the A-2, was made from USS *Observation Island* off Cape Canaveral in March, and the missile traveled 1,400 miles down range. Development of the A-3, scheduled to go 2,500 miles, was underway.

Congress authorized the construction of 10 more Polaris submarines, bringing to 29 the number of submarines built, building or authorized.

Other strike missiles were Regulus and Bullpup.

Sidewinder and Sparrow III were the basic armament for fighters and ships were armed with the proven Terrier, Talos and Tartar missiles.

The Eagle-Missileer program was cut back sharply in April. The Missileer aircraft went first, followed by curtailment of the Eagle missile program. Some development work on a missile to fulfill the Eagle concept continued.

Navy interest turned to consideration of aircraft designed to be used by all services. These included the TFX, an air superiority and attack aircraft for Navy and Air Force use, and VAX, to fulfill TAC and carrier needs.

Development continued on the long range, surface-launched anti-air missile Typhon.

Asroc, the long-range antisubmarine weapon fired from ships, became operational in the Pacific fleet after a firing from the guided missile frigate USS *Mahan* in January.

Development of Subroc, a submarine launched underwater to air to underwater antisubmarine missile, continued.

In the space field, five Navy-sponsored satellites were orbited.—

Transit III-B, another in the series of Navy navigational satellites, was orbited in February, and reentered the atmosphere in March. A piggy-back satellite, Lofti, was aboard and provided new information on very low frequency radio waves.

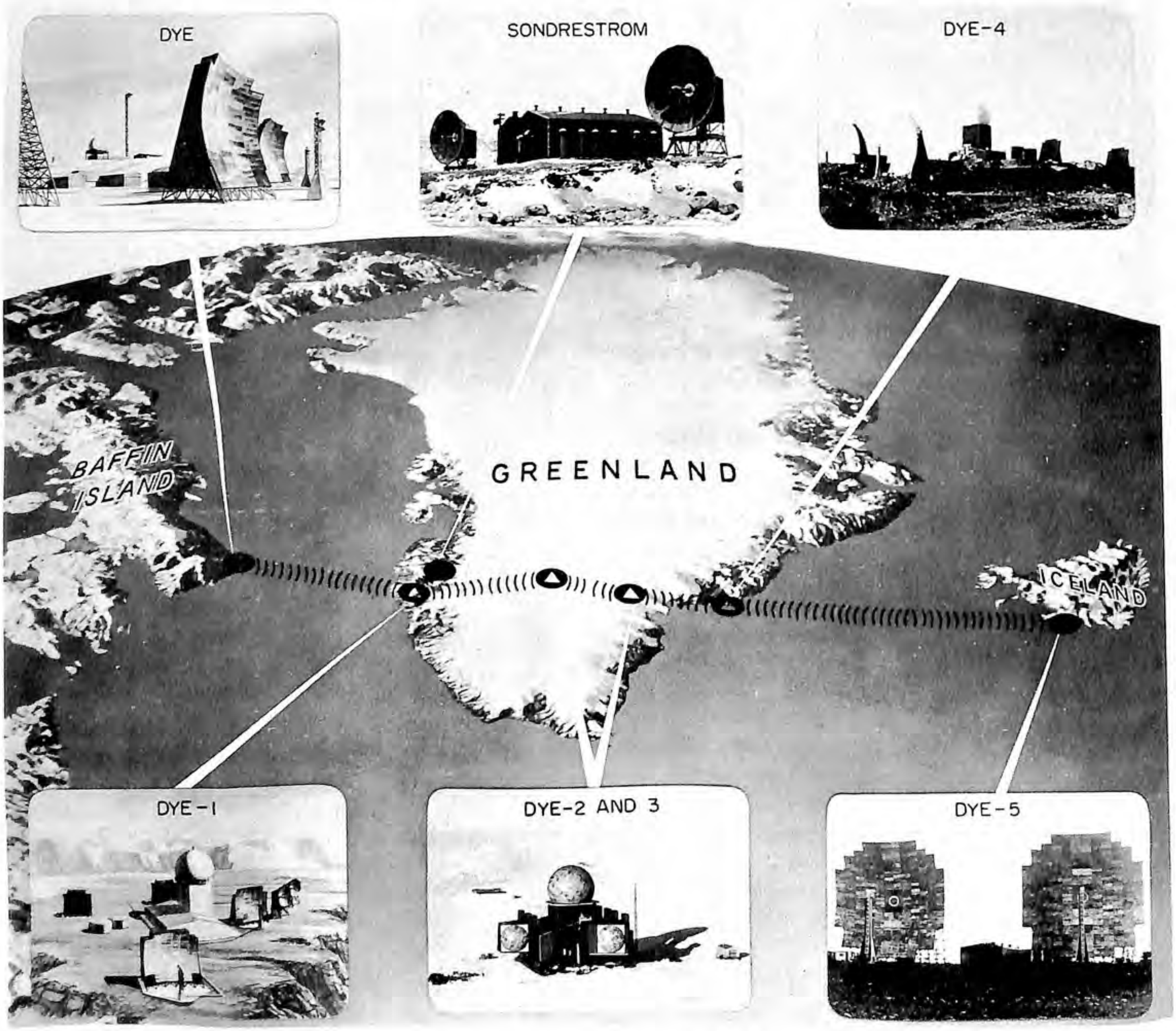
The second Transit of the year was launched in June, this time with two piggy-back satellites, Injun and Greb III, Injun measuring cosmic radiation and the Greb III measuring X-ray radiation from the sun.

Navy and Marine task forces recovered the nation's first two astronauts, CDR. Alan B. Shepard, Jr., USN, in May, and Capt. Virgil I. Grissom, USAF, in July. Navy units also participated in recovery of five unmanned space capsules.

AIR FORCE

In keeping with the increased emphasis on space, the Air Force during 1961 intensified its efforts toward developing space technology. The experimental X-15 set new records for manned aircraft. In November, 1961, it exceeded a speed of 4,090 miles per hour; earlier it had attained an altitude of 217,000 feet. These flights were part of a continuing effort to reach greater altitudes and velocities in order to investigate aerodynamic heating, stability and control.

On October 5, 1961, the Air Force successfully fired an 82-foot Atlas rocket 9,000 miles at a speed of 17,000 miles per hour. This was the fourth 9,000 mile flight in U.S. missile history, all by Atlases. The recovery of the nose capsule marked the longest range recovery of a capsule flown on a ballistic missile. The nose cone, a Mark IV model, capable of carrying a five megaton nuclear warhead, passed its most important test when it survived the near-absolute chill of space and the sun-like heat of return to earth. The new model Atlas will give the missile storable fuel capability for the first time with a much shorter countdown than Atlases now in use. It was scheduled to go into underground silos protected by concrete and steel doors. In contrast to earlier versions which are stored in near-horizontal



The Eastern segment of the DEW line, stretching 1,200 miles from Baffin Island to Iceland, includes seven communications and radar sites.

positions, the new Atlas will be stored in a vertical position, ready for launching.

The Air Force fired a Titan I ICBM on May 3, 1961 from Vandenberg AFB, Cal. This was the first launch of a U.S. missile from an underground silo and it was successful.

Initial tests on a Minuteman, a completely guided, three-stage solid propellant ICBM, began on February 1, 1961 with highly successful results. The Minuteman can be dispersed in hardened launch sites or placed on mobile rail cars. It is simple to manufacture, maintain, and operate and also less expensive than other strategic missiles.

To shelter the Atlas, Titan and Minuteman, a total of 45 bases was planned. Two were completed at Spokane, Wash., and Topeka, Kan., in October and early November, 1961, respectively. These last bases will shelter the Atlas E in semi-hard coffins sunk into the ground so that only the roof shows, making them less vulnerable than before. These models have their own inertial guidance systems not subject to jamming techniques.

The IM-99B BOMARC completed successful test flights against Regulus supersonic missiles and jet drones and was declared operational. On June 1, 1961, the first squadron was activated at Kincheloe AFB, Mich. The Air Force also continued development of the ASG-18 fire control system and the GAR-9 missile to obtain the best advanced armament system for the air defense version of an advanced tactical fighter.

The Discoverer research satellite program has the objective of developing reliable hardware techniques, and procedures for the operation and control of space systems. As of October 30, 1961 the Air Force had launched a total of 33 Discoverers, orbited 23 successfully and recovered 9. Of these nine recoveries two were by sea and seven by air. These flights obtained data on radiation, biomedicine and other research areas.

Cooperating with the National Aeronautical and Space Agency (NASA), the Air Force launched the Atlas Able 5A and 5B orbit attempts and three Mercury Atlas shots supporting the man-in-space program. The Air Force also increased the number of technically qualified USAF military personnel on duty with NASA.

The Air Force continued development of the B-70 prototype to explore the problems of flying at three times the speed of sound with an airframe potentially useful as a bomber. Funds were available for the development and test of three noncombat prototype XB-70's. Fabrication of the first aircraft was on schedule at the end of the year. This program, subject to speed-ups and cut-backs, received appropriations for fiscal year 1962 of $180,000,000 above the amount asked by the President, and plans to accelerate research and development of the B-70 were being considered.

The Strategic Air Command, the nation's primary striking force received additional Atlas ICBM's, B-52G's and H's, B-58's and KC-135 tankers. In January, 1961, a B-52G flew 10,000 miles without refueling. Both the G and H series of the B-52 were modified to include improved bombing-navigation and electronic countermeasure equipment and capability for carrying GAM-77 Hound Dog, GAM-87 Skybolt and GAM-72 Quail. At the end of June 1961 SAC had 1 missile, 2 reconnaissance, and 34 bomber wings.

The Tactical Air Command participated in numerous exercises both singly and jointly. In August, 1961, it took part in the largest peacetime military training exercise since 1941, Operation Swift Strike. The operation resulted from President Kennedy's decision to alert and increase the combat readiness of the armed services because of the Berlin crisis. The exercise included dropping parachute troops and fighting under simulated war conditions with TAC providing air support with F-100's, F-105's and F-104's. It was designed to test the ability of the command to fight small or limited wars anywhere in the world with composite air strike forces relying on speed, mobility, and versatility. To help carry out its mission, TAC received in 1961 more all weather F-105D's, and SAC's KC-135 tankers supported TAC's long-distance deployments. In the F-105, TAC received for the first time a high-performance aircraft with full all-weather and night attack capabilities.

MAT's modernization program was given high priority and it was able to purchase 50 C-130E's and 30 C-135's. The C-130 is a turboprop transport while the C-135 is a jet transport, a modification of the KC-135 tanker. With a crew of six, the C-135 can carry 126 seated passengers or 40 litter and 54 ambulatory patients. Ultimately MATS planned to acquire the C-141, which has turbo fan engines. This long range, high speed plane will have a true global capability.

The Air Defense Command's Ballistic Missile Early Warning System (BMEWS) neared completion. Addition of the all-weather interceptors, the F-101B and the F-106, completed the modernization of the ADC interceptor force. The F-102, already in operation for some years, was equipped with GAR-11 rockets which have a nuclear armament comparable to the MB-1 nuclear rockets carried on the F-101 and F-106. All three interceptors have improved fire control and armament systems.

Late in 1960 the Air Force received responsibility for the Project Space Track. The entire Space Detection and Tracking System (SPADATS) was assigned to the North American Air Defense Command (NORAD). In February 1961, the first Aerospace Surveillance and Control Squadron was activated and an interim SPADATS Control center was opened at Ent AFB, Colorado.

A prototype atomic bomb alarm system covering 14 areas of the United States became operational during the year; it was eventually to be extended to 97 target areas. Command and control projects included an emergency message automatic transmission system between Washington and the unified and specified commands, a new mobile communication system to contact key personnel in transit, and a Washington command post alert net covering most of the major USAF Commands.

To assure Air Force commanders instantaneous worldwide contact, the Air Force initiated on July 1, 1961, the new Air Force Communications Service (AFCS), which planned to have the most extensive communication capability possible—a worldwide system under centralized management. It has facilities for communication, air navigation, and command and control. In two years the AFCS will assume responsibility for operating and maintaining USAF communication facilities and navigational aids throughout the world. When fully manned, it will have a staff of 50,000.

The USAF's Midas satellite, launched by an Atlas-Agena, takes off from Cape Canaveral.

Major organizational changes occurred during the year. In April 1961, the Air Force established the Systems Command (formerly Air Research and Development Command) to handle advanced technology, testing, procurement, production, contract management, and site activation. It provided a single authoritative course for dealing with industry from time of requirement to delivery of production article. The Air Force Logistics Command (formerly Air Materiel Command) maintained responsibility for support of the weapon systems and a substantial amount of procurement. To accord with these changes, Headquarters USAF realigned the functions of the Deputy Chief of Staff, Development and the Deputy Chief of Staff, Materiel and redesignated them respectively as Deputy Chief of Staff, Research and Technology, and Deputy Chief of Staff, Systems and Logistics. These changes will permit more rapid review and approval of system program matters and will increase emphasis on more effective management of such programs. Further, an Office of Aerospace Research, a separate and independent office, was established directly under Headquarters USAF.

Another most important change for the Air Force involved its leadership. Eugene L. Zuckert became Secretary of the Air Force in January, 1961. Mr. Zuckert had been an Assistant Secretary of the Air Force in the late forties and early fifties, and a member of the Atomic Energy Commission from 1952 to 1954. On June 30, 1961, General Curtis E. LeMay, Vice Chief of Staff for four years, succeeded retiring General Thomas D. White. General Frederic H. Smith, Jr. assumed the duties of Vice Chief of Staff, reporting from his post as Commander of the U.S. Air Forces in Europe.

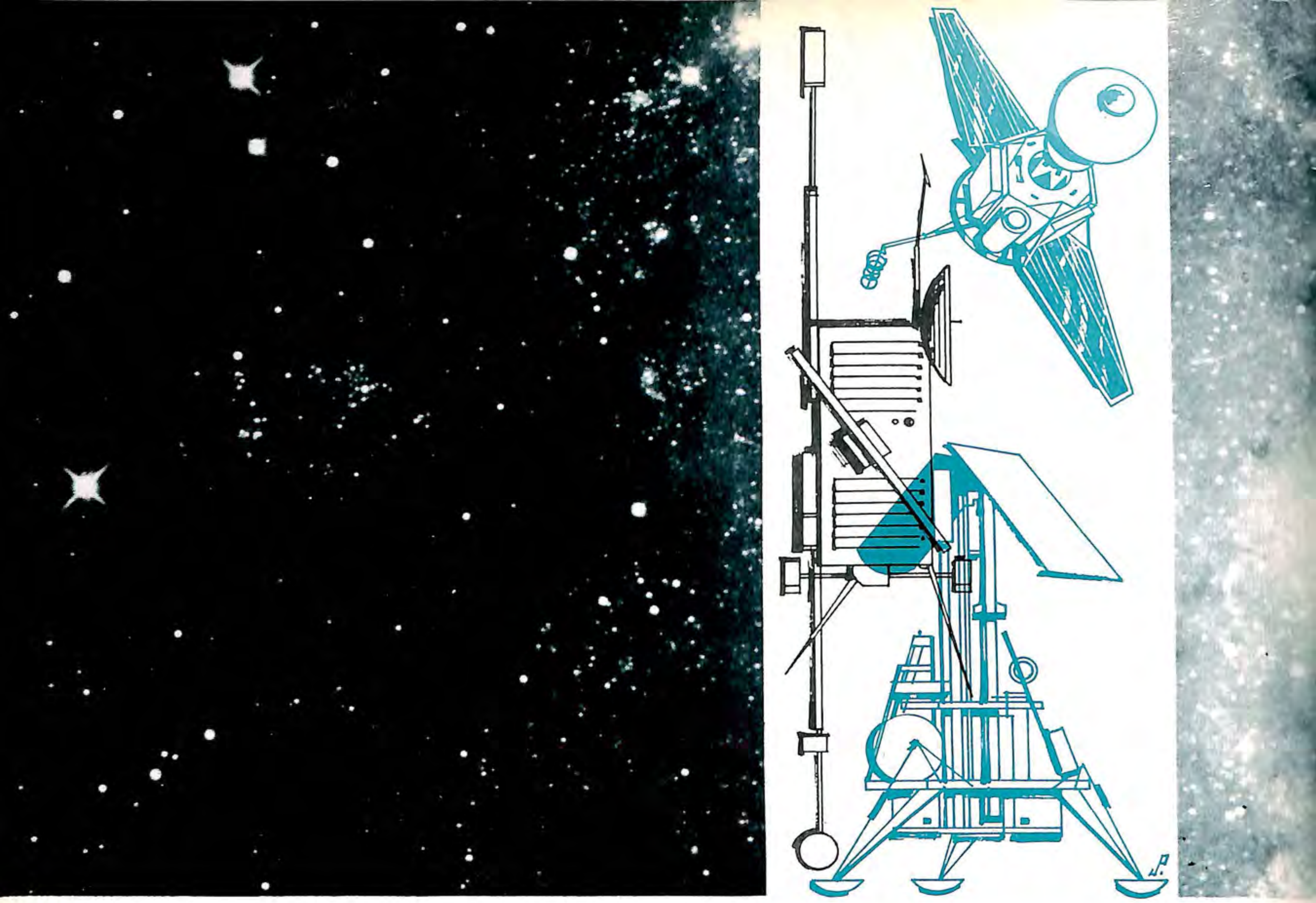
The Air Force showed a small increase in manpower over 1960 which allowed augmentation of support and training forces where shortages were most pronounced. As of June 30, 1961, 821,151 military personnel were on active duty and 303,367 civilians were employed by the Air Force. Of the military personnel 128,793 were officers and 692,358 were airmen. A total of 204,131 officers and airmen were serving overseas. The AFROTC continued to supply the largest number of officers. In 1961 it commissioned 3,279 graduates, as compared with OTS which graduated 581 men and OCS which commissioned 396 men. The Air Force Academy graduated its third class; 213 regular Air Force Commissions were granted. 802 new cadets entered the class of 1965, the largest to date.

As a result of the Berlin crisis, President Kennedy's proposed increases in the armed services were authorized by Congress almost immediately. The Air Force was allowed a 63,000 man increase, 30,000 to come from Reserve units and 33,000 from extensions of service personnel already on active duty. As of October 10, 27,320 Air Force Reservists had been called to active duty. Ordered to report on October 1 were 18 fighter squadrons, four reconnaissance squadrons, eight transport squadrons, eight weather squadrons, five troop carrier squadrons, and a number of ground support units. Three additional fighter interceptor squadrons with their supporting units were given a reporting date of November 1. Some squadrons will replace regular Air Force squadrons already deployed overseas while others will themselves go overseas.

Of the increased authorizations of funds, the Air Force was allotted $425,000,000 for equipment: $241,000,000 for planes especially F-105D supersonic fighter-bombers and C-130B and E transports; $62,000,000 for missiles (Sidewinders and Bullpups) for fighter and interceptor squadrons; $111,000,000 for conventional bombs and ammunition, and $11,000,000 for base and organization equipment.

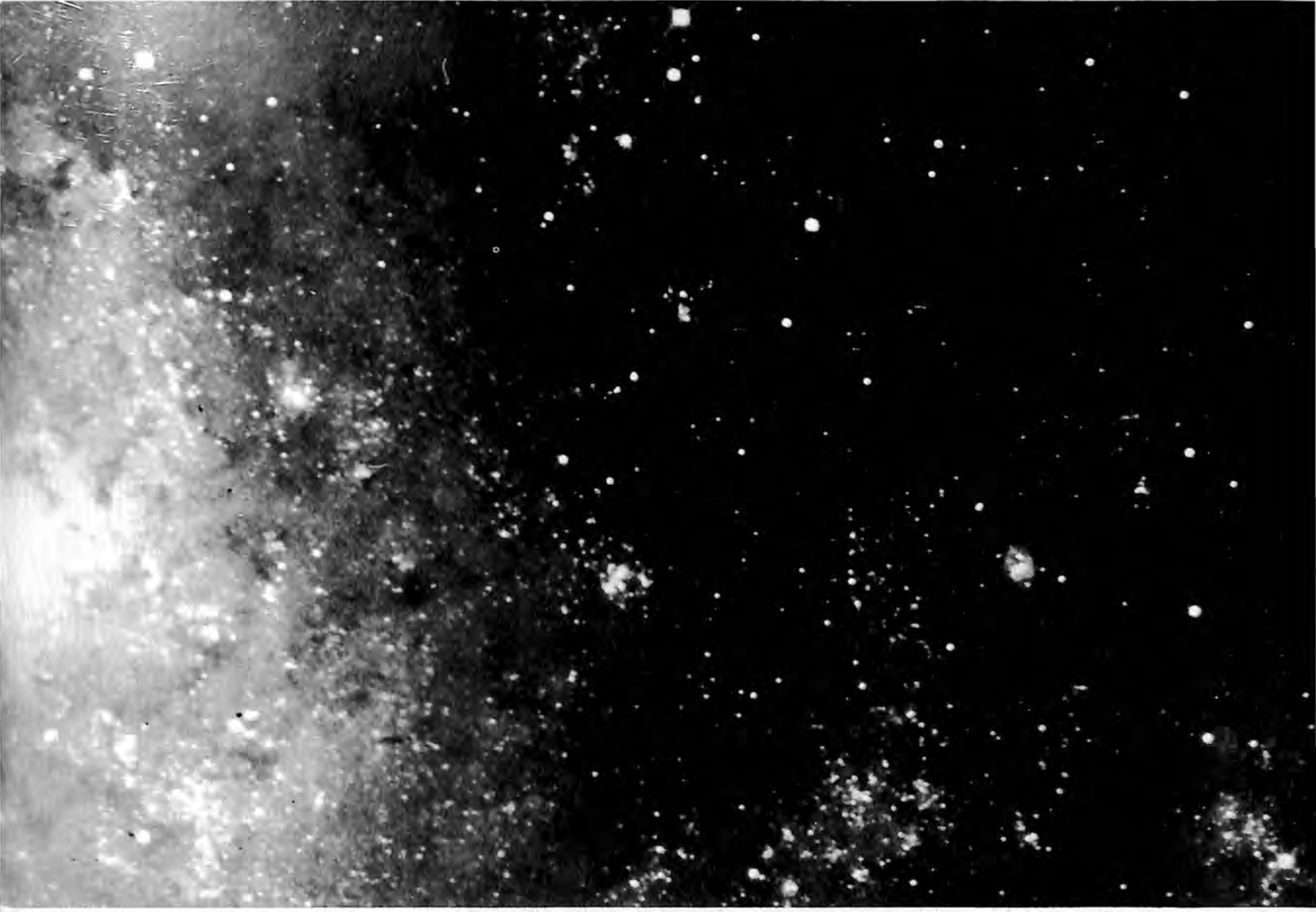
During 1961 the Air National Guard and the Air Force Reserve increased their stature as part of the combat-ready forces of the nation. Under the new plan instituted in 1960, the major commands assumed responsibility for training and inspection of ANG and AFRes units that would be assigned to them if mobilized. The application of identical training and performance standards to both active duty and inactive duty units of the same type resulted in increased responsiveness to USAF needs. Further, reservists assumed greater responsibility for their own program and for managing local unit programs. In keeping with the policy of assigning new and useful missions to the reserve forces, the Air Force gave one AFRes troop carrier wing the additional mission of mid-air recovery of nose cones. Inactive duty reserve aircrews will also fly airlift missions in support of site activation.

The USAF was preparing for early introduction of the Titan missile to operational service.



RESEARCH AND DEVELOPMENT

A resume of the major government-sponsored research and development programs is contained in this section. Details of the vast amount of research and development accomplished by aerospace manufacturers are contained in the individual company summaries.



THE MILITARY SERVICES

AN IMPORTANT STEP in the administrative end of military research and development took place on April 1, 1961, when the USAF established the Air Force Systems Command, in which all phases of systems acquisition, from design study to delivery, were placed under a single manager. The realignment was hailed as "one of the most significant and forward-looking management undertakings in U. S. Air Force history."

The new command retained most of the research and development responsibilities of the Air Research and Development Command. At the same time, it acquired the added responsibility for systems production and procurement, formerly assigned to the Air Materiel Command. A third major responsibility delegated to AFSC was supervision of the construction of ballistic missile sites—a task performed by the Army Corps of Engineers.

AFSC's mission calls for the delivery of complete, timely, and operable weapon systems to using commands such as the Air Defense Command, the U. S. Strike Command, and the Strategic Air Command.

Specifically, AFSC was established to provide improved management of research and development through realignment of functions and responsibilities and through redistribution of associated resources.

The command's progressive management policies were designed to provide rapid decisions and speed up actions for all U. S. Air Force systems programs; insure efficient, responsive management of space development responsibility assigned to the Air Force by the Secretary of Defense; provide for close integration and participation of the Army Corps of Engineers in the construction and activation of ballistic missile sites; and provide effective liaison and participation by Army, Navy and NASA on projects being developed for those agencies by the Air Force.

Undoubtedly the most significant single management policy effected by the command focused on decentralization. Responsibility for system projects was delegated to command field levels. Consequently, AFSC was able to coordinate more effectively the efforts of the military-science-industry team at local levels.

Lastly, decentralization enabled headquarters to devote more effort to long-range planning and aerospace policy decisions.

Three months after the formation of AFSC, the command acquired three Contract Management Regions—once part of AMC. Each region is responsible for surveillance, production, quality control, property quality control, flight test, and other operating functions relating to the administration of Air Force contracts in their respective geographical areas.

The Eastern Contract Management Region (ECMR), covering 19 eastern states and the Caribbean area, has its headquarters at Olmsted AFB, Pa. The Central Contract Management Region (CCMR) at Wright-Patterson AFB, Ohio, takes in an 18 state area. The Western Contract Management Region (WCMR), covering 13 states including Alaska and Hawaii, has its headquarters at Mira Loma AFS, Calif.

The face value of contracts managed by AFSC represents, over the years, an expenditure of more than $60 billion.

On July 1, 1961, the command acquired the Aerospace Technical Intelligence Center, later known as the Foreign Technology Division. FTD integrates foreign with domestic technology so that time spent on scientific research may be reduced and duplication of effort eliminated.

Organizationally, the command is made up of seven divisions and six functional centers. The divisions and their locations are: Aeronautical Systems Division, Wright-Patterson AFB, Ohio; Electronics Systems Division, L. G. Hanscom Field, Bedford, Mass.; Space Systems Division, Los Angeles, Calif.; Ballistic Systems Division, Los Angeles, Calif.; Foreign Technology Division, Wright-Patterson AFB, Ohio; and the Aerospace Medical Division at Brooks AFB, San Antonio, Texas.

The six AFSC functional centers are the Air Force Missile Test Center (AFMTC), Patrick AFB, Fla.; the Air Force Flight Test Center (AFFTC), Edwards AFB, Calif.; the Air Force Special Weapons Center (AFSWC), Kirtland AFB, N. Mex.; the Arnold Engineering Development Center (AEDC), Arnold Air Force Station, Tenn.; the Air Force Missile Development Center (AFMDC), Holloman AFB, N. Mex.; and the Air Proving Ground Center (APGC), Eglin AFB, Fla. A seventh center, Rome Air Development Center (RADC), Griffiss AFB, N.Y., is administratively assigned to the Electronics Systems Division. RADC provides direct electronics systems engineering support in ground environment to ESD.

The increasing interest being placed on AFSC military space activities was indicated by Air Force mission assignments and appropriations made by Congress.

On March 6, 1961, Secretary of Defense McNamara announced his decision to assign responsibility for military development in space to the Air Force.

Less than two weeks later, the Secretary of the Air Force and the Chief of Staff detailed a far-reaching reorganization of the Air Force's scientific research, development and procurement programs. Thus it came about that all phases of systems acquisition became the responsibility of a single manager —AFSC.

AFSC engages in both conventional and scientific aerospace research as it has in the past, but both the command's activities and its appropriations have kept pace with the space age.

In six years, for instance, the Air Force's annual budget for ballistic missiles and space systems alone soared from about $4,000,000 to more than $3 billion.

In 1961, AFSC was spending the largest single portion of the Air Force budget—$7 billion, or over one third of the total USAF budget.

In fulfilling its 1961 mission, AFSC's activities ranged the scientific spectrum from aviation medicine to "zero" launching of jets.

Activities in the ballistic missile testing area included the first successful launching of the solid-fuel Minuteman ICBM; the first successful flight of the advanced Atlas Series E missile; and the first successful silo-launching of a Titan ICBM.

The principal test activity of the Atlas program centered in the E Series. The SM-65E Atlas uses an all-inertial guidance system and an improved propulsion system operating at a higher thrust level than earlier versions of the Atlas. Incidentally, the new Atlas booster engines were adapted for use in the Saturn space booster.

Tactical deployment of the E Series missiles employed the "coffin" launch implacement for protection from near-miss detonations. Atlas Series F missiles, mechanically similar to the Series E, were designed for launching from silos, as were Titan ICBMs.

After the preliminary sub-orbital flights of the Redstone-boosted Mercury program were completed, attention focused on the Atlas Series D, scheduled for use in the Mercury orbital program. Series D development launches were completed and tactically deployed at Strategic Air Command sites.

During the year, progress continued on the Titan II program associated with large liquid propellant space vehicles.

An improved version of Titan I, Titan II uses a storable oxidizer propellant which eliminates many of the tactical hindrances with liquid oxygen as an oxidizer.

Titan II was the first large liquid propellant vehicle suitable for use in space explorations that incorporated a propellant which could be left in the vehicle for extended periods. The technical difficulties and design requirements inherent in using cryogenic propellants thus were eliminated.

The first solid propellant ICBM, the Minuteman, was classified as an unqualified success. The initial captive test program at Edwards AFB, Calif., was reduced considerably when tethered launchings proved to be outstandingly successful. The first attempt at full-range from Cape Canaveral on February 1, 1961, proved equally successful.

Testing of the supersonic strategic Hound Dog continued during the year. The 43-foot missile with a range of more than 500 miles was scheduled for early SAC use.

Skybolt, an air-to-surface ballistic missile was further researched and tested. The missile, to be launched from B-52 type bombers, has a range of more than 1,000 miles. B-52's can carry four of the two-stage, solid-propellant Skybolts in addition to other armament.

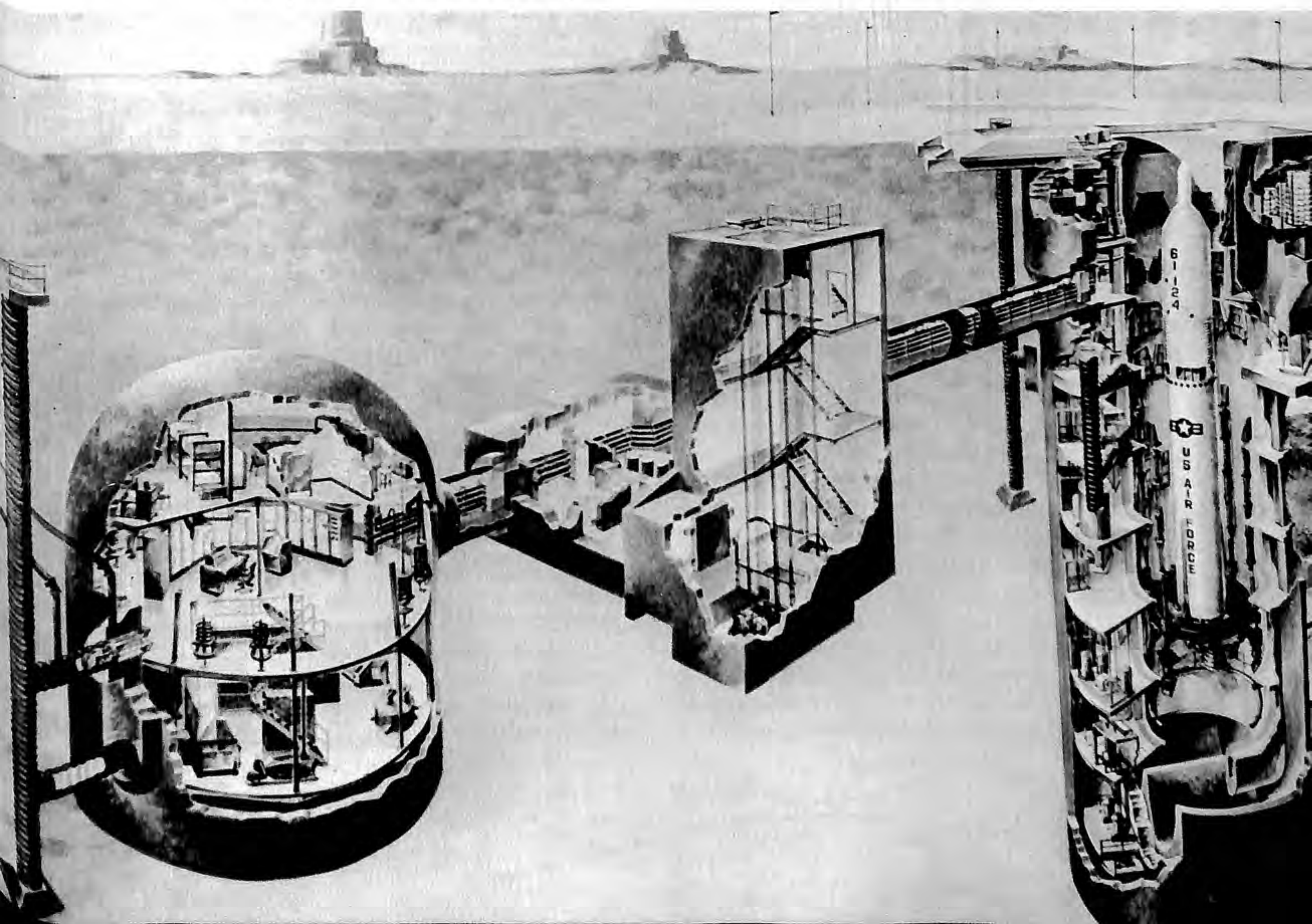
In the transport field, AFSC had under development the C-141 all-jet cargo carrier. Approaching the final design stage at year-end, the C-141 was scheduled for a first flight late in 1963 and introduction to the operational inventory by mid-1965.

The C-141 will be capable of airlifting 69,300 pounds of payload across the Atlantic and 39,000 pounds across the Pacific. For domestic operation, it will be capable of airlifting 80,000 pounds of payload from coast to coast at a cruising speed of 440 knots.

In conventional flight testing, the X-15 research aircraft was piloted by Major Robert White to a speed of 4,093 miles per hour and by civilian Joseph A. Walker to an altitude of 217,000 feet.

The X-15 was first flown under rocket power in

The complexity of an underground ICBM installation is pointed up by this artist's conception of a Titan II launch complex.



The North American X-15 special research plane reached an altitude of 217,000 feet and a speed of 4,093 miles per hour during 1961.

September, 1959. Individual test objectives were steadily increased during the intervening period with new records for altitude being set on almost each succeeding flight. The data being produced by the X-15 program is a major contributor to the Dyna-Soar program.

Research continued during the year on Dyna-Soar, the planned follow-on to the X-15. It was planned that the orbital manned spaceship will be boosted by a modified Titan III. Re-entry was planned from orbital altitude and velocities at hypersonic speed, and the spacecraft will land normally at conventional air fields.

Other projects researched or developed by AFSC during the year included a series of studies of high-altitude space environment with the Blue Scout rocket.

In the bioastronautics area, AFSC carried out investigations to further knowledge on such space problems as weightlessness, space feeding, and radiation.

One of the more dramatic programs under AFSC direction was Discoverer. This satellite program earned the U.S. a series of space "firsts." At year-end 33 Discoverers had been launched, and 23 of them were successfully placed in orbit. Nine capsules were recovered. Of the successful recoveries, seven were aerial recoveries and two water recoveries.

The Army's research and development effort in 1961 was concentrated on air defense missiles and new types of VTOL/STOL aircraft. The Army had no direct sponsorship of space programs, but it contributed to the national program through a support role in Project Mercury. The initial U.S. men in space were launched by the Army-developed Redstone booster.

The Army's major missile program continued to be the Nike-Zeus anti-missile missile, designed to "kill" enemy IRBM or ICBM warheads. During the year, the Army held a successful series of test firings, including a shot late in the year when Nike-Zeus intercepted and destroyed a Nike-Hercules. At year-end, the Army was preparing for an advanced test series in which the Nike-Zeus would attempt to shoot down, from a base at Kwajalein, ICBM's launched from the Pacific Missile Range.

In advanced development status were two important battlefield missiles, Pershing and Sergeant. The latter is a solid-fueled surface-to-surface weapon, designed as a replacement to the Corporal in service, but offering a higher degree of mobility. Pershing, also solid-fueled, is a Redstone replacement.

Also in advanced development were two new air defense weapons, Redeye and Mauler. Redeye, shoulder-fired and man transportable, is an infrared-guided missile for use by ground troops against aircraft attacking at low altitude. Mauler is a highly mobile, radar-guided weapon for use against aircraft and short range missiles in forward battle area positions.

The Redhead/Roadrunner, the Army's ramjet powered target missile, completed a successful series of flight tests at the White Sands Missile Range. The target missile is designed to operate at speeds from Mach 0.9 to Mach 2.

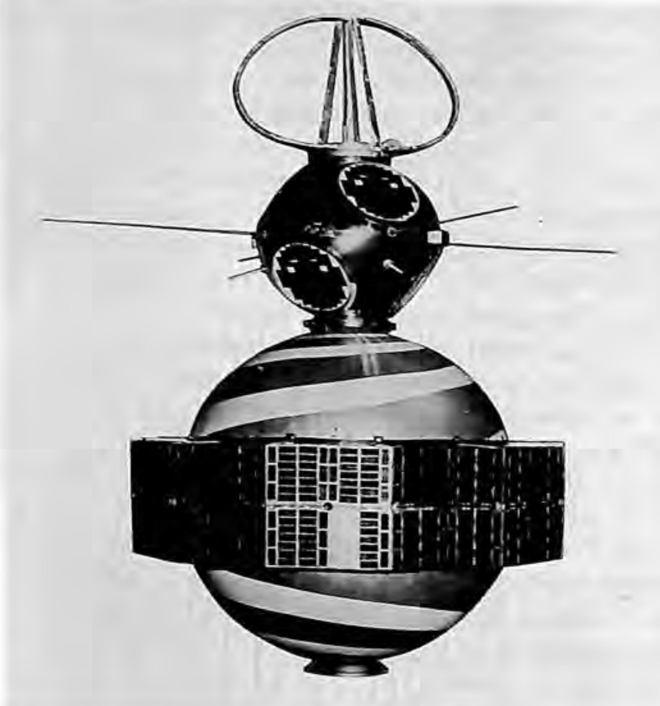
An Army research program of considerable interest was the Bell-designed rocket "flying belt," designed to provide troops with free flight capability with portable rocket equipment. On April 20, the first test of this system was made by a Bell test engineer, who successfully flew 100 feet. More than 60 flights were made during the year. At year-end, the developmental effort was being concentrated on producing operational hardware with lower weight and greater range than the prototype model.

In the fixed-wing aircraft field, the Army continued development of the Grumman AO-1 Mohawk, an infrared and radar equipped surveillance plane, and the STOL Caribou, which can lift three tons of supplies from an unimproved field less than 1,000 feet long.

During the year, another step was taken toward filling the Army's important light observation helicopter requirement, which envisions approximately 3,500 of these craft in service by 1970. The Army conducted a LOH competition among rotary wing manufacturers and selected designs submitted by Bell Helicopter Company, Hiller Aircraft Corporation and Hughes Tool Company's Aircraft Division, all powered by Allison T63 turbine engines. Contracts were awarded for prototypes of the three designs, one of which will be selected as the final LOH.

In the VTOL field, the Army's XV-3 convertiplane, being built by Bell, was put through a series of NASA tests and made more than 100 conversion flights.

The Navy's space effort centered on the Transit navigational satellite. Three of the Transit vehicles were placed in orbit during the year—Transit IIIB on February 21, Transit IVA on June 29 and Transit IVB on November 15. Each of the Transits carried a "piggyback" passenger spacecraft. Transit IIIB carried a Naval Research Laboratory spacecraft called Lofti, designed to measure solar radiation in the ionosphere. Transit IVA carried two small spacecraft called Injun and Greb III, the former designed for measurement of cosmic radiation intensity and the latter equipped for solar X-ray radiation measurement. Transit IVB carried a 43-inch diameter doorknob-shaped satellite named TRAAC, the objective of which was to test the



The Navy's Transit IIIB satellite with its piggyback passenger, Lofti.

feasibility of a spacecraft stabilization system using the earth's gravitational field.

The Navy also participated in the Project Mercury man-in space program, providing task force support for the recovery of both manned and unmanned Mercury capsules.

The Navy's major missile development program during 1961 revolved about the Polaris weapon system. With the A-1 Polaris on operational duty with the fleet, work advanced on the A-2 version, first flight tested late in 1960. The A-2 is designed for a range of 1,500 nautical miles, 300 miles longer than the initial version. During 1961, the Navy also worked on development of a still-longer-ranging version, the A-3, which will have a range of 2,500 nautical miles and is expected to be in service by 1965.

Development continued on two other important Navy missiles, the Typhon and the Subroc. Typhon, an outgrowth of the Talos missile, is a versatile weapon, designed primarily as a long range anti-aircraft missile, and having in addition a surface-to-surface capability for use against enemy fleets. Subroc is a submarine launched underwater-to-air-to-underwater antisubmarine missile.

The Bullpup B air-to-surface missile moved into advanced development status with first test launchings from A4D aircraft at Point Mugu, Calif. The Bullpup B, which carries a 1,000 pound conventional warhead, is a larger version of the Bullpup A already in Navy service.

The Eagle-Missileer system, which was to have mated a medium-performance aircraft with a high performance air-to-air missile, was sharply cut back during 1961. The Missileer portion of the program was canceled and the weapon portion continued at a reduced rate. The Navy did, however, continue development of the TF30 turbofan engine which was to have powered the Missileer.

In the aircraft field, the Navy served as co-sponsor of two competitions for military aircraft, the TFX, an air superiority and attack aircraft for Navy and Air Force use, and the VAX, a tactical fighter designed to fill the needs of both Navy carrier task forces and the USAF's tactical air command.

In February, the Navy concluded a helicopter design competition for a new assault transport, accepting a new version of the Vertol 107, designated HRB-1.

The Navy continued to investigate ground effect machine concepts, completing evaluation during 1961 of the Bell Hydroskimmer, a craft which rides over the water on a cushion of air with forward momentum provided by an outboard motor. The Navy was considering a Bell proposal for a larger GEM machine, to be used as a cargo and troop transport vehicle.

The Navy also continued to explore the possibilities of drone helicopters for the anti-submarine warfare mission. In March, the Navy concluded evaluation trials of the Gyrodyne DSN-1 drone. The DSN-2 made its first flights during the year and the advanced DSN-3 was delivered to the Navy for shipboard evaluation. The Navy was also investigating a manned version of the DSN-3, which had its first flight on April 6, 1961. A number of companies were competing with antisubmarine drone helicopter designs.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The National Aeronautics and Space Administration (NASA) accelerated planning for Project Apollo in 1961 as a result of the President's May 25 decision to land a crew on the moon by 1970 and his recommended increases in the agency's 1962 budget request.

The President established the manned lunar expedition as a national goal. To carry out this and other space missions, NASA effected a major reorganization and extended its facilities, including plans to establish a Manned Spacecraft Center in Houston, Texas, and a fabricating plant for advanced launch vehicles at Michoud, outside New Orleans, La. The agency planned to increase its launch facilities at the Atlantic Missile Range, Cape Canaveral, Fla.

The year also witnessed the following events:

- The first two manned suborbital flights in Project Mercury and the first orbital flight of an Atlas-launched Mercury capsule carrying a chimpanzee.
- A succession of speed and altitude record-breaking flights by the rocket-powered X-15 airplane (a joint Air Force-NASA-Navy project).
- The first flight test of the powerful Saturn (S-1) booster and successful static tests of the single chamber 1.5-million-pound-thrust F-1 engine.
- The launching of Explorer XI, the first astronomical observatory satellite and TIROS III, an experimental weather satellite.
- Acceleration of plans, in conjunction with the Department of Defense and the Federal Aviation Agency (FAA), for the development of a supersonic jet transport capable of cruising at Mach 3, or more than 2,000 mph.

NASA, which was three years old on October 1, was created to direct the Nation's non-military space and aeronautical research programs and to support the military effort. The National Aeronautics and Space Act of 1958 calls upon the agency to exploit the earth's atmosphere and space "for the benefit of all mankind."

At year-end, Project Apollo was the spearhead of NASA's multi-billion-dollar program for the 1960-70 decade, a program which should advance science and technology across a broad front with resultant practical benefits in scores of areas—meteorology, life sciences, electronics, communications, fuels, metals, data processing, and geophysics.

Most of the NASA program relates in some measure to Project Apollo. The project is closely tied in with the Mercury and Saturn programs; development of the huge F-1 engine and the Nova superbooster concept; development of rendezvous techniques; and the unmanned lunar and planetary exploration programs. NASA's research into high temperature-resistant materials, high-energy fuels, bio-astronautics and many other subjects feed into the Apollo effort.

Project Apollo is a major step toward manned exploration of the solar system. The lunar program will provide the agency with the experience for conducting flights to the nearer planets. It will enable NASA to perfect communications and guidance and propulsion systems over the lunar distance—about a quarter of a million miles—and thus get experience for the longer voyages to Venus and Mars.

The manned and unmanned planetary missions have as their scientific objectives the study of the origin and evolution of the solar system; the study of the nature of planetary surfaces and atmospheres; and the search for life forms.

Project Apollo's basic concepts were worked out in numerous studies by NASA and by private industry. The ultimate objective is to land three men on the moon: a spacecraft commander, a navigator-pilot and an engineer-scientist. After exploring the lunar surface for a matter of hours, the crew will launch their spacecraft and return to earth. This objective will be reached in progressive steps.

The Apollo spacecraft will first be flown in earth orbit where its many components and systems will be well-tested and evaluated in the space environment. These flights will also provide for crew training and the development of operational techniques. In conjunction with these qualification flights, the spacecraft can be used as an earth-orbiting laboratory for scientific measurements and technological studies.

Next, the spacecraft may be flown to greater and greater distances from the earth, until manned circumlunar flight is achieved. In circumlunar flight, the crew will perform many of the guidance and control tasks that will later be required for the lunar landing mission including return to earth, high-speed reentry and earth landing.

A number of launch vehicles and techniques are being considered for these missions. The two-stage Saturn C-1 will launch the earth-orbital missions. The Saturn C-3 model, plans for which have not yet solidified, may fire the circumlunar spacecraft. And the giant Nova, still in the concept stage, may propel the manned lunar landing spacecraft. Rendezvous techniques, employing the advanced launch vehicles, were also under consideration and large solid-propellant engines were under Air Force study and development with NASA support.

The Apollo spacecraft design had not been set by the end of 1961. George M. Low, Assistant Director, Manned Space Flight Programs described it in general terms:

"In order to achieve the multiplicity of Apollo missions; the so-called 'modular-concept' will be employed in the design of the spacecraft. In this concept, various building blocks, or modules, of the vehicle systems are used for different phases of the mission.

"The first of these components, which we have called the 'command center module,' will house the crew during the launch and reentry phases of the flight; it will also serve as a flight control center for the remainder of the mission. It will be sufficiently large for a three-man crew.

"The second module is a propulsion unit. In earth-orbital flights this unit will serve to return the craft to earth under both normal and emergency conditions. It will also be used for maneuvering in orbit and for orbital rendezvous with other satellites. For circumlunar flights, this same propulsion module will be designed so that it can return the spacecraft to earth safely from any point along the lunar trajectory. For circumlunar flights, it will provide mid-course and terminal guidance corrections; and it can place the spacecraft into a satellite orbit around the moon and eject it from that orbit and return it toward the earth. For the case of the lunar landing mission, the same propulsion unit will be the take-off stage from the moon in order to return the spacecraft toward the earth.

"The third module is the propulsion stage that will decelerate the spacecraft as it approaches the moon and gently lower it to the moon's surface.

"For the earth-orbital missions, an additional module can be provided to serve as an earth-orbiting laboratory.

"Of all the modules mentioned, only the command center will be designed with the capability of reentering the earth's atmosphere and of being recovered on the surface of the earth.

"The Apollo spacecraft is, therefore, seen to be a versatile one; it will involve the development of a number of components but maximum use will be made of these components for three Apollo missions. . . ."

In November, NASA awarded North American Aviation, Inc., a contract to design and build units of the three-man Apollo spacecraft.

The first manned suborbital flight in Project Mercury was carried out successfully on May 5.

At 9:34 a.m. EST, a 78,000-pound-thrust Redstone (MR-3) lifted off from Pad 5 at Cape Canaveral carrying astronaut Alan Bartlett Shepard, Jr., 37, in a Mercury capsule.

The 2,800-pound capsule landed 302 miles downrange in the Atlantic Ocean 15 minutes and 22 seconds later, after reaching a peak altitude of 116½ miles and a top velocity of 5,180 mph.

Shepard underwent five minutes and four seconds of (zero-g) weightlessness, and maximum reentry forces of 11 g's. He carried out all his tasks as assigned and suffered "no physiological defects" from his flight.

Shepard was hauled into a Marine Corps HUS-1 helicopter within two minutes of landing; he was on board the carrier, three miles away, after another six minutes.

On July 21, astronaut Virgil I. Grissom became the second American to carry out a suborbital flight.

The Redstone lifted off at 8:20 a.m. EDT and propelled the Mercury ("Liberty Bell 7") capsule on a 15.37-minute, 303-mile flight that reached a peak altitude of 118 miles.

A mishap marred what would have been a completely successful test. While a helicopter hovered overhead, and Grissom prepared to leave the capsule, explosive bolts blew the escape hatch and the capsule began flooding. Grissom was forced to swim about 75 feet to the point where he was picked up.

On November 29, Enos, a 5½-year-old, 37½-pound chimpanzee was launched by an Atlas from Cape Canaveral in a Mercury capsule for what was to have been a three-orbit mission. But near the end of the second orbit, data flowing back from the capsule indicated overheating of the electrical equipment and abnormal operations of the spacecraft controls.

The Point Arguello, Calif., tracking station sent a signal to trigger the capsule's braking rockets to drop it earthward. The capsule and its passenger were recovered at 1:28 p.m. EST 330 miles southeast of Bermuda.

Enos performed his tasks well during the flight and plans moved ahead for the first manned orbital flight early in 1962.

To carry out its broad-front space exploration program, NASA was developing a fleet of launch vehicles ranging from Scout (103,000 pounds thrust) through the first version of Saturn (1.5 million pounds thrust) to the Nova conceptual vehicle, one version of which might cluster eight single-chamber, 1.5-million-pound-thrust F-1 engines to provide 12 million pounds thrust. Another version might involve a solid propellant stage.

The booster (S-1) for the two-stage Saturn C-1

Astronaut Alan Shepard, Jr., first U.S. space man, is hoisted aboard a Sikorsky HUS-1 helicopter after his suborbital Mercury flight.

was flight-tested successfully late in 1961, carrying two water-filled upper stages. The C-1's eight-engine cluster, generating 1.5 million pounds thrust, will eventually fire the manned Apollo spacecraft on low earth-orbital training missions.

Meanwhile, the more powerful advanced Saturn versions were being reevaluated and several approaches to the launch vehicle for the manned Apollo lunar missions were being considered. For a direct-ascent, a Nova consisting of either clustered F-1s or an equivalent solid stage might be used. Another possibility: with orbital rendezvous techniques, smaller vehicles such as Saturn might prove feasible.

Juno II, an interim vehicle (150,000 pounds thrust) based upon the U.S. Army's Jupiter, was phased out of the NASA program after a 10-flight series. Development of the all-solid-propellant Scout went forward on schedule, as did Delta, Thor-Agena B and Atlas-Agena B. The Atlas-boosted Centaur, which will see heavy duty in the unmanned lunar exploration program, ran into development problems which postponed the first flight test originally scheduled for May, 1961.

NASA propulsion research in 1961 centered upon three basic types of rocket engine: chemical, both liquid and solid; electric and nuclear.

Liquid propellant engines dominated the NASA launch vehicle family; solid propellants were under vigorous research and development, and increasing effort was going into electric and nuclear systems which appeared to hold the most promise for future interplanetary flight.

NASA's scientific earth satellite and sounding rocket programs were both concerned basically with two broad areas of research: geophysics, the study of the earth and its cosmic environs, with heavy emphasis on the Earth's atmosphere and ionosphere and the Sun's influence thereon; and astronomy, the study of the solar system and the universe.

Another key function of the sounding rocket program is to develop and test out instrumentation for use in more extensive experiments with satellites and deep space probes.

Among the satellites launched under NASA project direction during the year were:

The Explorer series. Five Explorers were launched during the year. Explorer IX, launched February 16 by a four stage Scout booster, was concerned with a determination of the earth's atmospheric density by measuring the drag on an inflatable 12-foot sphere. Explorer X, placed in orbit on March 25 by a Thor-Delta booster, investigated earth and interplanetary magnetic fields. Explorer XI, launched April 27 by a Juno II launch vehicle, was concerned with detection of high energy gamma rays from cosmic sources and their distribution. Explorer XII was the first of four spacecraft designed to explore solar winds, earth and interplanetary magnetic fields and energetic particles in the Van Allen belts and in interplanetary space. It was launched by a Delta vehicle on August 15. Explorer XIII, launched by a Scout on August 25, was designed to investigate micrometeoroid impact and to further evaluate the Scout launch vehicle.

Tiros III. The third of a series of satellites designed to supply test data toward development of an operational meteorological satellite, Tiros III was launched on July 12 by a three-stage Delta. It contained a more advanced set of television cameras than those in the earlier Tiros spacecraft. Tiros III was credited with discovering Hurricane Esther and it photographed many of the tropical storms during the 1961 hurricane season. Photograph quality was excellent and a great amount of useful data was obtained.

In 1961, NASA contracted for 135-foot-diameter, inflatable passive communications satellites in the Echo program, as well as Relay "active repeater" communications satellites. (Passive communications satellites are used to reflect or "bounce" radio signals over great distances; the active repeater satellites are capable of receiving messages at one point on the earth's surface and of retransmitting them to ground receiving stations thousands of miles apart.) The first satellites in both new series were to be launched in 1962.

A succession of instrumented probes—television-equipped hard- and soft-landing units, remotely controlled mobile experiments, and lunar orbiters—will pave the way for manned expeditions to the moon in the years ahead. Other spacecraft will voyage to Venus and to Mars. Spacecraft will sail deep into interplanetary space gathering data on magnetic fields, plasma streams, energetic particles and other activity in the teeming "void" of outer space.

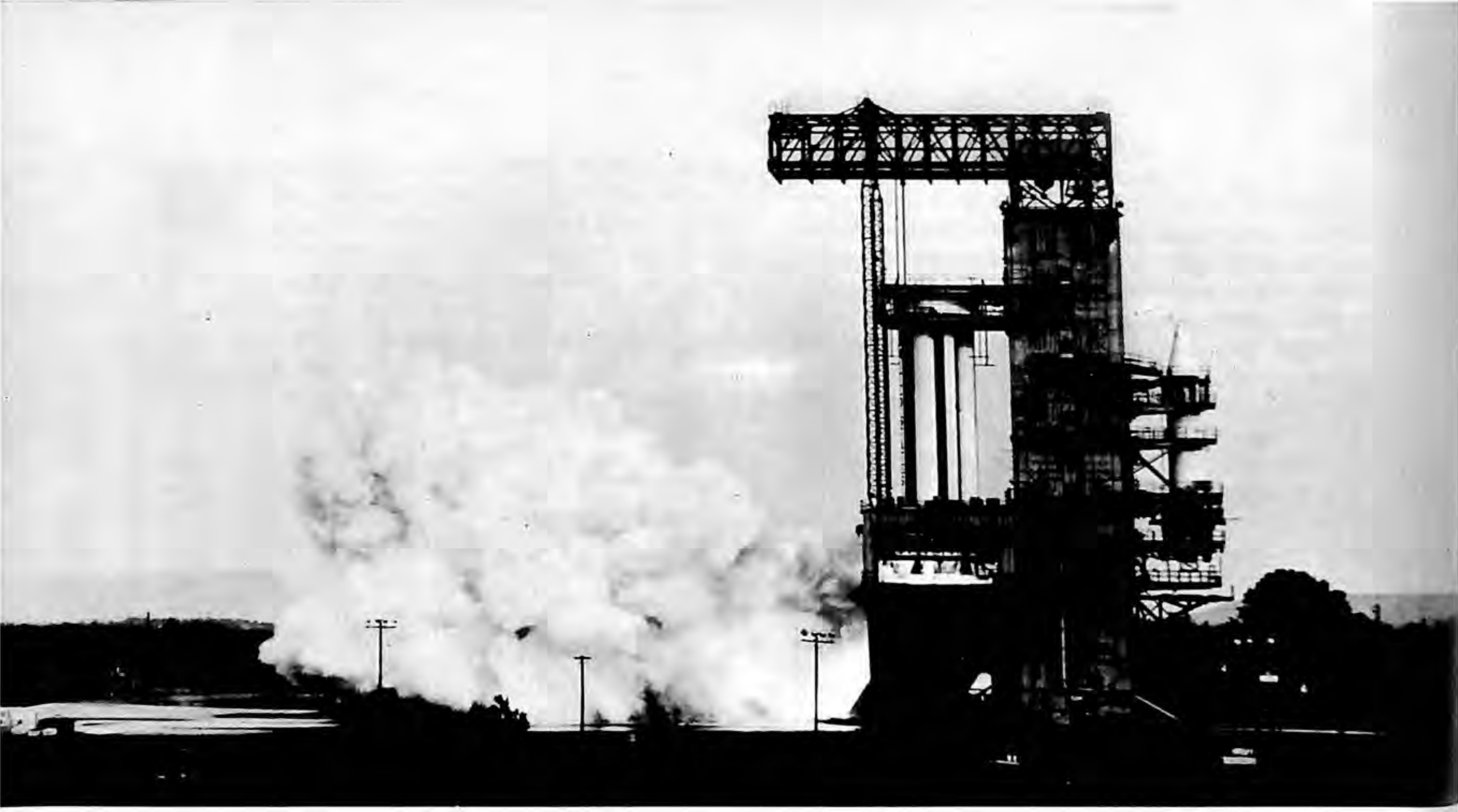
The early phase of lunar exploration includes Projects Ranger, Surveyor and Prospector.

Ranger's objective is to rough-land a 300-pound instrumented capsule on the moon after televising the lunar surface and examining it by gamma ray spectrometry during the landing phase.

The Jet Propulsion Laboratory (JPL) is developing the 750-pound, 10-foot high Ranger spacecraft which will be launched by the Atlas-Agena B.

The principal experiment in the package is a seismometer to record and transmit data on moonquakes and other disturbances, including meteoritic impacts, for about three months.

Project Surveyor is a Centaur-launched lunar



The eight-engine Saturn booster in static test at NASA's George C. Marshall Space Flight Center.

soft-lander weighing about 2,500 pounds. Two thirds of the weight will be taken up by propellants for the controlled landing maneuver, leaving a 250-pound scientific payload.

The spacecraft will contain four television cameras; a drill for acquiring samples of lunar surface and subsurface material and for processing and conveying it to analyzing equipment; surface geophysical experiments; lunar atmosphere samplers; radiation detectors; seismometers; magnetometers; and other experiments.

Studies were under way in 1961 to adapt Surveyor for lunar orbiting missions. The orbiters will be interspersed with the soft-landers to provide broad area mapping; data on the moon's shape and mass distribution; its magnetic field and radiation environment and other characteristics.

The last unmanned lunar project for the decade is Project Prospector, scheduled for launch with the advanced Saturn.

Prospector will be a highly versatile space "truck" capable of soft-landing on the moon payloads such as:

. . . a self-propelled, remotely controlled roving vehicle for instrumented exploration of large areas of the lunar surface.

. . . a lunar sample-return system for acquiring lunar material and sending it to earth for study.

. . . a large propellant tanks to enable the spacecraft to hover and to move laterally above the lunar surface, thus permitting low-altitude reconnaissance and site selection for subsequent manned landings.

. . . supplies, shelter and other logistic support for manned lunar operations.

The Mariner (A) spacecraft, an outgrowth of the Ranger vehicle, was scheduled for a Venus "fly by" in 1962.

The flight plan will be similar to that of Ranger in that Mariner will be stabilized with jets which will keep the solar panels oriented toward the sun and a high gain antenna oriented toward earth.

The spacecraft will carry an array of radiation and magnetic field experiments to sound interplanetary space en route to Venus. It will pass within 16,000 miles of the planet at which time its instruments will be aimed at the body. Instrumentation will include a radiometer to scan the planet for surface temperature distribution; an ultraviolet spectrometer to examine atmospheric constituents; a fluxgate magnetometer; radiation detectors, and other experiments.

Planning for Mars missions in 1964 called for development of Mariner (B), a more advanced vehicle than (A) which will be capable of ejecting an instrument capsule into the atmosphere of Mars as it passes that planet.

Voyager, a still more advanced planetary vehicle than the Mariners, which will be launched by an advanced Saturn in mid-decade, will be designed to orbit its target planet (either Venus or Mars) and eject a survivable instrumented capsule to its surface. The orbiting spacecraft will observe the planet from an altitude of several hundred miles, while the capsule makes detailed measurements during descent and after landing. The orbiting spacecraft will relay this data, including television pictures, to earth.

In another area, NASA was working on spaceplanes such as X-15 and Dyna-Soar, the latest in a line of research aircraft which began with the X-series in the early 1940s. The rocket-powered X-15, with its 57,000-pound thrust XLR 99 engine, was designed for speeds of about 4,000 mph and altitudes of about 50 miles.

The rocket-launched Dyna-Soar glider will be capable of soaring completely around the world at orbital velocities and altitudes. The X-15 is a joint U.S. Air Force-NASA-Navy project; Dyna-Soar is a NASA-supported Air Force program.

During 1961, the slim black X-15 set a succession of speed and altitude records, reaching 217,000 feet and 4,093 miles per hour. Its pilots and instruments compiled masses of scientific and engineering data.

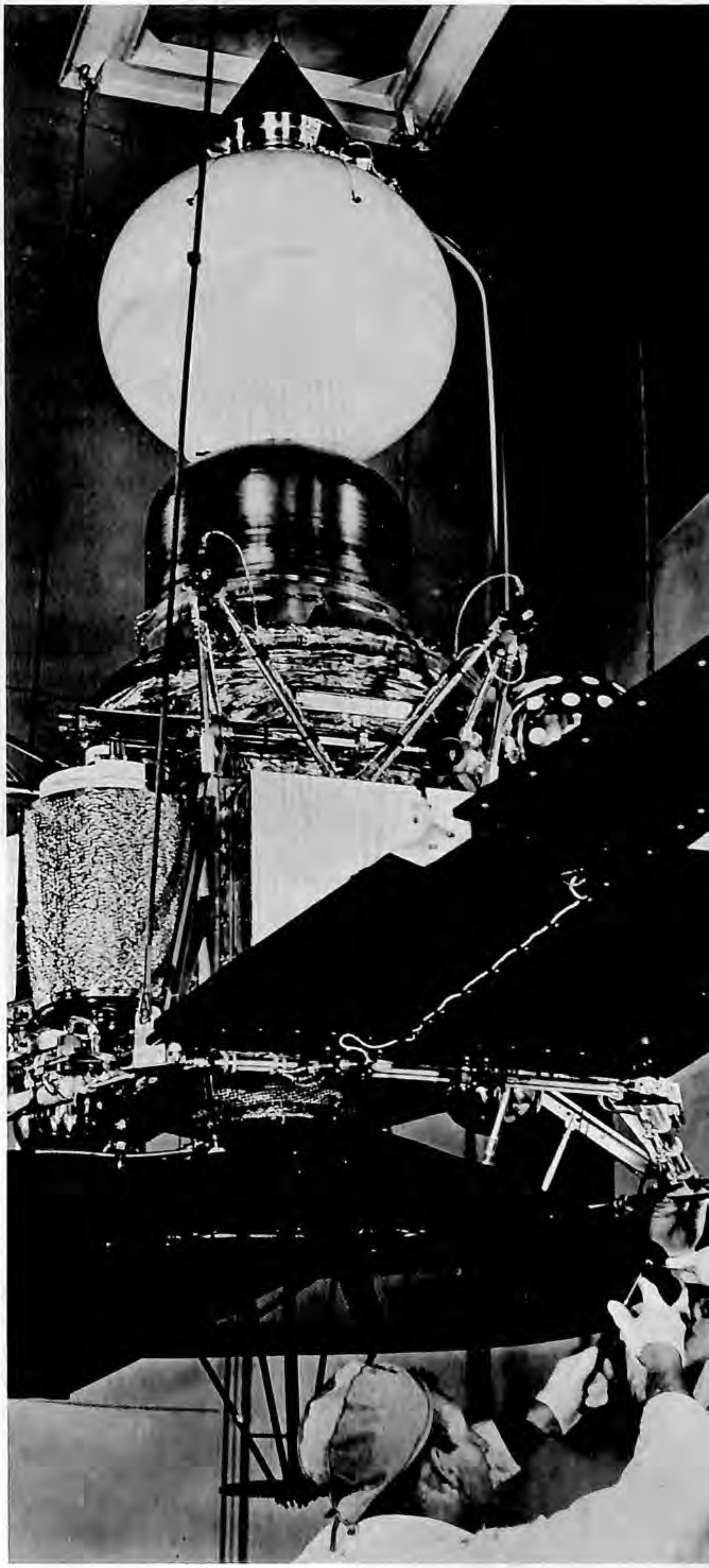
As the year ended, the design altitude objective of 50 miles was under consideration for an early attempt.

NASA also continued research support to the Dyna-Soar project during 1961. Dyna-Soar will be a flat-bottomed, delta wing glider with vertical fins on the wing tips. A one-man vehicle, its fuselage will be entirely above the wings.

The ability of the Dyna-Soar aircraft to reenter the atmosphere at satellite speed, decelerate and land at a conventional airport under the pilot's control will be its distinctive feature.

NASA research and development went forward in 1961 in a great many areas. In cooperation with private industry and educational and research institutions, for example, NASA stepped up studies of the myriad problems involved in interplanetary travel: earth atmosphere reentry corridors; spacecraft rendezvous techniques; launch from the lunar surface; navigation; guidance and control.

Basic and applied research went forward in the research centers and field stations across a broad front. Work continued on aerodynamic heating of spacecraft; fuel sloshing in liquid propellant rocket tanks; development of heat-resistant materials—and scores of other continuing problems.



JPL technicians make final adjustments to Ranger spacecraft.

CIVIL AVIATION

THE AIRLINES

The year 1961, with financial figures available for the first nine months, gave every indication of being the worst of six successive years of depressed earnings for the U.S. scheduled airlines.

While the Civil Jet Age brought greatly improved service to the U.S. domestic and foreign commerce, the postal service, and national defense, it had not, by the end of 1961, been a financial success for the airline industry.

During the five years before 1961, the earnings of the domestic trunk airlines had been $285 million below the 10.5 per cent the Civil Aeronautics Board established as a rate of return on investment necessary "to insure the retention and attraction of capital in amounts adequate to foster economic health and development."

The year 1961 was the sixth year to add to the "earnings deficiency" and it was expected to be a substantial deficiency, with the highest loss since 1947 when the trunks wound up with a loss of $20 million.

The ten-and-one-half per cent rate of return on investment that the Civil Aeronautics Board established was a goal, of course, not a guarantee—as the results of recent years show.

In 1960, although gross revenues reached a record $2 billion, the net profit was only $1,188,000, which meant an "earnings deficiency" of $127 million. This earnings deficiency was based on the fact that the investment of the trunk airlines attributable to domestic operations in 1960 was slightly over 1.6 billion dollars. On this they should have earned $172 million, at the rate of return found needed by the CAB. This would have covered the interest payments of $43.8 million and provided a profit after interest of $128.2 million. Instead, trunkline profits after interest were only $1,188,000—or an earnings deficiency of $127 million.

While the average corporation in 1960 was making a 5 cent profit on every dollar of sales, the airlines required $83 of sales to make 5 cents.

This, in 1961, was the problem of the industry, and the paradox of the problem was well-stated in *Project Horizon,* the report to the President on national aviation goals. *Project Horizon* said:

"The U.S. airline industry's physical and operational transition to jet transportation might suggest that it had met the financial challenge posed by the jet program and had satisfied its capital requirements. No such unqualified assumption would be warranted. The present low level of earnings, if continued, threatens the industry's financial structure."

As to the increase in available capacity during the jet age one finds the increase has been relatively modest in comparison with previous periods. For example, more piston-engine capacity was added in 1957—when the bulk of CAB route grants were being implemented—than in the 1960 and 1961 years combined.

Clearly, the problem of "empty seats" could be traced directly to a retarded rate of traffic growth. If the rate of traffic increase had been maintained at just 10%—or from 2.5% to 12.5% under the 1953-57 period—the jet age would have been one of peak peacetime load factors. In 1960, for example, the load factor, if traffic had increased only 10% annually, could have been 66%, rather than the 59.4% actually experienced. For the twelve-month period ending August 31, 1961, it would have been 71% rather than 57.37%.

Furthermore, much of the "increase in capacity," modest as it was, resulted not just from additional equipment that can make more trips between a given pair of points in a given period than did the piston-engine aircraft, but also from the switch from first class to air coach configurations. A jet in coach configuration has just about 50% more seats than it would in first class configuration. Coach capacity increased from 38% of total in fiscal 1958 to 49% in fiscal 1961 and to 60% in August, 1961. In fiscal 1961, for example, first class capacity decreased approximately 2.5 billion seat miles from fiscal 1960, while coach capacity increased approximately 3.8 billion seat miles, for a net increase of 1.3 billion. It is apparent that practically all the capacity increase during that period resulted from the switch to coach.

Airline growth to serve airline potential entails much more than providing aircraft. Primary factors are safety, dependability, convenience to the public, and other components of good service. Using the single item of reservations to illustrate the costs of improving service: The domestic airlines in 1961 were spending at the rate of $93 million a year on the multitude of transactions involved in reservations for over 50 million passengers. To improve the accuracy and speed of reservations, they were increasingly installing computers, memory drums, other electronic marvels. During the year, one airline put $2,250,000 in a system whereby its agents in almost 100 cities can find out instantly seat availability up to six months ahead on 60,000 itineraries. Another was installing a centralized automatic system which, by late 1962, will serve 1,100 sales desks, handle 7,500 reservations an hour, process them in 3 seconds (as compared to 45 minutes) and reduce errors. The cost: $5,000,000 per year.

There was a further substantial increase in airline cargo capacity in 1961 as more new jets and converted planes came into service and several carriers took delivery on new prop-jet airfreighters.

Freight volume in 1960 reached a record high of 643,792,000 ton miles, up 9.7% over 1959, and 45 times the volume carried in 1946, the first full year of industry airfreight operations. As a result of this rapid growth, airfreight was the second most productive form of traffic carried by the airlines, accounting for 12.5% of total ton miles of traffic. During the first six months of 1961, freight ton miles increased nearly 10% over the same period in 1960.

Vast improvements in the Postal Service were

CONSOLIDATED AIRLINE INDUSTRY SUMMARY, UNITED STATES

Year	*Available Seat Miles (billions)*	*Increase (billions)*	*Increase (%)*	*Passenger Miles (billions)*	*Increase (billions)*	*Increase (%)*	*Load Factor (%)*
1952	18.0	...	....	12.1	...	....	67.08
1953	22.1	4.0	22.4	14.2	2.1	18.1	64.65
1954	25.6	3.5	16.1	16.2	1.9	13.9	63.35
1955	30.0	4.3	17.4	19.2	2.9	18.5	64.05
1956	33.7	3.7	12.5	21.6	2.4	12.7	64.12
1957	39.8	6.1	18.4	24.4	2.8	13.6	61.50
1958	40.6	0.8	2.2	24.4	...	....	60.05
1959	45.7	5.1	12.7	28.1	3.7	15.3	61.42
1960	49.1	3.3	7.4	29.2	1.1	3.9	59.47
*1961	50.3	1.2	2.5	29.0	...	....	57.37

(*—Figures for 1961 are for 12 mos. ended Aug. 31, 1961, compared with calendar year 1960.)

made possible in 1960 and continued into 1961 as the airlines made increased capacity and speed available and participated in expansion of non-priority mail by air services to the new states of Alaska and Hawaii.

At the end of June, 1961, compared with June, 1960, although changes had occurred in types of equipment of the scheduled fleet, the over-all total of 1,867 remained the same. Four engine turbojets increased by 60, from 202 to 262.

During the second quarter, the first twin turbojets operated by U.S. air carriers were placed in service.

Four-engine turboprop transports were up from 181 to 192. Included in the total were 4 all-cargo turboprop jets.

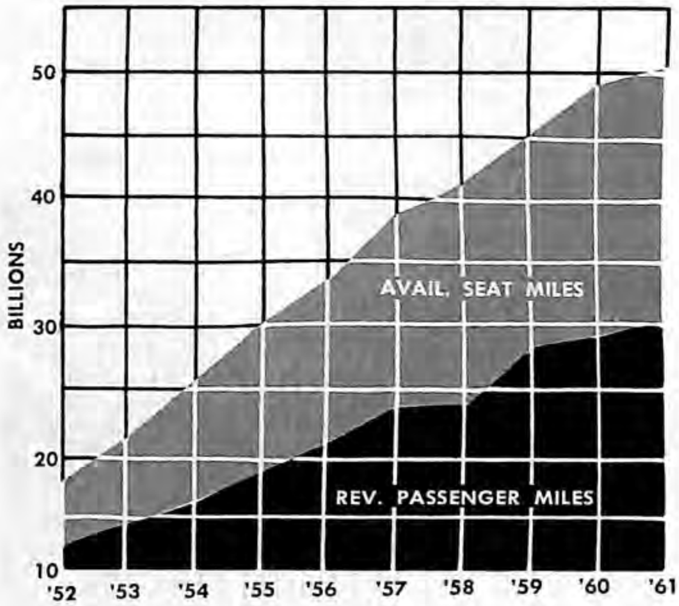
Twin-engine turboprops totaled 48, only two more than were in service at the beginning of the year.

The scheduled fleet of piston-powered transports decreased by 75 units, 57 fewer four-engine powered and 18 fewer twins. The number of helicopters in operation remained the same at 25. These figures do not include aircraft used for crew training and inactive aircraft held for disposal.

This jet re-equipment was one of the most extensive modernization programs ever undertaken by any single industry. The investment of private capital in jet equipment and facilities through 1962 will exceed \$3,000,000,000—this by an industry whose total investment at the end of 1958 was \$1.7 billion.

Another half-billion dollars was going into maintenance facilities and ground equipment commensurate with the jet age.

The safety rate of the U.S. scheduled airline industry in 1961 for the nine months through September was .40 passenger fatalities per 100 million passenger miles. This compares with .51 for the same period of 1960. The awareness of the fact that safety comes first in the airline industry is shown when one recalls that the U.S. scheduled airlines spend about \$1.5 million daily to inspect and maintain their aircraft. Electronic safety equipment in a jet airliner costs about \$900,000—nearly one-fifth the cost of the plane. U.S. scheduled airlines invested \$60 million in 1960 in training and testing of flight personnel. The maintenance and improvement of safety requires continuing new expenditures. For example, the domestic airlines during 1961 were in the process of installing Distance Measuring Equipment ("DME") and radar transponders. Both of these will be major contributions to safety. They will cost the domestic airlines some \$40 million to install—about the cost of eight new jets.



ALLEGHENY AIRLINES, INC.

Expansion in all phases of activity keynoted Allegheny's 1961 record.

Allegheny's most dramatic growth during the year occurred in the area of traffic. Even in September, with the nation's trunklines unofficially reporting a traffic gain of less than 1% over September 1960, Allegheny posted a 12% increase. This increase resulted despite the fact that no additional cities had been added to the carrier's route during the previous 12 months. June marked the high point of the airline's 1961 traffic, as over 85,000 passengers flew more than 17,500,000 revenue passenger miles. On June 30, Allegheny missed the 4,000 passenger mark by only 51 passengers, breaking all previous records.

The Middle Atlantic-New England airline also expanded its cargo services significantly during 1960. In May nearly 150 new joint cargo rates were established; several weight and commodity restrictions were also relaxed. Industries on Allegheny's 12-state system began using its air cargo services in increasing numbers. As a result, the airline airlifted nearly 2,000,000 pounds of revenue cargo during September, a 30% boost over the year before.

Record growth in revenues and profits were also reported by Allegheny during 1961. In its Annual Report to Stockholders and Employees, distributed during May, the airline reported that 1960's profits amounted to \$766,581, or \$1.45 per outstanding share. Allegheny expected to be in the black for 1961, and expected an upswing in profits for 1962 as it completes adjustment of its flight schedules to the Civil Aeronautics Board's "class mail rate" sub-

Allegheny inaugurated "no red tape" commuter service.

sidy system, which went into effect in March 1961.

Facilities expansion also highlighted 1961 for Allegheny. While expanding its office and shop facilities at the Washington headquarters, the airline announced ground-breaking for a $4 million maintenance center at Pittsburgh. The dual-bay hanger, is expected to be ready for occupancy in the spring of 1963.

Service-wise, Allegheny continued to expand its operations linking major points in New England with cities in the Middle Atlantic area. With public enthusiasm running high for these new specialized short-haul services, Allegheny celebrated its first "birthday" in New England by reporting that at Providence, for example, over 38,000 passengers used its flights during the first full year of service.

Allegheny's airlift capacity continued to expand during 1961. An additional turbine-powered Convair 540 joined the fleet, along with eight piston-engine aircraft. Plans were announced to retire the remaining DC-3s early in 1962.

The airline also expanded its "commuter" flights between Pittsburgh and Philadelphia to 18 nonstop jet-prop flights daily. By the end of 1961, Allegheny had carried 200,000 passengers on these no-red-tape services, with monthly traffic exceeding 11,000.

ALOHA AIRLINES

Aloha Airlines marked the end of an era January 3, 1961, when it retired its remaining DC-3s and inaugurated all jet service between Islands with its Rolls-Royce powered Jetprop F-27s.

The airline received the National Safety Council's Aviation Award for another year of perfect safety. Aloha has never had a passenger or crew fatality in its history.

Early in the year Aloha completed arrangements with Pan American World Airways and United Air Lines for instantaneous teletype service from every major city in the world.

During the year Aloha participated in two major Hollywood film productions. The Hal Wallis Paramount Production of "Blue Hawaii" and Columbia Pictures production "Devil at Four O'Clock". In addition, Aloha figured in production of two top-ranking television series, Warner Bros. "Hawaiian Eye" and Twentieth Century Fox's, "Follow the Sun".

Through fares inaugurated in June by the major overseas carriers serving Hawaii provided a boost to inter-island travel.

The Governors of the 50 states and the territories held their annual convention in Hawaii in June. Chartered Aloha Airline's Jetprop flights transported the governors to the major neighbor islands in Hawaii.

A further increase in Aloha's traffic was brought about by the large volume of tourist and local residents who flew from Honolulu to Hilo to view the volcanic eruption occurring on that Island in July.

Aloha's "international" operation has grown to the extent that now the airline dispatches more overseas flights than any other carrier serving Hawaii. The airline handles ground maintenance, flight watch, passenger service and dispatching of more than a dozen charter, supplemental, military contract and foreign carriers. Beginning in a small way in October, 1959, this growing new arm of Aloha was expected to bring the airline an income of $400,000 in 1961. Aloha moved into its new terminal at Honolulu International Airport October 22. The airline unveiled new passenger service features including self-service baggage trucks, direct from airport to terminal, super market type luggage carts for passenger convenience, conveyor belt handling and pneumatic tube communications between load coordinator central and ramp gates.

Despite the early year mainland recession, a shipping strike and the threat of a local sugar strike, the airline expected to top its 1960 all-time passenger volume high.

AMERICAN AIRLINES

American Airlines in 1961 became the first airline to equip its 707 jets with advanced fanjet engines.

Within a few months after the first Astrojet flight, nearly all American's 707s were equipped with these superior engines. By year-end the entire fleet was fan-powered and American was looking forward to starting service with another new airplane—the Convair 990 Astrojet.

With their new engines, American's Astrojets quickly proved they could carry greater payloads, take off from shorter runways, climb more swiftly to altitude and deliver more cruise thrust per gallon of fuel.

The Astrojets quickly caught the public fancy, more rapidly, in fact, than any AA development in years.

Besides the 990, American in 1961 sets its sights on still another new airliner. It contracted for 25 three-engine fanjet Boeing 727s for delivery in 1964-65. The 727 is expected to bring jet service to most of the cities on American's routes with airports not now able to accommodate the bigger jets.

The ever-growing Astrojet fleet enabled American in 1961 to upgrade service on a number of short and medium flights with Electra II turboprops, the routes originally planned for the airplane. The Electra II load factor zoomed, exceeding at one point that of the Astrojet fleet, and in July American offered coach service on the Electra for the first time, increasing the capacity of the airplane to 71 persons.

American, which broke all records for domestic airfreight service in 1960, continued to surge ahead in 1961. Even before the traditional peak fall season arrived, American had set an industry record for any month in May and again in June and then proceeded to break that record only two months later in August by flying 11,787,000 ton miles of airfreight. That record fell in October when American flew 13,237,000 ton miles.

In September, just 17 years after it filed the industry's first airfreight tariff, American asked the CAB to approve an entirely new kind of airfreight rate. Instead of hundreds of rates set according to commodity, American proposed a single rate for nearly all items. This proposal represented a break not only with traditional airfreight tariffs, but also with the usual tariffs of railroads, truck lines and steamships companies, where commodity categories often run into the thousands.

During the year, American's "Truck-Air" service was expanded so that it linked more than 3,000 communities, through nearly 50 participating truckers, with American's airfreight network. Under the system, shipments move by truck to the nearest city served by American and are flown within hours to the destination airport. A single bill of lading simplifies paperwork for the shipper.

Virtually complete at year-end was the building for American's central processing unit for its vast new SABRE electronics reservations system. During the first three or four months of 1962 equipment will be installed and training will begin in the center, which is located at Briarcliff Manor, north of New York City. Not only is SABRE the most advanced reservations system ever devised, it is, in fact, the largest electronic data processing unit ever designed for business use. The SABRE system will link more than 1,100 of American's reservations desks in nearly 60 cities using more than 10,000 miles of leased wire. Hartford, Conn., will be the first city to be "cut over" to SABRE in the Spring and the rest of the cities will follow until all are joined by the Fall of 1963. As a nationwide system, SABRE will enable American to process more than 7,500 complete passenger reservations an hour. The average interrogation from any point on the system will take only three seconds.

American was able to point out in 1961 that its jet fleet was already fully equipped with Distance Measuring Equipment—the first fleet to be so outfitted long before the Federal Aviation Agency announced that all jets would be required to have the equipment. DME enables a pilot to tell from a glance at a cockpit dial just how far he is from the particular airways radio facility to which he is tuned.

American took time, however, in 1961 to look backward instead of forward on two occasions. On June 25, AA marked the anniversary of the inauguration by the airline of the DC-3 into passenger service. In July, American noted the 15th anniversary of its huge Tulsa Maintenance Base with its 4,000 employees.

A large number of routes were served by AA with jets for the first time in 1961. These included El Paso with New York; Nashville and Memphis with New York and with the West Coast; Baltimore-Los Angeles; Cincinnati with New York and with St. Louis and Los Angeles; Tulsa and Oklahoma City with Dallas and Los Angeles; New York-Phoenix, Baltimore-Dallas, Boston-Baltimore and others. American started operating jets from Newark Airport to Chicago and Los Angeles in October.

One of the most successful new 1961 trips was American's late-evening "Flight 21" from New York to Los Angeles. Designed as a flight to provide overnight airmail service from the New York Metropolitan area to Southern California, the flight quickly caught on as a celebrity trip popular with Broadway and Hollywood personages and others who wanted an evening out in New York City before flying West. As 1961 neared its end, American inaugurated a companion "Flight 49" late evening airmail Astrojet to San Francisco and said it would base the service aboard on that of the famed 21 Club in New York, as it had done with "Flight 21".

BONANZA AIR LINES

January was highlighted with the first retirement of a Bonanza Air Lines employee under the airline's retirement program. The retiring employee, Harry Burt, Sr., had been with the company for ten years, and had been supervisor of inventory control since 1958.

February marked the beginning of the fifth year of reduced rates for clergymen. Bonanza was the first airline to institute the clergy fares. Several airlines have since followed suit.

Bonanza added service to Burbank, California, in March, offering two round trips a day to connections at Los Angeles. March traffic hit an all-time high for the airline, with 29,271 passengers enplaned.

On April 1st, Bonanza's new low resort and commercial fares went into effect, with special fares offered between 26 pairs of cities on the company's system. During the first three months these fares were in effect, Bonanza's traffic increased 121% on the routes where the fares were offered. Even the routes not having the low round trip fares showed healthy traffic increases. Because they had proved so successful, Bonanza inaugurated nine additional fares, bringing the total to 35.

In May, at the annual stockholders' meeting, vice president of finance Robert J. Sherer, reported that the company made a net profit of over $250,000 for 1960. The 1961 profit was expected to exceed $400,000.

In June, Bonanza took delivery of another F-27A jet-prop "Silver Dart", making the airline, with a total fleet of nine, the largest F-27 user in the world.

On June 20th, Bonanza announced the filing of a "Youth Fare" tariff—the first scheduled airline to propose such a fare. On the 29th of the month, the company announced the filing of its unique "BonanzaLand" area fare, applicable to unlimited air travel in the states of California, Arizona, Nevada and Utah.

Traffic gains for June, and for the first half of the year, continued to set records for the airline. June revenue passenger miles were up 22.8% over June, 1960, with available seat miles increasing only 1.2%. The first half of 1961 reflected a passenger mile increase of 21.3% over 1960, as against a 4.8% increase in available seat miles.

The airline's average passenger loads for June, and for the first half of the year, were up 28.1% and 31.4% respectively, with 17.3 passengers per mile flown in June, and 18.0 per mile for the first half of the year.

Bonanza instituted 24-hour operations at two of its reservations offices on the first of July. Around-the-clock operations were inaugurated at the Phoenix reservations and city ticket office and at the Las Vegas office. The Phoenix offices were expanded during the first half of the year and were opened July first as the largest facility of its kind for Bonanza. The offices are equipped to accommodate 15 phone lines.

The substantial traffic gains achieved during the first six months continued in July with revenue passenger miles up 25% over July of 1960. Revenues showed a 22% growth while available seat miles were up less than three percent.

Bonanza's "Youth Fare" was approved by the Civil Aeronautics Board and went into effect on August 10th. By the end of the month, 192 identification cards had been sold and 182 young passengers had flown Bonanza. During the month of September, the identification cards had increased to 495 and 363 youths had taken advantage of the fare.

In August, Bonanza filed objections to a Civil Aeronautics Board "show cause" order for dismissal of proposed service between Las Vegas and Boise, Idaho. Proposed service between these points had been severed from a previous case because of geographic reasons. As a result of the objections filed by Bonanza, two other local service carriers, and other interested parties, a pre-hearing conference was held in Washington, D. C. in October and public hearings were scheduled for January in Boise.

Bonanza was also involved in two other route cases during the year. The airline participated in oral argument for the Pacific Southwest Local Service Case in which Bonanza has applications for the lifting of restrictions on its Las Vegas-Los Angeles and Los Angeles-San Diego routes, and applications for new routes between Las Vegas-SanDiego, Las Vegas-Oakland/San Francisco, Reno-Oakland/San Francisco, and Reno-San Diego; the first three routings via intermediate points and nonstop, and the Reno-San Diego route via intermediates and two-stop authority.

The other case in which Bonanza is a party is the Southern Rocky Mountain Local Service Case.

Evolutionary display, showing all types of planes flown by Braniff from 1928-1961, was presented to Smithsonian.

Hearings before the examiner were conducted in Washington, D. C. during May and briefs were filed in September. In this case, Bonanza is seeking routes to Denver and Albuquerque from Las Vegas; to El Paso from Phoenix; a direct route from Las Vegas to Salt Lake City—both nonstop and via Cedar City; and direct service to Los Angeles, San Diego and El Paso from Tucson.

In September, Bonanza Air Lines officials toured three European aircraft factories to evaluate medium-haul pure jet equipment. The tour included visits to British Aircraft Corporation to study the BAC—111, to Sud-Aviation to examine plans for a junior Caravelle, and to Fokker Company to look over plans for a medium-range pure jet replacement for the F-27. Bonanza anticipates having pure jets by 1964-65.

Third quarter traffic reports continued to reflect the 1961 increase for the first and second quarters. Revenue passenger miles were up 24% over the third quarter of 1960. This—during a period when the airline industry as a whole was experiencing very little gain over the previous year—can be attributed directly to all-out 1961 promotional program undertaken by the company.

Revenue for the third quarter increased more than 20% over the same period in 1960, despite the fare reductions throughout much of Bonanza's system.

Meanwhile, following its porgram for all-out advertising (the airline was second highest among the local service carriers in advertising dollars spent per available seat mile in 1961) Bonanza prepared a half-million 4-color brochures describing its "BonanzaLand" area fare which went into effect on October 1st. The folder contains an art-illustrated map of Bonanza's area and photo-illustrated descriptions of the points served by the airline. Included is a full panel which may be used by other organizations or groups to print their own messages in connection with the area tour. Distribution of the brochure will be made internationally.

In October, the fall quarterly meeting of the Association of Local Transport Airlines was hosted by Bonanza at Las Vegas, with the Honorable Carl Hayden, U. S. Senator from Arizona, and Irving Roth, Director of the Bureau of Economic Regulations for the C.A.B., as guest speakers.

BRANIFF INTERNATIONAL AIRWAYS

Jet Age expansion continued in high gear at Braniff International Airways during 1961.

Braniff's fleet of Boeing Super Jets grew and Braniff jets began service for the first time to Mexico City from Minneapolis-St. Paul, Kansas City and Texas, and to Denver from Texas.

Jet service also increased in frequency between Texas and New York, Texas and Chicago and to South America.

Braniff accomplished the biggest commercial airlift in history during the year when a total of 5,034 dealers and distributors of the Gibson Refrigerator Division of the Hupp Corporation were jetted from 28 different U.S. cities to Montego Bay, Jamaica, and Panama for a sales convention.

Passenger miles flown on this fantastic charter operation reached 21,054,177. It was done over a 39 consecutive day period in September and October with a 147-seat Boeing 707-227 averaging over 5,000 miles daily.

For example, a Super Jet would depart one of the U.S. cities each morning and fly to Montego Bay where the 147 guests of Gibson would stay overnight. But the Super Jet would pick up a similar group that it had left the day before and continue to Panama that afternoon. That evening the Super Jet would fly one of the Gibson groups that had been in Panama for four days back to their point of origination in the United States and then ferry to a different city for another originating group.

Total operational miles flown by Braniff in the Gibson charter were 200,555, equal to more than four times around the world at the equator. Flying time required was 432 hours and 54 minutes.

One of the most gratifying features of the Gibson airlift was its contributions to goodwill between the Americas. The Gibson company provided space on the charter flights for 90 college students and medical cases who could not otherwise have afforded transportation to the U.S.

While Braniff was playing an expanding role in

Canadian Pacific introduced new stewardess uniforms.

the jet age of the present, it also was making plans to be a leader in the jet age of the future.

In October, the company placed orders for six BAC One-Eleven twin-jet air transports with an option on the purchase of six more. Delivery will begin in October, 1964.

The BAC One-Eleven characterized by its clean wing, aft-mounted engines and high horizontal stabilizer, will bring the luxury of jet service to the short haul routes in the 200 mile category. The Rolls-Royce powered jet will carry 63 passengers, including 24 first class and 39 coach, at a cruising speed of 540 miles per hour. The purchase, including spares, represents an investment of $35 million.

Another highlight of the year came in March when the airline made a presentation to the Smithsonian Institution in Washington, D.C.

The display, only one of its kind, shows the evolution of commercial air transport from its beginning to the present day. Including models of all planes that have carried the Braniff colors, the display ranges from the five-passenger, 100 mile per hour Stinson Detroiter of 1928 to the 100-passenger, 600 mile per hour Super Jets of today.

A jet simulator, made by the Link Corporation, was installed in Braniff's Operations and Maintenance Base at Dallas Love Field at a cost of more than $1 million. This combination of an actual Boeing Super Jet cockpit and an electronic brain does everything a real jet does except leave the ground and provides Braniff with the most modern and advanced crew training facility.

A new DC-6A Air Freighter service was inaugurated for the first time in 1961 from Tulsa to New York, in addition to the Texas-New York and Texas-Chicago all cargo service.

In answer to public demand, coach seating was increased on most four-engine aircraft, including the Boeing Super Jet, the Lockheed Electra II and the DC-7C.

And "teamwork" was at a new high. The "Sell-A-Friend" program, in which nonsales employees may earn prizes through outside sales work, resulted in more than $750,000 in revenue in its first year of operation.

Braniff, which reached its 33rd birthday on June 20, marked a historic milestone during 1961 by logging its 10 billionth revenue passenger mile.

CANADIAN PACIFIC AIRLINES

Canadian Pacific took delivery of the first of four Douglas DC-8 jet transports in mid-February, 1961, and, as a result of an accelerated training program for aircrew and maintenance personnel, the airline was able to introduce jet service on six major international routes during the remainder of the year.

CPA's first DC-8 service between Vancouver and Honolulu was inaugurated on March 25. Later, the jets were put into operation on the Canadian transcontinental service between Vancouver, Winnipeg, Toronto and Montreal (April 21); the Polar service linking Vancouver, Edmonton, Amsterdam (April 30) and Rome (June 1); and the mid-Atlantic route between Toronto, Montreal, Lisbon and Rome (June 2).

One of the most significant developments in the growth of the company in 1961 was the Federal Cabinet's decision awarding CPA traffic rights from Vancouver and Edmonton to London, with a technical stop at Gander. At the same time, Calgary was added to the Airline's international route pattern, thus providing direct jet service from southern Alberta to Europe and to Honolulu. Although actual operation of the service linking western Canada and London was delayed pending approval by the British Government, CPA established jet service between Calgary and Amsterdam on October 6th.

Continuing with the plan to introduce jet service on all its major international routes, the airline was preparing to extend DC-8 service to Latin America, pending clearance of technical difficulties at Mexico City.

At year-end, CPA was in the process of a major consolidation program involving the disposal of surplus aircraft, including the bulk of its jet-prop Britannia and DC-6B fleets, with corresponding reduction in staff. Objective of the plan was to trim the company's aircraft and equipment to current route and frequency requirements.

Meanwhile, in Canada, the airline introduced two major passenger service attractions this year. On October 29, CPA became the first airline in Canada to abolish the rule whereby passengers must reconfirm their reservations six hours before departure. The cancellation of the reconfirmation rule on all CPA flights within Canada was to be carried out on a six-month experimental basis.

For the convenience of passengers in British Columbia, the airline established a daily air service between Vancouver and Prince Rupert's new airfield on Digby Island, using DC-6B airliners on August 16th, 1961. This flight marked the first time Prince Rupert had been served by four-engined, wheel-type aircraft. The introduction of the new service signaled the re-establishment of regular air service to the northern coastal city after an absence of two years. The airline formerly operated a Canso Flying Boat link between Sandspit and Prince Rupert Harbor.

CARIBBEAN-ATLANTIC AIRLINES, INC.

The "Caribbean's busiest airline" was busier than ever in 1961. During the month of July alone, for example, Caribair carried in excess of 43,000 passengers on all routes—an all time record.

Summer business continued to grow, particularly to St. Thomas and St. Croix in the Virgin Islands. For three consecutive years Caribair has carried more summer traffic, to and from the Virgin Islands, than during the former peak winter season months. The principal reason for this summer growth is the popularity of the Virgin Islands as a cool summer vacation paradise for residents of both the mainland U.S. and Puerto Rico. Added to this are the reduced summer hotel rates plus attractive package tours offered by Caribair in cooperation with travel agents. Even the normal off season months of September, October and November were far from dull in 1961. Some 3,500 Fedder's dealers were awarded prize vacation trips to St. Croix during this period. Caribair charted an aircraft to Fedder's to fly these people from St. Croix to St. Thomas in groups of 270 weekly.

Major developments for Caribair in 1961 included:

The opening of a New York City Sales office in January to service stateside travel agents as well as interline carriers. This attractive office is located at 9 Rockefeller Plaza.

Inauguration of Convair-540 (Jet Prop) service to St. Thomas and St. Croix in December. Caribair has purchased 3 of these fast 55 passenger aircraft to supplement their present DC-3 fleet. Convair-540 service to other points on Caribair routes will be inaugurated in 1962.

Service was started from San Juan to Guadeloupe, F.W.I. in early December. This new Caribair route links Guadeloupe with San Juan via St. Martin and St. Thomas.

Free sale with U.S. and Puerto Rican Travel Agents and other carriers was started in July and proved to be highly successful, enabling agents and carriers to immediately confirm Caribair space to their clients. Tied in with the above have been significant improvements in newer reservations control center in San Juan.

Caribair at year-end was operating from San Juan to Ponce and Mayaguez in Puerto Rico, Ciudad Trujillo in the Dominican Republic, St. Thomas and St. Croix in the U.S. Virgin Islands, St. Martin in the Netherlands Antilles and Pointe-a-Pitre, Guadeloupe in the French West Indies.

CENTRAL AIRLINES

In 1961 Central Airlines launched the greatest expansion program in its 12 year history.

Early in the year Central introduced its new Radar Convair service to 14 cities in Arkansas, Kansas, Missouri, Oklahoma and Texas. These 40-passenger planes were put into service on the airline's more heavily traveled routes.

At the time of the Convair advent Central expanded the number of cities it served by nearly 50 per cent. The 14 new cities were: in Kansas, Coffeyville, Dodge City, Garden City, Goodland, Great Bend, Hays, Hutchinson, Independence, Junction City, Manhattan, Parsons, and Salina; in Missouri, Fort Leonard Wood; and in Colorado, Pueblo.

The greatest increase of passenger traffic for the year was seen in Colorado Springs, Denver, and Kansas City. With the opening of the easternly routes across Kansas and the suspension of Continental Airlines' service to many Kansas cities, Colorado Springs and Denver boardings showed over a 1,000 per cent increase. With the opening of

Central's westernly routes from Kansas City and the suspension of Continental's service across the state, Kansas City's boardings rose nearly 100 per cent.

During the year Central carried its millionth passenger and logged its 34 millionth passenger mile.

The year 1961 also saw Central Airlines make another broad move for expansion when it prosecuted its application before the Civil Aeronautics to extend its routes west from Dallas to El Paso via intermediate Texas cities and to Roswell, Albuquerque, Santa Fe, and other New Mexico cities.

CHICAGO HELICOPTER AIRWAYS

A larger proportion of Chicago airline passengers rode CHA helicopters in 1961 than ever before. This greater penetration of the available market was achieved in the face of lower levels of air travel. Given a resumption of normal growth in airline traffic as the recession wanes, CHA was poised to maximize benefits of the accelerating swing to helicopter service in Chicago.

Notwithstanding the 1961 decline in airline traffic, a slump that hit the Chicago area more, perhaps, than other leading airline centers, CHA continued to promote sales aggressively. As one result, CHA carried 280,944 passengers on its inter-airport, downtown and suburban runs in the year ended June 30, 1961.

This number of helicopter passengers equalled 2.3% of all those coming into or leaving from Chicago's two major airports—O'Hare and Midway. It was nearly three times the 0.8% carried in fiscal 1958, the company's first full year of operations. (If comparisons are made with just the number carried by either helicopter or limousine, CHA's proportion rose from 4% in the calendar year 1957 to 18% in 1960. This ratio probably rose further in 1961.)

Central theme of the company's 1961 space and other media effort was "Up and Over." This snappy slogan is short, to the point. Shown against a background of bumper-to-bumper traffic, this theme probably expresses best the thesis that only the helicopter has the ability to short-circuit (or leap-frog) steadily worsening traffic on our streets and highways. It is beamed continuously at passengers originating both in Chicago and elsewhere.

Another advertising and educational tool used with great effect was Sikorsky's new movie with the same "Up and Over" title. This long-needed sales promotion film was shown to large groups both in and outside the airline industry. It was in increasing demand by numerous civic and planning groups.

In still another drive for "first riders" CHA expanded promotion of its helicopter Skytours. Special efforts were aimed at greater family use. Past experience has shown that a high percentage of Skytour passengers become regular riders and enthusiastic boosters of helicopter service.

Parallel to these efforts was a program to "bring helicopter service to the people." This means making helicopter service more convenient, more readily available than ever before. Full interline services, convenience and speed are the only things the company has to sell. One major step in this program was the recent relocation of the Midway check-in counter from Gate 24 to Gate 19 on American's concourse or "finger." CHA's counter is now 450 feet nearer to American Airline's main waiting room. It also made helicopter service more convenient to passengers arriving on other lines.

Since Gate 19 is the first one on the finger, CHA has the important advantage of being "exposed" to all of American's passengers. Gate 24 was situated at the far end of the concourse. Now, for the first time, each passenger goes right by the CHA counter. A series of signs arranged to attract maximum attention quickly inform the inbound passenger of what CHA does for him. The first is: "Chicago Loop—7 minutes" and "O'Hare—11 minutes"—CHA flight times on these segments. Later signs contain similar appropriate messages.

Because the helicopter is such a vital link between the customer's true origin and his true destination, CHA intensified its schedule coordination efforts with major trunklines. An example of this was the coordination of advance schedules with two trunks. TWA and United, so their passengers could make better connections with CHA's Gary, Indiana, run.

Two other things were being counted upon to help boost CHA's future market penetration. First was the new terminal building at Meigs Field, Chicago's convenient lake-front heliport. This larger, more comfortable downtown terminal has long been needed. The new Meigs facility will have cost close to $1 million by the time the "temporary" wooden structure erected in 1949 is razed. CHA is the only scheduled operator at Meigs, but thousands of private business aircraft land at the field on Northerly Island. Some provide passengers for CHA to O'Hare and even Midway since it is easier and cheaper to land and park a private plane at Meigs.

The most important booster of traffic was new equipment. As experience with the S-58 demonstrated, the company expected new growth to result from introduction of new equipment. On order since December 1959 were four 25-passenger Sikorsky S-61s. Delivery was expected to begin in January, 1962. This twin-turbine helicopter represents an advance of more far reaching significance than the transition from seven-passenger S-55s to the S-58. Both passenger capacity and speed will be increased, but perhaps most important is the major reduction in noise and vibration levels, as well as in costs. According to the manufacturer, seat-mile costs of the S-61 will be cut 50% as compared to the S-58.

CONTINENTAL AIRLINES

During 1961, Continental Airlines further enhanced its reputation as one of the fastest growing airlines in the nation.

A small regional carrier just a few years ago, Continental at the end of 1961 had nearly 3,000 employees headed by Robert F. Six, president for the past 23 years.

In its first 27 years of operation, Continental carried a total of 8,000,000 passengers four billion revenue passenger miles. For the year 1961, the company expected to have flown an additional 1,500,000 passengers another one billion revenue passenger miles.

Continental began operations on July 15, 1934, as the Southwest Division of Varney Speed Lines, flying a 520-mile route between Pueblo, Colo. and El Paso, Texas, carrying nine passengers in the first 15 days. In 1961, the company served 36 cities on a 7,000-mile route through nine states, flying between Los Angeles, Denver, Kansas City and Chicago; between Los Angeles, Arizona and Texas; throughout the Rocky Mountain region and the Southwest.

The company's five Golden Jet Boeing 707s and 13 jet-powered Viscount IIs accounted for more than 90 per cent of CAL's daily seat miles—the highest percentage of jet-powered service offered by any trunkline in the nation. Continental also operated 11 piston-engined aircraft during the year.

On order were four Boeing 720B fan-jet transports. The new planes were to be delivered to the company in the spring of 1962, permitting a substantial expansion of jet schedules for the prime summer vacation months. Acquisition of the new planes will boost the company's assets to approximately $100 million.

In addition during the year was a $250,000 flight kitchen at Los Angeles International Airport, completed on Oct. 1, 1961. The kitchen, which has a capacity of 5,000 meals a day, will be for Continental's own use. Food boarded on CAL's flights at Los Angeles previously was prepared by caterers.

Continental was operating its Golden Jets on flights connecting Los Angeles, Chicago, Denver, Kansas City, Houston, San Antonio, Phoenix, and El Paso. The Viscount IIs were scheduled throughout Colorado, New Mexico, Texas, Oklahoma, Kansas, Missouri and Arizona.

In June, 1961, Continental opened up its newly-awarded Southern Transcontinental route by inaugurating flights between Houston and Los Angeles, both nonstop and via San Antonio, El Paso, Phoenix and Tucson. The expansion of Continental's system also marked the first time the airline had served Arizona.

At year-end Continental had a number of major route applications pending before the Civil Aeronautics Board, including requests to fly between the Mainland and Hawaii; to fly between Los Angeles and San Francisco; to fly nonstop between Dallas/Ft. Worth and both Houston and San Antonio; to fly between Dallas and Los Angeles via Lubbock, Albuquerque, Phoenix and Tucson; and to fly nonstop between major cities in Texas, Oklahoma and Colorado.

Continental made a major bid to extend its system to the East Coast, by asking for authority to fly between Chicago, Cleveland and New York; between Cleveland and Philadelphia; and between Philadelphia and Detroit. The application was made in the Chicago-East case, which the CAB opened to determine what new service is needed on the routes to fill the competitive gap resulting from the merger of Capital Airlines into United Air Lines.

During the year, Continental gained new recognition within the industry for several reasons:

—It was one of the few of the nation's 11 major trunk airlines which showed a net profit in the first six months of 1961 despite the severe effects the general business recession had on the industry.

—Continental achieved what one trade publication (Airlift Magazine) called a "phenomenal" utilization of its Golden Jets by scheduling each aircraft for 15 flying hours a day, highest in the industry. A major factor in the high utilization was the company's "perpetual" maintenance program whereby major overhaul is done on a regular daily timetable, thus eliminating the need to pull aircraft out of service for long periods of time.

—The company made several new service innovations. Example: The "instant boarding" system whereby passengers need only to check their luggage at the terminal, immediately board the Golden Jets, then buy their tickets in-flight from a male cabin service supervisor known as the Director-Passenger Services.

—Because of rigid cost control, high aircraft utilization and the overall efficiency of its operation, Continental had the lowest break-even load factor in the industry for the first six months of 1961—43.8 per cent systemwide.

Delta installed new rapid, highly accurate inter-city teletypewriter system.

DELTA AIR LINES

Delta Air Lines advanced into the ranks of the transcontinental air carriers this year with the coveted Southern Transcontinental Route award.

The CAB award transformed Delta from a regional trunk line into a full-fledged transcontinental trunk carrier by authorizing it to extend its routes west of Texas to California, effective June 11.

The nation's fifth largest airline, Delta pioneered the trans-Southern routes between Texas and the Southeast starting in 1929. For the past 12 years it had developed an increasing flow of passenger traffic from the Atlantic to the Pacific across the Southern tier of the United States by means of interchange agreements with other airlines.

In 1961, with a fleet of pure jet aircraft and more than 50 propeller-driven planes, Delta linked 70 cities in the United States and Caribbean, maintaining the same high service standards which characterized its operations since the airline's inception.

First airline in the world to fly the 122-passenger, four-engine DC-8 pure jet on a regular schedule, Sept. 18, 1959, Delta enjoyed the same distinction when it introduced the Convair 880 on May 15, 1960. Its millionth DC-8 passenger was welcomed aboard in 1961, on the second anniversary of jet service, Sept. 18.

The DC-8 in two years surpassed 930 million revenue passenger miles, operating with a load factor of 70.66 per cent. The fleet of DC-8s and 880s combined carried in excess of 1,500,000 passengers more than 1.4 billion revenue passenger miles.

Delta, which had 18 jets in operation at the end of 1961, announced a $36,000,000 expansion of its jet program with the purchase of four additional Convair 880s and three DC-8s for delivery in 1962.

Delivery of the aircraft will increase Delta's jet fleet to 25, representing an investment in excess of $125 million. The DC-8s in the new order will be powered by four JT3D-1 Pratt and Whitney forward fan engines, each generating a 17,000-pound thrust. This model is the most powerful DC-8 built by Douglas Aircraft Company.

The 88-passenger Convair 880 has been a record-setter since its delivery flight on Feb. 10, 1960, when it flew the 2,359 miles from San Diego to Miami in 3 hours, 31 minutes, and 54 seconds. The sleek plane set two additional official inter-city speed records in 1961 during the operation of pre-inaugural flights between Atlanta and San Francisco. On Oct. 5 a Convair 880 covered the 1,914 miles between San Francisco and New Orleans in three hours, 18 minutes 56 seconds. On Oct. 8 another Convair 880 flew the 2,195 miles from Atlanta to San Francisco in 4 hours, 18 minutes, 41 seconds.

At year-end, Delta offered jet service to 19 cities, and it was the first airline to introduce jet service to seven of those cities.

Delta's revenues and traffic columns, increased by a brief interruption of competitive services, reached record levels during 1961. For the fiscal year ending June 30, 1960, Delta's net earnings from operations were $4,126,000 with disposition of flight equipment boosting total earnings to $4,652,000, equal to $4.15 per share of outstanding common stock.

Total operating revenues for the year rose to $146,132,000, an increase of 21.5 per cent over the $120,191,000 for the previous year. Operating expenses were $134,431,000, up 18.48 per cent.

Delta carried a record 3,569,778 passengers during the 12 months, an increase of 10 per cent over the previous 3,241,511. There also was a gain in passenger revenue, up to $134,946,000, an increase of 23 per cent above the previous $109,671,000.

During the month of August, 1961, Delta set three cargo records. The airline carried 1,809,000 ton miles of airFREIGHT, 398,000 ton miles of express, and 528,000 ton miles of mail. The airFREIGHT figure was up 45 per cent over the same month last year and was 17% more than the carrier hauled in July, 1961. Delta carried 27% more express and 33 per cent more mail than it carried in August, 1960. Express ton miles represented a gain of 22% over July, 1961, and mail an eleven per cent gain over the same period.

Delta attributed the increase to a general upswing in the national economy, as freight transportation is normally the first industry to feel the results of an improving economy. Merchants, says the airline, just do not order goods if they do not expect to sell them.

Delta, with a fleet of five Super D-46 airFREIGHTERS, offered all-cargo flights to eleven cities in nine states.

The first door-to-door airFREIGHT rates in the industry were put into effect by Delta on Oct. 6. Previously all quoted rates were based on airport to airport service, and Delta felt that the new program offers the biggest boost that airFREIGHT has ever had. Although airFREIGHT rates have been steadily reduced, increases in pickup and delivery have been offsetting these reductions, but door-to-door rates can offer shippers considerable savings, in some cases as much as 40 per cent.

In July, Delta demonstrated its newly-ordered IBM 9074 SABRE airline reservation system which will make up-to-the-second flight and passenger information available instantly to its reservations agents in 66 cities. The far-flung IBM tele-processing network will link nearly 300 remotely located electronic agent terminals to a powerful computer center, located in Atlanta, with installation scheduled to begin in April, 1963.

Delta's SABRE airline reservation system will improve customer service by providing reservations agents with immediate access to accurate, complete and current information on space availability for all Delta flights and for the most frequently used connecting flights of other airlines.

SABRE, with nearly 70 million words of information in magnetic disk storage, will file and follow up complete individual reservation records of all Delta passengers.

Another Delta demonstration, in September, unveiled the first developmental model of the world's fastest, most accurate inter-city teletypewriter system. The model system, furnished Delta by the Bell Telephone System, is known as Developmental Line Switched Teletypewriter Service.

EASTERN AIR LINES

A highlight of Eastern Air Lines' year was the introduction, in the spring of 1961, of "Air-Shuttle" service between New York and both Washington and Boston.

The Air-Shuttle offered positive seats, no prior purchase of tickets, no check-in delays, and no baggage tagging. A passenger picks a boarding pass out of a vending machine, takes his baggage with him or leaves it at the gate to be loaded, and pays for his ticket on board the flight. A reduced fare is charged for this service.

The Air-Shuttle proved highly successful. At the end of the first 11 weeks of the experiment, more than 50,000 passengers had tried the service. Eastern invested $525,000 in an Air-Shuttle station at New York's LaGuardia Airport, where it will have its own access roads to the main highways between New York City, Westchester and Long Island. Super-Constellation aircraft are used for the Air-Shuttle service.

Beginning with every-other-hour schedules, the service between New York and Boston was doubled to hourly on August 1, and on September 15 increased on the same basis to Washington. By late October, Eastern had carried more than 300,000 passengers by Air-Shuttle.

During the year, Eastern received authorization to extend its services as far west as Dallas and Fort Worth, Texas, with direct flights across the Gulf of Mexico from Miami and Tampa via New Orleans.

Also, as part of a program to strengthen its long-haul operations and to provide better regional and connecting service for some of its smaller northern cities, Eastern arranged during the Summer to transfer to Mohawk Airlines two Vermont and six upstate New York stations which it had acquired with the Colonial merger in 1956.

The frill-free Air-Bus service which was introduced a year ago between Pittsburgh, Cleveland, St. Louis and Florida with considerable success was further expanded in 1961 to include flights between Detroit, Tampa and Miami, and between New York, Newark, Philadelphia, Miami and San Juan, Puerto Rico.

Looking to the future, Eastern placed an order during 1961 for a $175 million fleet of short/medium range jet aircraft—the Boeing 727—with three rear-mounted by-pass engines giving it a speed capability of 585 mph over ranges from 200 to 1500 miles non-stop. The first of these planes will be delivered in 1963.

As it entered the Winter travel season of 1961-62, Eastern was looking forward to a greatly enlarged jet fleet and jet schedules tripling those of the previous Winter, with some 15 Douglas DC-8s and 15 Boeing 720s in service and many new pairs of cities linked for the first time by the modern aircraft.

ELLIS AIR LINES

Outstanding in the events of the 1961 Ellis year was the announcement of the agreement of the directors of Ellis Air Lines and Alaska Coastal Airlines to merge the two companies. Pending Civil Aeronautics Board approval, the two companies worked for a January 1, 1962, date of consumation. The new company (proposed name—Alaska Coastal Ellis Airlines) expected to have its central offices in Juneau; however, the maintenance facilities will be distributed between Juneau and Ketchikan, and the Ketchikan Base will be retained as a terminal point. Coastal Ellis will have a fleet consisting of three Convair 28-5ACFs, sixteen Grumman G-21As, three Cessna 180s, one Bellanca and one Howard, and will serve virtually every human being in Southeastern Alaska.

The greatest immediate effect of the merger will be the consolidation of the maintenance department. It was tentatively planned to overhaul the Grumman aircraft at the Ketchikan base and the Convair aircraft at the Juneau airport. Engines will also be overhauled in Juneau. The two companies were in a position to accomplish this development with little or no transfer of personnel or equipment.

Changes in routes and schedules will be considerably more gradual, but the combined existing routes will cover all of Southeastern Alaska, from Prince Rupert, British Columbia in the south, to Skagway, Alaska in the north, providing scheduled service to 41 communities, and charter service to any spot in Alaska or British Columbia. Although there are only three usable airfields in Southeastern Alaska, this extensive service can be provided by Coastal Ellis since each of its aircraft will be equipped to land on water.

The new color scheme will be black and white, and feature high visibility red trim on the engine cowel, wing tips, and tail. The emblem will be the two Ellis Geese imposed over the moon, the long standing symbol of Ellis Air Lines.

FRONTIER AIRLINES

Frontier Airlines in 1961 made considerable progress both in profits and in passenger volume. For the twelve months ending in October, Frontier's "Sunliner" fleet of thirty-two twin-engined aircraft carried 352,000 passengers a total of 95,551,000 passenger miles. This was a six per cent increase in revenue passengers and a nine per cent increase in the total distance which they traveled over the previous twelve month period.

For Frontier's 1,300 stockholders the good news came in a third quarter Stockholders Report with profits for the first nine months of 1961 setting a new high. The operating profit of $596,000 was an increase of 139 per cent over 1960. Net income before special adjustments totaled $243,000 or a 122 per cent increase over the same nine-month period in 1960. These much improved operating results were primarily attributed to a 15 per cent increase in passenger revenue, a four per cent increase in subsidy and only a five per cent increase in operating expenses.

An aggressive sales and advertising program took honors for most of Frontier's better passenger traffic story in 1961. Attractive packaged vacations to the many major national parks directly served by the airline resulted in a healthy increase in interline traffic to Yellowstone, Grand Teton, Grand Canyon, Mesa Verde national park vacationlands and to the dude ranch resorts areas served by Frontier.

In July, a presentation was made to the Civil Aeronautics Board by Frontier and North Central Airlines for the transfer and sale of certain of Frontier's route segments in Montana, North Dakota and South Dakota to North Central. Historically and economically, the thirteen towns and cities served by Frontier on these route segments have had much stronger community of interest with the area served by North Central than with the communities of the Rocky Mountain West and Midwest served by Frontier. By selling and transferring the route segments to North Central Frontier hoped to reduce its annual subsidy need by $1,300,000. Although North Central's subsidy would be increased by serving the routes the overall annual subsidy savings would amount to $450,000. In addition the towns and cities affected would receive improved air service because of North Central's east-west traffic flow and its ability to feature one-carrier service to Minneapolis-St. Paul and Chicago trade centers.

New air service was inaugurated by Frontier between Salt Lake City and Billings, Montana, with intermediate service to Jackson, Wyoming. Jackson is the gateway to Yellowstone National Park and directly serves nearby Grand Teton National Park plus the dude ranches and resorts in the Jackson Hole country. The new route provided much needed direct air service to the terminal cities and afforded good connecting interline service to the West Coast. Frontier Airlines was serving the travel needs over this new route with 44-passenger Convair 340 aircraft.

Frontier started new service to Yellowstone and Grand Teton National Parks.

In the Spring of 1961, Frontier was a participant in the extensive Southern Rocky Mountain Area Local Service Case. The airline's case was based on a more liberalized operating authority over route segments being served between the important terminal cities of Denver and Tucson; Phoenix and Albuquerque; Albuquerque and Salt Lake City and between Salt Lake City and Tucson. In addition, Frontier established the need for more frequent air service between Denver and Las Vegas, Nevada via Grand Junction, Colorado. Since Frontier was already serving the heartland of the area under study in the Southern Rocky Mountain Case and links the major trade centers of the Rocky Mountain West with twice daily round trip flights, the airline based its case on the imperative need for liberalizing its authority to allow for one-stop operations between terminals. This would make possible profitable longer haul flights and at the same time provide intermediate communities with better service to and from terminal cities via faster on-line connecting services. Frontier Airlines also proposed to operate faster turbine-powered Convair 540 aircraft between the terminals on each route segment should its basic presentations in the case be found acceptable by the Civil Aeronautics Board.

In the early summer of 1961, Frontier opened negotiations with British Aircraft Corporation for the purchase of six twin turbo jet-powered BAC One-Eleven aircraft. Rolls-Royce Spey jet engines mounted in pods on each side of the rear fuselage section would carry 62 passengers at 540 miles per hour. Additional contractual negotiations were to be conducted later in the year. Earliest delivery of the jet aircraft to Frontier Airlines would be in the summer of 1965.

LAKE CENTRAL AIRLINES

In the first six months of 1961, Lake Central Airlines progressed from one of the smaller local service airlines to one of the largest.

This tremendous forward advance was a result of the 1960 CAB decisions permitting Lake Central to extend service to the District of Columbia and 48 cities in the eight states of Indiana, Illinois, Ohio, Pennsylvania, New York, West Virginia, Michigan and Maryland. Consequently, Lake Central increased its daily flights from 39 in December 1960 to 71 in September 1961.

One of the new routes served by Lake Central was the north-south segment between Cincinnati and Detroit via the intermediate cities of Columbus, Dayton, and Toledo, Ohio with unrestricted non-stop privileges. Lake Central in 1961 offered non-stop service between Cincinnati-Detroit and Columbus-Detroit. As a result of the various route awards, Lake Central has more than doubled the number of flights in and out of Cincinnati with an increase from 12 to 28 daily.

Evansville, Indiana was also one of the new cities added to the Lake Central route structure. Exclusive service on a non-stop basis was provided between Cincinnati and Evansville.

Lake Central began serving many new routes between cities which had not been previously served by the airline. Among them are such segments as Erie-Pittsburgh, Detroit-Cleveland and Bloomington-Cincinnati. In the expansion of Lake Central's east-west service the cities of Parkersburg, Elkins and Clarksburg, West Virginia, Baltimore, Maryland and Washington, D. C. were added to the Lake Central structure.

To provide better service for the expanded Lake Central system, the airline took delivery of the first of five Convair 340s in October 1960. Two more were delivered in November and December 1960 respectively, and the last two in the first few months of 1961. By June of 1961 all five Convairs were in operation serving the new routes. As of September 1961, Lake Central offered Convair service to 19 cities.

The Lake Central DC-3 fleet was also increased to meet the new needs of the airline. Ten additional aircraft were purchased which boosted the DC-3 contingent from 12 to 22.

As passengers boarded the Convairs or the DC-3s they were welcomed by Lake Central stewardesses wearing a new uniform created in 1961 especially for Lake Central by the internationally famous Beverly Hills couturier, Don Loper. The new uniforms were officially donned in October, 1961. Lake Central was the first local service carrier to use a design of the well known couturier.

During the past year an underwriting group headed by William Blair & Co., a Chicago investment banker, offered 130,000 shares of 6½% convertible preferred stock at $20 par value of Lake Central Airlines, Inc., at a price of $20 per share. The proceeds of the convertible preferred stock offering and a $3,000,000 bank loan were used to acquire the additional aircraft and applied toward other requirements of Lake Central's expanded route system. The total proceeds from the offering and the bank loan were $5,600,000.

Lake Central offered the first quarterly dividend on the newly issued preferred stock in February of 1961. The initial dividend was 14.44 cents per share on the 6½%, $20 par value preferred stock. Quarterly dividends of 32.5 cents per share were also paid in June and September.

As part of a long range development program, Lake Central evaluated different types of vertical take-off aircraft throughout the year. Lake Central officials observed the operation of the Fairey Rotodyne, Sikorsky S-61 and S-62, and the Vertol 107. Lake Central's interest in verticle take-off aircraft is to determine their feasibility of operating in the downtown to downtown passenger travel market.

Because of the acquisition of new routes which serve many cities for the first time, Lake Central's passenger and community relations program has also been stepped up. Eight pre-inaugural flights were conducted by the airline during the year. These included Akron-Canton, Ohio; Columbus and Evansville, Indiana; Jackson, Michigan; Baltimore, Maryland; Clarksburg and Martinsburg, West Virginia and Washington, D. C. In each case one or two Lake Central planes were used to fly, local and city officials, area and state dignitaries, members of the press, radio, and television, and Lake Central personnel on scenic flights followed by welcoming ceremonies at the new terminals.

In addition to the pre-inaugurals, four receptions were held in connection with the establishment of Lake Central's north-south routes between Cincinnati and Detroit.

In observance of National Aviation Day, which was celebrated on the birthday of Orville Wright, Lake Central presented gold-framed certificates of commendation to the Aviation Committees of 23 cities served by the airline. These cities were cited for their outstanding performance in the promotion of aviation in their respective areas.

Once again, Lake Central was the recipient of the National Safety Council's highest award. The airline was presented with the Award of Honor, an award for airlines which accumulate 75,000 aircraft hours or more without a passenger or crew fatality. Lake Central has received the National Safety Council's award every year since the airline began operating.

MOHAWK AIRLINES

Mohawk Airlines continued its fast-paced expansion in 1961 by a growth of 45% through acquisition of new routes, installation of a central reservations complex, acquisition of additional equipment, new fare reduction plans.

These were Mohawk's 1961 highlights:

Mohawk grew 45% in September as eight northern United States cities were transferred to Mohawk from Eastern Air Lines. Among the cities included in the transfer were Glens Falls, New York, Plattsburg, New York, Albany, New York, Saranac Lake, New York, Rutland, Vermont and Burlington, Vermont, Watertown, New York and Massena, New York.

The airline installed a central reservations system in both Syracuse and New York City speeding the reservations process considerably. Central reservations is a result of the recent telpak tariff filed by the American Telegraph and Telephone Company. New York center is located in the East Side Airlines Terminal Building. The Syracuse center is located in the Mohawk Airlines Building in Syracuse. Central Reservations allows a person to dial a local listed number in his area. Through a direct line, he is connected to one of the reservations centers at no extra cost to the customer. Central Reservations will be in operation 24 hours a day.

Mohawk purchased nine Martin 404s to supplement the Convairs on the routes transferred from Eastern Air Lines.

Service to Pittsburgh from New York was inaugurated during May along with service to the Canadian border at Massena, New York.

The number of cities served increased to 52 within a ten state of the populated Northeast section of the United States. Service extended from Detroit to Boston, from the Canadian Border to New York City and Pittsburgh.

The company announced the retiring of the three remaining DC-3s at the end of 1961. They will be sent to Mohawk's Ithaca base, where the rest of the DC-3 fleet is waiting to be sold. The DC-3s were used in 1961 for Mohawk's famous Gas Light Service which received wide acceptance throughout the United States, including Alaska and Hawaii.

The Golden Age Fare was introduced as a one-third reduction in fare for men over 65 years old and women over 62 years old. The travel is good anywhere on the Mohawk system at the special Golden Age Excursion Fare between the hours of 12:01 a.m. and 12:59 p.m. on a round trip basis. There is a $5.00 annual membership fee in order to attain the reduction.

Mohawk hosted the 14th New York State Airport Operators Conference in Utica. Over 200 airport operators attended this conference sponsored by the New York State Department of Aviation. Previously held in Syracuse, this conference was one of the most successful in the series.

A Market Development Department was created within the company.

Total charters contracted during the year represented a 40% increase over 1960. As of August 1961, the total amount of charters surpassed 1960's income. Charters were expected to gross over $400,000 in 1961.

The airline created a customer custom interior department for Mohawk's contract maintenance service through acquisition of Aeronautical Upholsters, Inc. Mohawk will install a custom interior according to the customer's specifications on any multi-engine equipment.

The Ready Ticket check-in procedure was introduced eliminating the waiting at the airport ticket counter. The customer calls for reservations, writes his own ticket, and picks a boarding pass from the Ready Ticket check-in board on the airport ticket counter. The customer is then billed at the end of the month.

An exemption for the Group Travel Developer Tariff was received by Mohawk. This tariff allows a group travel arranger to travel free if the group consists of fifteen or more people.

The New York City Area General offices were moved to the East Side Airlines Terminal Building.

A weekend excursion fare was introduced which gives a 25% reduction in the round trip fare anywhere on Mohawk's system. This reduced fare is good from midnight Friday to midnight Sunday.

Mohawk's fleet at year-end consisted of 27 aircraft: 13 Convair 240s, 5 Convair 440s and 9 Martin 404s.

Management was studying various types of jet equipment for possible purchase. Among the contenders were the British BAC-111 and the French Sud Aviation Caravelle.

NATIONAL AIRLINES

Jetting West on June 11, 1961, National Airlines became truly a national airline with the inauguration of the southern transcontinental route linking Florida and California. In 1961, NAL served all three coasts of the country—East, West and Gulf—and was certificated to serve 44 cities in 15 states, the District of Columbia and Cuba.

In its decision on March 14, 1961, awarding the new route, the Civil Aeronautics Board extended NAL's Miami-to-Houston route by two segments, one to Los Angeles via San Diego, and one to San Francisco via Las Vegas. Included in the award was the authority to fly non-stop from Florida to California.

The new route, just about doubled the miles the Florida airline was flying. The CAB decision predicted the route should develop about 343,900 passengers and 667,829,000 revenue passenger miles, and increase the revenues of NAL by $41,000,000 a year.

NAL President G. T. Baker in April announced the purchase of seven DC-8 turbofan jets from the Douglas Aircraft Co., and the first was delivered in October, 1961. The Pratt and Whitney JT 3-D-1 turbofan engine gives these aircraft more power and speed, combined with fuel economy. The DC-8 turbofan jet of this type in 1961 held the record of flying further, faster and higher than any other commercial jets. Overall cost of the seven planes was $39,800,000.

June 11 was set by the CAB as the inaugural date of the new route, and in the intervening months 25 NAL crews trained to fly the route.

Initial schedules called for five daily round-trip flights from Florida to California. Two of them were DC-8 jet flights from Miami to Los Angeles, one via Tampa, and one via New Orleans and Houston. On September 24, National inaugurated

DC-8 jet service between San Francisco and Miami, via New Orleans and Houston, first jet link between the cities.

All-cargo service between Florida and California was launched August 1, with round-trip flights Monday through Friday each week from Miami to Los Angeles, via Orlando, Tampa and Houston. The Department of Defense had stressed the need for the air freighter service, given by two Super-H Star air freighters with a cargo capacity of 38,000 pounds. Two air freighters continued to serve the New York-Miami route, with a big increase in the amount of cargo carried on the East coast route, compared with loads for 1960.

The American Red Cross asked National Airlines to fly relief supplies collected in South Florida to Houston, for relief of victims of Hurricane Carla in September in the air freighters.

It was predicted that the new route would be lucrative. The first two months of operation proved even better than predictions. In July and August National flew 115,825,000 revenue passenger miles, up 43.6 per cent over the same period in 1960. Operating profit for the period was $450,000 and net profit was $119,400, highest for any July-August period in National's history.

Not all the increase in traffic was due to the Florida-California route. Record summer traffic from Idlewild was reported following National's introduction of new low coach fares in May, Mondays through Thursdays, between New York and Miami, Philadelphia and Miami, and Washington and Miami. Mid-summer package vacations sales also set a record.

Missile activity at Cape Canaveral, in New Orleans at the Michoud Airport moon-rocket project, at Houston's space laboratory and in California missile manufacturing plants generated a substantial part of the travel on National's new route.

National reported a net loss for the fiscal year ending June 30, 1961, of $7,254,145 after depreciation charges of $11,116,000 and non-operating charges of $1,772,000. Despite an increase of $1,869,000 in depreciation and an overall wage increase of 14.9 per cent, an overall cut in expenses of $4,332,000 was made.

Among the adverse factors to which the loss was attributed were: the temporary certification of Northeast Airlines in the New York-Florida market; the general business recession; loss of the Cuban market; the demands of labor resulting in two strikes during the fiscal year; the speed restriction on the Electra which increased its unit cost per mile; and most unusual and severe weather conditions in the northeastern area during the winter, causing cancellations and substantial loss of revenue.

A $10,288,000 issue of subordinated convertible debentures was successfully marketed during the year and actively traded on the New York Stock Exchange.

A third Douglas DC-8 jet, the DC-8 turbofan jet, and two additional Lockheed Super Electra II planes were delivered in the fiscal year 1961, increasing the NAL fleet to 48 aircraft. These were in addition to the turbofan jets. Two additional daily round trips between Miami and New York with DC-8 jet equipment and five round trips weekly on DC-7B equipment were obtained through an interchange agreement.

The CAB approved a National Airlines plan to divest itself of 400,000 shares of Pan American stock by means of sale in the 1962 fiscal year.

A CAB examiner recommended in February that NAL provide service between Florida, Buffalo and Toronto, by extending NAL's present route from Philadelphia. NAL filed an application with the Board to fly non-stop from New York to Jamaica in a newly created route case. And NAL became a contender for a route to South America by asking the CAB to consolidate National's applications for route extensions to Balboa, Canal Zone, both from Key West non-stop and from Key West via Kingston and Montego Bay, in the newly created United States-South American route case.

As 1961 ended the most important case involving National Airlines pending before the CAB was the proceedings to determine whether to renew Northeast Airlines' temporary five-year certificate to fly the New York-Miami route, which expired on November 27, 1961. National asked the CAB to expedite hearings, and the Board announced that among other things it would consider in the case would be proposals for a merger with Northeast.

The position of National in the case is that the traffic on the New York-Miami route will not support three carriers, and that the over-competition since the award of Northeast's temporary certificate has brought financial disaster to Northeast and losses to the other two carriers serving the route, National and Eastern Airlines.

At the NAL board meeting on November 3, G. T. Baker announced his desire to retire as president in favor of Robert E. Wieland. Baker continued as board chairman.

The NAL fall sales conference took the entire system-wide selling team of National to the west coast cities now added to the system, to familiarize them with the new routes possibilities, while operational personnel were brought to the Miami executive offices for a conference on systemwide operational problems.

NEW YORK AIRWAYS

Receipt of the first of its fleet of Vertol 107 twin turbine helicopters highlighted the 1961 year for New York Airways. NYA received the helicopter, first of five on order, on September 25 and put it into immediate use in training and route development work.

The helicopter airline planned to start scheduled operations with its 107's in January, 1962. With its 1961 fleet of five Vertol 44B's, the line was able to operate out of Newark and Idlewild every 50 minutes. With the new, faster 107's, and the removal of certain operating restrictions permitted by the twin turbine power system, NYA expected to operate every 25 minutes. The 107's can carry 25 passengers and a crew of three, and cruise at 155 miles per hour.

In a mid-summer announcement, NYA stated plans to install a completely automatic flight control system in its 107's. A contract was awarded to Lear, Inc., for installation of Lear L-5H autopilots and command instrument systems in the craft. The Lear equipment, utilizing the DECCA Navigator system, makes possible automatic navigation and gives the helicopters Instrument Flight Rule capability.

In November, NYA entered into an agreement with Pan American World Airways and Pakistan International Airlines which could open new foreign helicopter service. Pan American engaged NYA to employ its knowledge and experience in the helicopter field to make a survey in East Pakistan to determine the feasibility of a helicopter operation in that area.

Under the agreement, NYA was to furnish three helicopter specialists, two of whom were to conduct the survey on location and be available for conferences with Pakistan International Airlines' representatives. The third, John E. Gallagher, vice president of NYA, was to serve as project coordinator. The survey was to take about four weeks, after which NYA was to submit a report to Pan Am setting forth the results of the survey and recommendations. The agreement was part of a technical cooperation program under way in Pakistan, whereby Pan Am, under the auspices of the Agency for International Development (AID) was helping the development of the Pakistan carrier.

During the year, NYA also announced plans to carry stewardesses aboard its Vertol 107's. Miss Fern E. Roberts was appointed the first chief stewardess of any helicopter airlines.

NORTH CENTRAL AIRLINES

Passenger records and new routes occupied the news highlights of North Central Airlines in 1961.

The Minneapolis/St. Paul-based carrier achieved new heights in its leadership of the local airline industry's boardings. On June 16, 4,285 passengers were enplaned throughout the Northliner system, the first time any of the locals had topped the 4,000 mark in one day.

To this was added the fact that in August North Central boarded 112,111 passengers, a new monthly record for the company and the local airline industry. (North Central had previously recorded a monthly first when it carried more than 100,000 passengers in August of 1960 and over a million for that year.)

North Central's new exterior markings made appearance in 1961.

These records were achieved with the carrier's growing fleet of Convair 340/440 aircraft, which by November numbered ten, and 31 DC-3s.

System expansion jumped from 6,900 miles at the start of 1961 to 7,100 with the inauguration of Northliner service to Cleveland on Feb. 1, and to Regina, the capital of the Canadian province of Saskatchewan, on May 1.

Cleveland is the eastern terminus of North Central. Daily Convair flights offer air travelers of this Ohio city convenient service to Detroit and the numerous Michigan cities on North Central's system.

Regina is served on a route from Minot, N. D., and is the carrier's third entry into Canada.

On April 30 North Central began serving Marshfield, Wis., on one of its present Twin Cities-to-Chicago segments.

The Viscount completed three years of service with Northeast Airlines.

With these additions, the system totaled 91 cities—the third largest U.S. carrier in the number of cities served.

In a further move to strengthen its route structure through expansion westward, North Central in July completed negotiations with Frontier Airlines for the purchase of several Frontier routes. Totaling 1,376 miles and 16 cities, these segments include:

*Between Rapid City, S. D. and Bismarck/Mandan, N. D., via Lemmon, S. D. and Dickinson, N. D.;

*Between Bismarck/Mandan and Billings, Mont., via Minot and Williston, N. D., Sidney, Glendive and Miles City, Mont.;

*Between Williston and Great Falls, Mont., via Sidney, Wolf Point, Glasgow and Havre, Mont.;

*And between Great Falls and Billings via Lewistown, Mont.

The purchase will become effective when the contract has been approved by the Civil Aeronautics Board.

During 1961 the company established a new program of commending its flight personnel. A captain, first officer and stewardess from each of North Central's four domiciles were honored as Crews of the Year.

The program was based on careful selection of outstanding flight personnel by their fellow crew members. Points for consideration included professional bearing, personality, initiative, conduct on and off the job, cooperation, appearance, industry and loyalty.

A new $1,250,000 maintenance hangar at Chicago's O'Hare field was completed late in the year. The structure is 37,400 square feet in size and large enough for three of the company's Convairs.

Included in this construction project was a special water deluge system for fire protection, shared with two other carriers. The unit holds the necessary pumps plus 480,000 gallons of water.

North Central continued the development of its corporate identity program—a re-designing of all visual features of the airline. Early in 1961 the "new look" made its apperance on the aircraft exterior, with smooth, uncluttered lines creating the look of motion.

Prominent colors used by industrial design consultant Karl Brocken in his overall planning are turquoise and gold, featured on the aircraft interior, flight bags, baggage stickers, matches and other items.

NORTHEAST AIRLINES

During 1961 Northeast Airlines phased in its complete 880 pure jet fleet to mark the beginning of its 29th year as a scheduled commercial carrier.

The popularity of Northeast's $30 million jet fleet was credited with a number of substantial traffic gains experienced during the year. New traffic records were set month after month; in September, over 51,000,000 revenue passenger miles were flown for an increase of 27% over the same period last year. During 1961 the 880 jets made their appearance in Northeast's major East Coast to Florida system cities. The planes dramatically cut flying times and in a number of cases provided the first and only pure jet transportation over the heavily traveled routes.

At year-end, Northeast's 880's served the following cities: Montreal, Boston, New York, Philadelphia, Baltimore/Washington, D. C., Miami, Fort Lauderdale, Tampa/St. Petersburg-Clearwater, and Jacksonville, Florida.

During the year Northeast's traffic results made it the number one and/or the number two carrier in seven of the thirteen northeastern U.S. to Florida markets it serves. Between Boston and Miami/Fort Lauderdale, for example, at one point the carrier reported it was carrying nearly twice as many passengers as its nearest competitor.

The impact of this 880 equipment was demonstrated by a 100% increase in the sale of Northeast's 1961-1962 Florida package vacations compared with the previous year. To make these vacation packages even more attractive the line's new Fall and Winter schedules increased available jet seats by more than 50% over last year for the greatest number of jet seats ever available throughout Northeast's system.

In keeping with this growth pattern in the Florida travel market, Northeast's "commuter" business moved steadily ahead. During the first six months of the year passenger traffic between Boston-Washington-Philadelphia-New York increased more than 30% over the same period in 1960. New York-Washington traffic alone increased over 60% for the period.

Statistics revealed that in 1961 Northeast carried two and one-half times as many passengers between Boston and Washington as the second major carrier. At this rate, seven out of ten Boston-Washington passengers were flying on Northeast. To accommodate this business, Northeast scheduled 16 non-stops daily and operated extra sections at peak traffic periods—most of it with the popular jet-prop Viscounts.

Throughout its entire East Coast operation Northeast has pioneered a number of service features. Beginning with the DC-6B and the introduction of the only low fare day coach service limited to two and two seating, it moved on until in 1961 it was the only major East Coast airline to honor American Express, Hilton Carte Blanche, and Diners' Club along with the familiar Air Travel Card on all flights. In 1961, it expanded into membership in the Vacation Travel Club, a special travel plan whereby passengers "save now and go later" in order to earn a 6% annual saving on their vacation funds plus full bank interest.

The DC-6B equipment formerly used exclusively in Florida service continued to bring new concepts of speed and four-engine reliability to New England. Throughout the region a number of cities formerly served only by DC-3's were enjoying year round DC-6B service for the first time.

To maintain its expanding fleet of jet equipment Northeast completed a move into its new $2½ million combination office building and maintenance hangar in Boston. The building is large enough to house a football field and grandstand on its hangar floor alone, and can accommodate three Convair 880 Jetliners simultaneously.

Northeast also announced plans to expand its Idlewild operation to include a new $10 million air terminal. The new facility is to be occupied jointly by Northeast, Northwest Orient Airlines, and Braniff Airways and will cover a total of three acres at New York's International Airport.

In New York the carrier occupied a new ultra-modern reservations and sales office on Fifth Avenue as part of its overall program to expand passenger service in the area. The new facility is one of the largest and best equipped in the metropolitan northeast area.

The "new look" in airport and city ticket offices continued to make its debut during the year. The line was moving forward with a master plan designed to modernize and standardize all its ticketing locations from Montreal to Miami.

At year's end Northeast was actively engaged in a number of new promotional and exclusive sales incentive programs designed to increase even more its share of the market between the 37 cities it serves.

NORTHERN CONSOLIDATED AIRLINES, INC.

Northern Consolidated Airlines in the year 1961 marked its 30th year of service in Alaska. The beginning of NCA came in 1931 with the flying exploits of Harrold Gillam, one of the predecessor companies.

The existing airline was the result of a merger of four "bush" airlines who had earned their "grandfather certificates" issued by the Civil Aeronautics Board for their part in pioneering of air transportation in southwestern Alaska. The date of the merger was 1947; it included the Gillam Air Service, Bristol Bay Air Service, Jim Dodson Flying Service and the Ray Petersen Flying Service.

Ray Petersen, who had spark-plugged the deal, was elected president and general manager of the airline, a position which he still held at year-end.

The year 1961 also marked two years of successful operation with the F-27 Propjet.

When residents of Alaska in the fall of 1958 voted overwhelmingly for "statehood", Northern Consolidated Airlines was ready to introduce the "jet Age" to Alaska with the F-27 Propjet.

The latest year of F-27 operation saw NCA increase passenger traffic 20 per cent. Freight volume jumped 10 per cent while mail volume zoomed 59 per cent. Gross income was up from $2,392,000 to $3,346,000.

The year 1961 also saw the tourist operation of the airline set up as a separate corporation. In 1950, NCA installed and built sports fishing camps in the Katmai National Monument and surrounding area, which were called "Angler's Paradise." This venture was set up as a seperate corporation in the last part of 1960, and in 1961 it was operated by Alaska Consolidated Vacations, a subsidiary of Northern Consolidated Airlines. The airline provides propjet transportation direct from Anchorage to the camps.

The "bush operation" of the airline was also greatly expanded in 1961 with 20 New Eskimo villages being added to the mail stops of Northern Consolidated Airlines, which now number 80.

Bush operations are based for the most part at Bethel near the Bering Sea Coast about 400 miles southwest of Anchorage. Here the Airline operates a fleet of Twin-Cessna Bushmaster aircraft on floats, wheels and skis. Two Cessna 180s and one Twin-Engine Beechcraft were stationed there to serve a large part of that operation. Other bush aircraft were operated out of McGrath about 200 miles northwest of Anchorage.

The main general offices and maintenance facilities are located at Anchorage where the airline has its own hangar at Anchorage International Airport. At year-end, NCA had 200 employees, with an annual payroll of over $1,000,000.

The city ticket office of NCA was moved in 1961 to the new Anchorage-Westward Hotel.

During the year 1961, a stock dividend of 5 cents per share was made to stockholders of the company.

A new overhaul contract for the Rolls Royce Dart engines was signed with Dallas Airmotive of Dallas Texas. Previously, the engines had been sent back to the Rolls Royce Factory in Montreal.

NORTHWEST ORIENT AIRLINES

For Northwest Orient Airlines, the year 1961 was one of movement, both in the air and in its own facilities on the ground.

Of first importance to the communities it serves, on routes spanning half the world, was the introduction of service with Boeing 720B fan-jet transports.

Taking delivery on nine of the 625-mile-an-hour most modern jets during the year, Northwest inaugurated 720B service from the Midwest to New York on July 1, and followed this with transcontinental 720B service on August 1. As deliveries of the nine 720Bs continued through the fall, Northwest added more cities to its 720B routes, and by the end of the year spanned the continent both across the northern tier of states and diagonally between the Pacific Northwest and Florida with 720Bs, as well as to Hawaii.

Ozark's 1961 fleet included three

These aircraft joined Northwest's earlier, DC-8 jet fleet to provide an integrated jet service—DC-8s on the long-haul transcontinental and trans-Pacific runs, and 720Bs basically on domestic flights, with Pacific Northwest-Hawaii service for good measure.

During the year, Northwest brought their first jet service to such cities as Minneapolis-St. Paul, Milwaukee, St. Petersburg, and Spokane, and such new jet services as Detroit's first jets to the nation's capital, via Friendship.

Northwest's polar jets, from New York to Tokyo direct via Anchorage were increased from one to three per week, with one of them stopping en route at Chicago to give the Windy City one-stop (at Anchorage) service to Tokyo.

Expansion of freight services also was accomplished during 1961, with five of Northwest's DC-7Cs being converted to DC-7CFs—with installation of a strengthened cargo floor and the largest forward cargo door ever installed in a commercial airliner, 81 by 124 inches.

Northwest on September 30 inaugurated the only through-plane all-cargo service from New York to Tokyo, with the converted DC-7CF aircraft. Intermediate stops on the cargo run are at Chicago, Seattle-Tacoma and Anchorage.

turbine-powered Fairchild F-27's.

In addition to trans-Pacific all-cargo service, the DC-7CFs were used in domestic cargo service.

As jets took over more of the longer flights, Northwest inaugurated jet-prop service in several of its smaller intermediate cities, with Electra IIs replaced by 720Bs and some of the additional eight Electra IIs on which the company took delivery in 1961.

During the year, also, Northwest completed occupancy of its $18,000,000 Main Base at Minneapolis-St. Paul International Airport. General Offices were moved into the facility in June, joining maintenance and overhaul facilities that had occupied the structure in 1960.

OZARK AIR LINES

The year 1961 was significant for Ozark Air Lines as it marked the first fiscal period that the airline's operations resulted in a substantial net income and the first dividend to stockholders.

Net income, after provision of $84,000 for federal and state taxes on income, amounted to $572,697 or 39¢ per share. A stock dividend of four per cent was declared, payable on December 15 to stockholders of record on November 15.

Three cases of substantial importance to Ozark awaited CAB decision. These were the Reopened Kansas-Oklahoma Case in which the suspension of Ozark's routes from St. Louis to Springfield and Joplin, Missouri, was involved; the suspension of American Airlines at Springfield and Peoria, Illinois, leaving Ozark to serve these cities exclusively; and the Wyoming-South Dakota Case which includes the issue of the suspension of Braniff between Sioux Falls, Sioux City, Waterloo and Chicago and the possible award of these routes, with limited non-stop authority to Ozark. A decision by the Board on each of these cases was anticipated late in 1961 or early in 1962. A decision favorable to Ozark in each of these three cases would materially improve the airline's operating results for the coming year and for the future.

Ozark had a tentative commitment for the purchase of five British Aircraft Corporation twin-jet airliners of a series to be known as the BAC One-Eleven. This commitment by Ozark was keyed to a long range forecast indicating that changes in Ozark's route structure operating rights and traffic may justify the larger, faster jet aircraft by 1965. The preliminary order for the pure jets required confirmation by January 1963 to insure delivery by 1965 and gave Ozark an opportunity to review its forecast from a shorter range.

Ozark Air Lines purchased four Convair 240 planes during the current year. The addition of the larger aircraft was part of a long range program to replace the airline's DC-3s on its major routes. The aircraft will be used between 1962 and 1965 when pure jet equipment will become available.

Ozark was operating 23 Douglas DC-3s and three Fairchild F-27 jet-prop planes in serving 53 cities in nine midwest states. The airline was operating approximately 25,000 miles per day.

Ozark's million dollar hangar at Chicago's O'Hare International Airport was under construction and scheduled for occupancy by January, 1962. Also nearing completion was Ozark's space in one of the new terminal buildings at O'Hare. The terminal facilities were also to be completed by January, 1962. The new facilities will permit Ozark to conduct full scale operations at O'Hare and should generate additional traffic and permit the airline to bring better service to the public.

Ozark Air Lines' new insignia—the stylized "Three Swallows"— was officially registered during the past year as the airline's trade mark, and was later selected in national competition as the most outstanding trade mark of 1960.

PAN AMERICAN WORLD AIRWAYS

In one of the most difficult years in the history of commercial aviation—in which the availability of the full potential of jet transportation coincided with the after-effects of a business recession—Pan American World Airways continued to increase its passenger and cargo volumes and its worldwide services.

With a fleet of 52 Jet Clippers in operation, the

Pan Am's Capt. Charles F. Blair is congratulated after 1,000th trans-Atlantic crossing by Stanley Zedalis, Atlantic pioneer.

airline on October 26 celebrated the third anniversary of United States-flag jet service, with its jets flying to 80 lands around the globe.

At the time of the anniversary, Pan Am's jets had flown well over 120,000,000 miles and transported almost 2,000,000 passengers. By year-end, the international carrier had logged a record quarter million jet hours.

The Jet Clipper America, which in 1958 made the first United States-flag flight from New York to Paris, had by the end of 1961 logged more than 4,000,000 miles, or approximately 8,000 hours in the air, the equivalent of almost a year's continuous flying.

Pan Am's three-year jet experience strongly emphasized the reliability of jet engines. The Jet Clippers' Pratt & Whitney powerplants had inflight failures only once in very 40,000 hours which means that a Clipper Captain, flying an average of 900 hours a year, could fly for more than 40 years without experiencing engine failure.

A year-end survey showed that a single Jet Clipper during a month's operation flies approximately 160,000 miles in 320 hours. A typical example was a Jet Clipper which at the beginning of a month was in Honolulu and by the end had made the following flights: It flew from the Hawaiian capital to Fairbanks via Seattle and then back to Honolulu. Then it flew to San Francisco and Los Angeles and over the polar route to London where it joined the transatlantic New York service. Eventually, it returned to the West Coast, via London and Keflavik. During the next 17 days it made more than 10 more roundtrips between the West Coast and Honolulu, two more roundtrips to Alaska, a roundtrip to Singapore and a roundtrip to Sydney before going to New York for maintenance, with this route taking it completely around the world. Once again the jet returned to the West Coast, via Iceland, and made one more roundtrip to Sydney before ending the month in Los Angeles. The Jet Clipper had operated out of 29 airports in 13 countries, and had been in North America, Australia, Asia, Europe and Africa, all in a 31-day period.

The "routine jet month" outlined above typified Pan American World Airways 1961.

With its jet fleet "assigned to the world," Pan Am in 1961 provided a continual international jet airlift for hundreds of thousands of passengers. During the summer season the airline operated 79 weekly roundtrip flights between the United States and Europe—putting travelers from coast-to-coast in direct contact with the Continental capitals, and vice versa—and as the peak season ended a record off-season transatlantic operation replaced it. Pan Am operated 53 transatlantic roundtrip Jet Clipper flights weekly in the 1961-62 17-day excursion season, 10 more flights than had been scheduled during the previous winter. This was the largest transatlantic scheduling ever made during the winter months.

In addition to the excursion fares, many travelers, both first flighters and regular Pan Am passengers, also took advantage of the family fares, which had gone into effect on October 1, and provided reductions of $150 roundtrip economy and $300 first-class fares for wives, and sons and daughters traveling with family heads. These special rates proved effective in encouraging two-way travel over the Atlantic.

The year 1961 saw Pan Am's conversion to the Jet Age virtually complete.

Early in the year the major cities of California and those of South America became the terminals of popular jet flights that connected with other international services in Central America, and Jet Clippers also linked New York with Oslo, Stockholm and Helsinki by direct service.

In 1961 the airline expanded, strengthened and enhanced its cargo services.

Following a two-year study of modern cargo-handling, Pan Am adopted the AirPak system which made it possible and practical to unload and reload an all-cargo Clipper within an hour. The AirPak system—fast, efficient, and independent of winches and complex balancing mechanisms—enables the DC-7F to transport almost 20 tons of cargo on seven preloaded pallets which were designed to Military Air Transport Service's specifications. It was first employed on Pan Am's Pacific routes and later went into service on the Atlantic.

An adjunct to Pan Am's cargo operations is the World Wide Marketing Service which, by mid-1961, was in extensive use in most parts of the world.

Established early in 1961 to assist cargo shippers find markets for their manufactured products and commodities and to assist others to acquire goods, WWMS matured as a free merchandising tool for Pan Am's customers.

In addition to bringing together producer and consumer via Clipper Cargo, the airline's marketing specialists also supply unlimited volumes of information about prices, tariffs, taxes, rates, currency changes and other essential data, and also act as representatives abroad for Pan Am's shippers and forwarders. By year end the unique service was in daily use in the 80 lands served by Pan Am and was providing regular shippers with new business and new shippers with regular business they had never expected to develop.

Pan Am was preparing to take delivery of the new Boeing 707-321B turbofan-powered Clippers. The new Clippers, their range and capacities even greater than the Boeing Intercontinentals already in service, will augment the airline's schedules with regular 5,000-mile flights.

A Panagra DC-8 was first jet into new Guayaquil, Ecuador, airport.

PANAGRA (PAN AMERICAN-GRACE AIRWAYS)

Passenger and cargo traffic over the Panagra (Pan American-Grace Airways) route along the west coast of South America soared to a new company high as the pioneer U.S. flag airline increased its jet frequencies and introduced lower economy fares in 1961.

Panagra revenue passenger miles for the first nine months of 1961 were 15 per cent over last year, the company's previous highest in its 33 year history and cargo ton miles were 16 per cent higher than the year before.

The lower economy fares, which Panagra put into effect in May of 1961, brought the price of a round trip ticket by jet from New York to Buenos Aires, Argentina from \$934 to \$599—a saving of \$335. New York to Lima, Peru was lowered from \$627 to \$460, a reduction of \$167.

At the same time, the airline increased its DC-8 jet service to Buenos Aires from four to six flights a week and inaugurated jet flights to Santiago on a five times a week basis. The new frequencies made it possible for Panagra to provide jet service to Guayaquil, Ecuador's principal commercial city and seaport, and to Antofagasta, near Chile's most important mining region.

The DC-8's replaced all DC-7 flights to Chile and Argentina, reducing travel time from Miami to Buenos Aires to eleven hours, to Santiago to ten hours and to Guayaquil to five hours.

In doing so, Panagra set new speed records for commercial airlines between key cities on its routes. Here, for example, were a few: Lima to Santiago, 3 hours; Santiago to Lima, 3 hours 16 minutes; Santiago to Buenos Aires, 1 hour 18 minutes; Buenos Aires to Santiago, 1 hour 46 minutes; Lima to Buenos Aires, 3 hours and 12 minutes; Lima to Antofagasta, 1 hour 41 minutes; Antofagasta to Lima, 2 hours 7 minutes; Santiago to Antofagasta, 1 hour 35 minutes; Antofagasta to Santiago, 1 hour 37 minutes.

In addition to the daily jet service, which Panagra continued to operate from New York to Lima by way of Miami and Panama over the routes of National Airlines and Pan American Airways, interchange flights with Panagra DC-7 equipment were increased from nine to twelve a week. These flights continue to Panama City, Panama; Cali, Colombia; Quito and Guayaquil, Ecuador; Talara and Lima, Peru; and La Paz, Bolivia, on the Panagra route.

The speed-up in service and lower fares together with President Kennedy's call for an Alliance for Progress combined to spark more interest in travel to South America and a resulting increase in low-priced package tours to the many and varied attractions of the continent.

Northbound travel also was at an all time high, as Panagra stepped up its "Excursiones Fabulosas" program to bring more visitors to the United States from South America in line with the Visit U.S.A. campaign.

Popular all-expense package tours introduced in Argentina, Bolivia, Chile, Colombia, Ecuador and Peru ranged from a 9-day stay in Miami to a 45-day grand tour of the U.S. visiting key cities, national parks and resorts from Miami to California and back. The airline also invited top South American travel agents to visit the east coast of the U.S. to learn first hand about tourist attractions and facilities in Miami, Washington and New York during a 12-day tour.

In September and October, to mark the inauguration of jet service to Chile and Ecuador and continuing its program to increase tourism between the United States and those countries, Panagra also invited several groups of prominent Chileans and Ecuadoreans representing the government, travel industry and press to visit Miami and Miami Beach. These groups toured the Dade county area, were greeted by the Mayors and hosted and entertained by leading businessmen, tour operators and hotel managers cooperating with Panagra in promoting travel to the United States via the Miami gateway.

In the cargo department, while household effects, agricultural and industrial machinery, and missile tracking equipment made up the bulk of the cargo shipped via Panagra, livestock to improve South American herds, and thoroughbred race horses were transported in greater numbers than ever before in the company's pressurized DC-7F all-cargo service.

The luxury of jet air travel was also extended to pets through the private "airborne kennels" which the airline provided for these travelers, at cost. The lightweight plywood kennels provide a maximum of light and ventilation and are carried in the air conditioned, pressurized compartment on Panagra's DC-8 jets and DC-7 piston prop planes. Each kennel comes equipped with a copy of the airline's "Petiquette for Air Travel," an amusing illustrated brochure containing tips for masters of traveling pets, and proper tags for the animal. The new service was introduced to assure pet owners of clean, germ-free housing which they can keep, to save them the aggravation of building or renting crates, and to eliminate the difficulty which connecting airlines had in trying to keep track of rented cages.

A new experimental advertising campaign designed to promote more travel to countries on its route was launched by Panagra in September. The new ads appealed to special interest groups and offered them information on how they could satisfy their own hobbies or individual pursuits in South America. Each advertisement tried to complement the editorial content of the magazine in which it appeared with special emphasis on food, fishing, shopping, archaeology, sightseeing or adventure depending upon the publication.

To help tourists and travel agents select their choice of accommodations in key cities and resort areas in South America, Panagra published and circulated a "Guide to Better Hotels in South America." Listing 112 of the top hotels on the continent, their rates, number of rooms and type of service offered, the guide is distributed to travel agents and Pan American ticket offices throughout the United States.

Latest addition to the airline's library of audio-visual aids for tourists to Latin America is a new LP language record titled "Hear How to Converse in Spanish". Prepared and recorded by Panagra's direction of public relations, Lou Garcia, and edited by the Language Laboratory of Columbia University, it contains all the words and phrases the tourist needs to get around Latin America. Included with the record is a 1000 word self-pronouncing glossary and a copy of the airline's Dictionary of Useful Phrases and most frequently used idioms.

Continuing its efforts to foster closer relations and create better understanding between the Americas, Panagra in 1961 awarded sixteen travel fellowships to South American students to study in U.S. colleges and universities. These brought to 359 the total number of fellowships which the airline has granted since the program was inaugurated in 1937 to help qualified South American graduate students further their specialized studies in this country.

In 1961, in recognition of its perfect safety record for the past seventeen years, Panagra received special aviation awards from the Inter-American Safety Council and the National Safety Council. During the period covered by the awards the airline flew a total of 2,387,098,000 passenger miles without a single accident over its routes in Panama, Colombia, Ecuador, Peru, Bolivia, Chile and Argentina.

The airline also won the coveted Chris Award presented by the Film Council of Greater Columbus for the best travel film. The Panagra film, "Continent of Contrasts" produced by Coleman Productions in 166 mm sound and color, depicts some of the outstanding attractions in South America.

SOUTHERN AIRWAYS

The initial purchase of five Martin 404's, establishment of new passenger boarding records and the addition of cities to its routes were indicative of the continuous progress made by Southern Airways in 1961.

Purchase of the larger equipment, part of the company's expansion program, was made late in July. The Martins were put into service October 29 and December 1. Cities in Southern's system first to receive the new service were Atlanta, Columbus, Ga., Dothan, Muscle Shoals and Huntsville, Ala., Fort Walton Beach and Panama City, Fla. On December 1, scheduled Martin flights began across the State of Tennessee and from Memphis to New Orleans.

The five larger aircraft, equipped with WP-103 all weather radar systems, were added to the airline's fleet of 26 DC-3's.

After setting boarding records in March, April, May, June and July, these and all existing traffic marks since Southern's founding in June 1949 were broken in August. A total of 37,506 passengers was boarded during that month.

A new daily passenger record was established June 30, 1961 when 1,813 persons traveled Southern. During this same month, the local service airline boarded its two millionth passenger. The number of passengers carried during the first six months of the year was a 42% increase over the first six months of 1960.

During the year, the airline topped the 400,000,000 passenger mile mark since its start of service. It has flown 2,270,000 passengers with a perfect safety record in twelve and one half years of operation.

At the end of the year Southern had increased its cities to 61, which are located in ten Southeastern states, employed 950, and was flying over 54,000 route miles daily.

TRANS-CANADA AIR LINES

Early in 1961, Trans-Canada Air Lines introduced the third aircraft of its planned all-turbine fleet to the traveling public—the 96-passenger, 425-mile-an-hour Vickers Vanguard turbo-prop.

The big planes, powered by four Rolls-Royce Tyne engines, went into service on transcontinental Canadian routes Feb. 1, to the Atlantic Provinces April 30 and to New York and Chicago June 15.

At year-end, the airline was operating 10 DC-8 jetliners on trans-continental and trans-Atlantic services, 49 Viscounts on short-haul domestic services and trans-border routes to the U.S., and 20 Vanguards on the longer domestic routes and to New York and Chicago.

The last of the airline's 21 inimitable North Stars was sold in the fall of the year, and only a handful of Super Constellations, flying on routes between Canada and the islands of the Caribbean, and two DC-3s on the Prairie "Milk Run" remained to be retired before the airline would be operating turbine-powered aircraft only. This was expected to be achieved at the end of the year.

With the transition to turbines came growth in most other areas of the airline's operations.

Passenger traffic rose from more than 3,440,000 in 1960 to 3,700,000 passengers carried in 1961, an increase of close to eight per cent. Freight traffic rose from 17,981,000 ton miles in 1960 to more than 20,300,000 ton miles in 1961, an increase of more than 13 per cent.

The airline flew a total of 52,221,000 aircraft miles during 1961, down 10.7 per cent from last year, while seat miles made available rose 25.6 per cent to 3,886,000,000, and occupied seat miles increased by 21.5 per cent to 2,480,000,000.

The increase in seat miles made available and the reduction in miles flown was due, of course, to the introduction of larger jet and turbo-prop aircraft.

TCA concentrated on strengthening its existing route pattern and increasing frequencies in 1961, and inaugurated only two new services. These were a DC-8 jet service between Cleveland, Ohio, and London, Eng., via Toronto, which gave the midwestern U.S. center its first direct jet links with Europe; and a new Viscount service connecting Canada's Atlantic Provinces with New York City, via Boston. At the year's end, it was flying over 39,000 miles of unduplicated routes.

Starting Jan. 4, 1961, TCA began operating only DC-8 jets across the North Atlantic between Canada and London, Prestwick, Shannon, Paris, Dusseldorf, Brussels, Zurich and Vienna and during peak summer months, offered 21 DC-8 jet flights a week in each direction across the North Atlantic to the United Kingdom and continental Europe, providing more than 2,600 seats weekly in each direction.

During the year, TCA introduced a simplified North American timetable incorporating quick-reference schedules. Trans-Atlantic and southern service schedules are now contained in separate timetables.

The airline's $20,000,000 engineering and maintenance base at Montreal International Airport, the first and largest of its type designed exclusively for turbine aircraft, was opened late in 1960 and was in full operation in 1961.

A new $3,500,000 maintenance base for turbine aircraft at Vancouver, B.C., was opened in the fall of 1961, while construction was started during the year on a slightly smaller maintenance base at Halifax, N.S., on Canada's east coast.

Trial testing of the airline's new multi-million dollar electronic system was well under way at the end of the year. This new system, which will greatly speed ticketing and reservations procedures, while reducing the chances of error to an absolute minimum, was to go into service early in 1962.

On Jan. 4, 1961, TCA applied an entirely new fare structure to its domestic routes, reducing fares on the longer flights, maintaining them on medium-length routes and increasing them slightly on the shorter routes.

At the same time it introduced new, low off-season domestic excursion fares and other attractive travel incentives, such as increased baggage allowances, which have done much to boost domestic travel. Coincident with the introduction of the new domestic fares, TCA converted a number of its 44-passenger first class Viscounts to 54-passenger economy class aircraft as it continued to follow a policy of bringing cheaper air travel within reach of more and more Canadians. On Oct. 13, these excursion fares were extended for travel to and from New York and Seattle, Wash.

On May 15, the airline introduced special 17-day all-year-round excursion rates between Canada and the islands of the Caribbean, for residents of Canada and Canadian nationals, up to 35 per cent lower than regular economy fares.

In conjunction with other Trans-Atlantic carriers, the Canadian airline introduced new trans-ocean freight rates on Sept. 1, up to 65 per cent lower than previously existing rates, giving added impetus to cargo traffic between Canada and the United Kingdom/continental Europe.

With an-all-turbine fleet, electronic reservations system, attractive fares and service, TCA expected to be in a strong competitive position during 1962.

TRANS CARIBBEAN AIRWAYS

The most significant development at Trans Caribbean Airways in 1961 was the introduction in the late fall of the series 50 DC-8 jet powered by turbofan engines.

Prior to the introduction of jet service, the following decisions were made and later implemented on Trans Caribbean's New York—Puerto Rico—Aruba route:

Dual configuration service—deluxe tourist and thrift—were featured on the fastest jet flights between New York and Puerto Rico.

Between New York and Aruba a combination of jet service to Puerto Rico and waiting propeller service from Puerto Rico was in effect to provide both the fastest flying time and the lowest fare.

A new, color-matching baggage tag system was implemented to speed baggage pick-up.

Additional personnel were hired in all departments, at all stations to provide "jet-speed" service on the ground and in the air for passenger convenience.

Special training programs were instituted for all personnel echelons to acquaint each with the interrelated responsibilities of others.

A new trademark, logo and slogan was adopted to better reflect the company's transition to jet operations. The slogan, the "5th Engine" jetline, was conceived to describe the four turbo-fan engines that have the speed, comfort and reliability of five conventional jet engines.

Increased advertising and sales promotional funds were allocated to support the new jet service.

In 1961, Trans Caribbean held its own on the New York—Puerto Rico run, a market affected by the general United States economy, war scares in the Caribbean and the introduction of jet equipment in thrift service by a strong competitor.

Traffic to and from Aruba increased substantially and the company expected this route to add importantly to its revenues in coming years.

Trans Caribbean believed that its introduction of jet service would expand the market between New York and Puerto Rico and on to Aruba. This belief was based upon several factors:

1. The comfort and speed of turbo-fan jet service.
2. A low fare of $8.00 above existing piston plane fares.
3. Attractively packaged tours.
4. Improved service on the ground and in the air.
5. Increased advertising and sales promotion campaigns aimed at separate and distinct markets.

This formula will be put into play on the nonstop route between New York and Jamaica should Trans Caribbean be awarded the operating certificate, application for which was pending before the Civil Aeronautics Board at year-end.

TRANS-TEXAS AIRWAYS

The "Super Starliners" and Convairs of Trans-Texas Airways in 1961 were operating over 5000 miles of air routes throughout five states—the result of almost 14 years of growth for the airline which began operations with two planes serving eight Texas cities.

The first DC-3's took to the air on scheduled flights on October 11, 1947, under the leadership of the company's founder and president, R. E. McKaughan.

In 1961, the local service airline maintained 40 airport stations serving 60 cities and embarked on a $5 million expansion program.

The Houston-headquartered Trans-Texas operated in Texas, Arkansas, Louisiana, Mississippi and Tennessee.

The TTA expansion program was launched by a contract for the purchase of 22 Convair aircraft from American Airlines. The 40-passenger Convairs—radar-equipped, high speed, air-conditioned and pressurized—were gradually being put into use throughout TTA's system and in 1961 were serving a number of TTA communities. The larger aircraft joined TTA's fleet of 25 Super Starliner DC-3's, many of which will be put into use in TTA's ever increasing charter flight service as the Convairs take over new routes.

A $250,000 fully equipped general office building at the Houston International Airport was another phase of TTA's expansion program. Nearly half of TTA's 800 employees were based in Houston. The airline's annual payroll was $4,666,313.

With an eye to the future, Trans-Texas applied to the Civil Aeronautics Board to establish new routes covering some 6900 air miles and 25 cities in the states of Texas, Oklahoma and New Mexico. The application was part of the Southwest Area Local Service Case which the CAB is investigating.

Behind TTA's expansion program stands a record of continual growth and air industry "firsts."

In 1959, Trans-Texas was the first of the nation's 13 local service airlines to pay a cash dividend to its stockholders, and in April, 1961, TTA declared its third consecutive cash dividend.

In its 11th year of operation, TTA was named "America's Fastest Local Service Airline." At this time TTA also held the title of "the nation's lowest cost operator in the local service field." The proof of TTA's right to these titles is found in the official records of the CAB. Both records were earned with the 200-mile-per-hour-plus Super Starliner DC-3.

Marking another airline industry first, TTA was the first United States line to sign with the American Express Company allowing its cardholders to charge air travel on TTA to their American Express accounts.

TTA in 1961 was one of the last of the nation's airlines to retain round trip discounts for travelers. Family plan rates and special excursion and group fares offered savings up to 35 and 40 per cent.

Trans-Texas is an outgrowth of Aviation Enterprise, Ltd., a company organized in 1940 to handle sales and service of aircraft, operate a CAA advanced flight school and an approved repair and overhaul station.

TTA was off the ground.

TWA inaugurated in-flight motion pictures on SuperJets.

TRANS WORLD AIRLINES

Setting the pace for the air transport industry in schedule performance and maintenance efficiency, Trans World Airlines advanced its reputation for reliability during 1961, and took positive steps in planning goals for the immediate as well as the long-range future.

Having added the Convair 880s to its SuperJet fleet of Boeing 707s early in 1961, later in the year TWA ordered 26 turbofan-powered Boeings for delivery in the fall of 1962. Twenty of these are 707-131Bs and six are 707-331Bs, the latter to be used on TWA's international routes. In the meantime, TWA leased four Boeing 720Bs, also turbofan powered, which were put into domestic service.

In September TWA placed another order for 20 of the newest, fastest and most advanced of the Caravelle series with Sud Aviation Company. These will be powered by the American-made General Electric CJ805-23C aftfan jet engines. Delivery is to begin in January 1963 and be completed by July of that year. The order included an option for 15 additional aircraft of the same type.

The way for the acquisition of new jet equipment and a firm, long-range service planning program was paved with the stablization of TWA's top management early in 1961 and completion of arrangements for a $165 million financing program.

The financing program included the transfer to a 10-year voting trust of the 78 per cent of TWA stock owned by the Hughes Tool Co. The trustees named were Ernest R. Breech, now TWA board chairman, formerly board chairman of Ford Motor Co.; Raymond M. Holliday, vice president of Hughes Tool, and Irving S. Olds, former chairman of U.S. Steel.

Without a president for eight months, since the resignation of Charles S. Thomas in July 1960, TWA moved ahead early in 1961 with the consolidation of its new management team.

Charles C. Tillinghast, Jr., who had been vice president of international operations for the Bendix Corporation, was elected president and chief executive officer and a member of the board of directors in March, assuming his duties April 17.

New directors were named at the 1961 annual meeting, to constitute a 15-man board composed of men prominent and experienced in a wide range of business and public service activities as well as TWA veterans.

Mr. Breech was elected chairman of the board at the annual meeting, succeeding Warren Lee Pierson, who announced his retirement from that office but who continued as a member of the board.

Among those elected to the Board was Floyd D. Hall, a former TWA pilot and operations executive, who had been made vice president and general transportation manager in 1959. As of September 1, E. O. Cocke, senior vice president and system general manager, was advanced to the newly-created position of senior vice president of Industry Affairs, and Mr. Hall was named senior vice president and system general manager to succeed him, and was also named to the executive committee. J. E. Frankum, who had been general transportation manager for the Atlantic Region, was named a vice president and general transportation manager to succeed Mr. Hall.

At the same time the Technical Services department, was elevated to the status of a division equal in rank with transportation and sales as one of the three divisions reporting to the senior vice president and system general manager.

Programmed by the Transportation Division, new standards for on-time performance were set and new records in this field were achieved in 1961. At the same time, the Technical Services division's performance in fleet maintenance and overhaul won government approval for time-between-overhaul extensions.

In jet on-time performance TWA substantially outstripped its principal domestic competitors, especially during the peak travel season in mid-1961. Domestic on-time jet reliability, continually improving through the year, reached new peaks of up to 76.8 per cent of all origin departures on time. Domestic SuperJet arrivals made as many as 74.4 per cent of all arrivals on time. The international division also enjoyed extensive improvement in on-time reliability, to the point where as many as 86.2 per cent of flight origins and 65 per cent of flight terminations were on time.

TWA maintained a high level of performance in technical services during 1961. This was especially evident in the maintenance of jet engines, and the time extensions granted by the Federal Aviation Agency on the frequency of engine overhaul. The JT-3 engines that power TWA's Boeing 707-131 SuperJets are now overhauled each 2,200 hours, while the JT-4 engines of the 707-131 fleet are reworked each 2,000 hours. Also the time-between-overhaul for the CJ-805 engines of the Convair SuperJets was increased from 800 to 1,200 hours.

One of the most rapidly growing elements within TWA, as within the entire air transport industry, was air cargo. Each month during 1961 brought new increases in revenue ton miles of air cargo. An example was September, when TWA's SuperJets and Jetstream Express piston freighters flew 5,785,000 domestic freight ton miles, a new record and 39 per cent better than the same month in 1960. International air freight enjoyed good growth also, September again being a good example with a 30 per cent increase over September of the year before.

In its Flight Training program, TWA in 1961 ordered a new $1,000,000 jet flight simulator at the Kansas City training center. This simulator is being tailored for training the crews that will fly TWA's new turbofan fleet, slated for delivery in 1962. TWA already has two simulators, one for the Convair SuperJet and another for the Boeings. The Military Air Transport Command sent its crews to Kansas City in 1961 for refresher training on TWA's simulators, and among these MATS crews were the men responsible for flying President Kennedy's plane.

New and upgraded services for the traveling public were provided by TWA during 1961. In the spring TWA added Geneva, Zurich and Ireland to its international SuperJet network. On October 29 TWA extended SuperJet service direct to Cairo and Tel Aviv. As of that date all of TWA's international passenger traffic was served by SuperJets, exclusively, making TWA the first U.S. flag carrier with all jet schedules over the Atlantic to 15 major world centers abroad. In February 1961 TWA marked the 15th anniversary of its international services.

In June TWA inaugurated "Royal Ambassador" service for first-class passengers on trans-Atlantic flights and other international segments. Insignia of the "Royal Ambassador" service, seen on ticket envelopes, chinaware, travel bags and two-foot-long menu cards, is white with a red ambassadorial sash stripped across it, surmounted with the gold "RA" decoration.

TWA's Royal Ambassador features highly-personalized attention to passengers from the time they make reservations to the time they deplane at destination. Three hostesses and a purser are assigned to maximum of 20 first-class passengers. The dinner service takes two and a half hours of the six and a half trans-Atlantic trip; service is from an aisle cart; the menu lists a choice of seven entrees. Rosenthal china, imported crystal stemware and fine silver distinguish the table.

Another passenger service innovation introduced during the year, exclusive with TWA, was the showing of first-run and pre-release films in flight on all trans-Atlantic flights and selected transcontinental U.S. flights.

TWA pioneered the new transcontinental round-trip excursion fare on U.S. routes and was the first airline to put the reduced fare into effect on August 16.

New and enlarged passenger terminal facilities were completed during the year at Los Angeles International Airport, Chicago's O'Hare, Orly airport at Paris, and Rome's Fiumicino airport. Others were slated for completion in 1962 at New York's La Guardia Field and International Airport (Idlewild).

At Idlewild, construction on the new TWA terminal building, designed by the late Eero Saarinen, was slowed up by labor stoppages within the building trades industry, but by year's end the exterior and enclosure were expected to be completed as well as one passenger loading "satellite," providing seven gate positions. The new TWA terminal was expected to be in complete operation by spring of 1962.

UNITED AIR LINES

The greatest expansion in the 35-year history of United Air Lines took place in the summer of 1961, following Civil Aeronautics Board approval of the merger of Capital Airlines into United.

Legal and financial steps to effect the merger were completed on June 1. Combined schedules over the merged systems were introduced a month later. Integration of the two companies was accomplished smoothly under the guidance of a Merger Planning Committee, which had been organized early in the year.

As a result of the merger, United's 14,000-mile system was increased to 18,000 unduplicated route

A United highlight of 1961 was introduction of the Caravelle Jet Mainliner.

miles. The new system linked 116 cities as compared to 82 previously served by United. The combined fleet totaled 264 aircraft, including 41 Viscounts which Capital had operated.

All Capital employees who wished to join United, except officers and directors, were assured of positions in the merged company. As a result of this offer, approximately 7,000 persons were added to United's payroll and the total number of employees at year's end exceeded 31,000.

United's turbojet fleet continued to be the largest of any airline in the world. It consisted of 38 DC-8s, 18 Boeing 720s and 19 Caravelles. On order for 1962 delivery were one more Caravelle and 11 Boeing 720s. The first of 40 Boeing 727s—a tri-engine jet for short to medium range service—will be received in late 1963.

Substantial upgrading of service occurred at cities formerly served by Capital. DC-4s, for example, were replaced by Viscounts or DC-6s. The Boeing 720 was introduced by United at New Orleans, Atlanta, Minneapolis-St. Paul and other cities. Six additional Viscounts were purchased in summer to accommodate traffic increases.

Elsewhere on United's merged system, there were steady improvements in service and equipment. The company inaugurated the first through-plane schedules between New York-Honolulu, Chicago-Honolulu and Detroit-Honolulu. To keep pace with growing interest in the 50th State, 35 round-trip DC-8 flights were operated weekly between Hawaii and California at summer peak.

The first Caravelle jetliners to enter U.S. scheduled service began flying United's New York-Chicago route on July 14. This French-built twin-engine aircraft subsequently was introduced at 16 cities. Placement of the engines at either side of the aft fuselage results in an extremely quiet cabin.

"Instamatic," the first nationwide electronic reservations system, was placed in operation by United at 100 locations on June 2. It enabled 3,000 sales agents to determine space availabilities on all flights with amazing speed. Approximately 80 per cent of space queries could now be answered in less than a second. The second phase of Instamatic, providing for space inventory records and other capabilities, was activated in early October.

Instamatic was designed and installed by the Teleregister Corporation in 33 months at a cost of about $16 million. As an integrated electronic data processing system, it is the largest in the business world and its extent is surpassed only by the nation's early warning defense network. Eventually, Instamatic will process reservations transactions at a daily rate of 180,000.

United continued to develop new techniques and equipment to speed and simplify the departure and arrival of passengers. A $500,000 baggage facility known as "Rapistan" was installed in the company's terminal at the new Los Angeles International Airport. This device, employing 6,000 feet of high-speed conveyors, enables agents to check through the baggage of up to 1,500 passengers per hour.

Mechanized baggage handling previously had been introduced by United at the San Francisco International Airport. The company also pioneered the use of conveyor systems at its air freight offices in Chicago and San Francisco. Similar installations are planned at other major terminals.

Another United innovation, the "Profit Analyzer," was developed so that shippers could easily determine whether the use of air freight would prove profitable. The analyzer is based on the concept that air shipment may reduce total procurement and distribution costs for some companies. A rule-of-thumb formula shows at a glance if air freight offers a profit potential in any specific case.

United also made it possible for salesmen to check in heavy sample cases just as though they were ordinary luggage, paying, however, the air freight rate. Previously, such cases had to be handled at air freight offices, with resultant inconvenience. The new method was so well received that it was extended to enable passengers to check other items of unusual bulk in the same manner.

The mid-year report on United's operations showed gains in every traffic category. Revenue passenger miles for the first six months of 1961 totaled 3,302,500,000, an increase of 28.6 per cent. Freight ton miles were 48,138,000, up 30 per cent; mail ton miles, 25,134,000, up 48.5 per cent; and express ton miles, 6,754,000, up 23 per cent. Passengers carried in the six months totaled 4,684,000, an increase of 25 per cent.

Totals for the nine months, including four months' of merged operations, showed that United had flown 5,500,505,000 revenue passenger miles, an increase of 27.4 per cent. The number of passengers carried was 7,953,000. Freight ton miles totaled 74,139,000, up 30 per cent; mail ton miles, 37,895,000, up 42 per cent; and express ton miles, 10,908,000, up 29 per cent.

A newly constructed Education and Training Center for stewardesses and management employees was opened in the fall five miles northwest of Chicago's O'Hare Field. Stewardess and management training previously had been conducted in leased facilities at Cheyenne, Wyo. The new building was designed to accommodate more than 2,000 trainees annually.

Late in the year United's executive headquarters were shifted from Chicago's Midway Airport to a site adjoining the Education and Training Center. Approximately 1,200 administrative and clerical employees were housed in the new $7 million structure.

An airline engineering laboratory—largest of its kind in the industry—was opened at United's maintenance base in San Francisco. The laboratory was equipped to handle all phases of engineering testing. It consisted of four basic sections—chemical, metallurgical, electronic and mechanical—each staffed by specialists, using the newest procedures and test apparatus.

United purchased Distance Measuring Equipment for its entire fleet of jetliners. A new type of transponder also was ordered for installation on Caravelles and the 11 Boeing 720s scheduled for 1962 delivery. Unlike the transponders used on United's DC-8s and previously delivered Boeing 720s, the new RCA transponder has an altitude reporting feature which can be used when the FAA provides suitable ground receivers.

At year's end United's fleet consisted of 75 turbojet planes, 47 turboprop, and more than 150 piston-engine aircraft. The company closed its 35th year of operations with confidence in the future.

WEST COAST AIRLINES

The year 1961 was a year of intensive effort in the West Coast organization for refinement of service in the greatly expanded area which West Coast Airlines serves.

Having expanded in the past several years from a three-state to a six-state operation, plus becoming the first local service airline to offer international service, the airline's year was one of experimentation in scheduling and patterns of service.

Much improvement in reliability of equipment was achieved. With the F-27, West Coast Airlines became the first local service carrier to introduce modern, jetpowered service.

Many improvements were made by communities at 45 airports served by West Coast Airlines. Salt Lake City moved into a new terminal building. Idaho Falls added additional space to its new terminal completed in 1960. Extensive remodeling and refurbishing of the Boeing Field terminal continued. Five hundred feet was added to the runway length of the Pasco airport.

Teletype and reservation improvements were widespread in the system. Cabins of airplanes were being refurbished and an intensified passenger service program was under way.

WESTERN AIR LINES—1961 HIGHLIGHTS

Highlighting its 35th year of continuous operations, Western Air Lines in 1961 augmented its Jet Age fleet with the introduction of 720B fanjet service between key cities on the Pacific Coast and Mexico City. At year-end Western was operating four of the jetliners over its key routes, and had ordered three additional 720Bs for delivery in July-August 1962.

Operating in 12 western states, Canada and Mexico, Western in January was granted new jet routes to Hawaii from Los Angeles, San Francisco-Oakland and San Diego, but a Civil Aeronautics Board stay order on the certificates prevented the company from inaugurating service over these major new routes. At year's end, the airline was still awaiting final outcome of the Trans-Pacific Route Case as the CAB proceeded with further consideration of the international portion of the complex proceedings.

Suffering substantial losses caused by a walkout of flight engineers in the February-May period, Western demonstrated marked improvement in its operating picture at the year's halfway mark and in early fall had recovered its earnings position.

Taking a unique stand in the widespread flight engineer controversy, Western replaced its striking crew members with pilot-qualified second officers.

The company paid four regular quarterly dividends of $0.25 during 1961, marking the 11th successive year that WAL has paid cash dividends to its shareholders.

At mid-year, net working capital of the company stood at $7.6 million with current assets at $18.4 million.

During the summer, the company occupied new hangar and terminal facilities at key points on its system, including Minneapolis-St. Paul and Salt Lake City. The airline expected to transfer its traffic operations to elaborate facilities at the new Los Angeles International Airport in January 1962.

The company again won several awards during the year, including a National Safety Council citation, the United Shareholders of America award and several honors for its unusual advertising campaigns. ■

GENERAL AVIATION

Continuing the phenomenal growth it had experienced during the past decade, general aviation again climbed in 1961, in terms of the number of aircraft actively flying. During the year, the number of active aircraft in this category topped the 76,000 mark, up from about 70,000 a year earlier.

The major plane type in general aviation service was the single engine, four-place craft, which accounted for about 35,000 of the total. There were approximately 33,000 single engine one-to-three place planes. There were about 7,500 planes in the multi-engine category and the remainder were rotorcraft and gliders.

Hours flown during the year were estimated at approximately 12,500,000, with a total mileage estimate of 1.75 billion. Aircraft sales totaled about 7,500 with a total value of $200,000,000.

A survey by the Utility Airplane Council of Aerospace Industries Association illustrated the growth of general aviation over the past decade. The Council reported that itinerant movements of general aviation aircraft climbed from 3,442,225 in 1951 to 8,909,153 in 1960, and during the latter year surpassed air carrier movements which grew from 4,555,509 in 1951 to 7,164,394 in 1960. In the same decade, general aviation instrument approaches recorded by Federal Aviation Agency Air Route Traffic Control Centers increased more than six times, from 21,781 in 1951 to 138,283 in 1960. IFR approaches by airline aircraft approximately doubled, reaching 566,651 in 1960.

General aviation is defined as all civil flying except that accomplished by the public carriers, including these principal areas:

Business—use of private aircraft as a means of rapid, efficient transportation in the conduct of business.

Instruction—teaching prospective pilots and upgrading and broadening the skills of existing pilots.

Commercial—charter carrying of passengers and cargo and agricultural crop dusting and spraying for hire.

Agricultural—the use of private aircraft by farmers and ranchers.

Personal—use of private aircraft for personal business or pleasure.

Miscellaneous—a variety of private aircraft uses such as power and pipe line patrol, geophysical exploration, aerial photography, forestry survey and patrol.

In 1961, as in previous years, business flying was the largest segment within the general aviation community. The business fleet numbered more than 30,000 aircraft and it flew almost 45 per cent of general aviation's total hours. The next largest segment was personal flying, about 24 per cent, followed by commercial and instructional flying.

A government sponsored report issued during the year predicted further growth for general aviation in the current decade. Project Horizon, the report of the Task Force on National Aviation Goals, predicted that the general aviation fleet would increase to 90,000 planes by 1965 and to 105,000 in 1970, and that the total number of flying hours would reach 18,500,000 by 1970. At the same time, the report predicted a change in the composition of general aviation, with personal flying expected to reach one third of the total hours flown, business flying dropping off to about 38 per cent, commercial flying remaining relatively constant, and instructional flying dropping to less than 11 per cent.

The helicopter inventory, said the Horizon report, should climb from about 650 aircraft in 1961 to more than 2,000 by 1970. The turboprop category was projected to increase from 90 in 1961 to 400 in 1970 and the jet inventory from two planes to about 200 by 1970.

HELICOPTERS

In the rotary-wing world, the year 1961 saw the start of a breakthrough in helicopter operations, as the first twin-turbine helicopters started flying in military service, and, later in the year, were delivered to the scheduled helicopter airlines for introduction to service early in 1962. The breakthrough will permit the helicopter to demonstrate its operational versatility on a larger scale than ever before, and, from the standpoint of commercial operations, it was expected to result in greatly reduced operating costs and eventually lower fares.

During the year, the military services continued to be the largest users of rotary wing aircraft. In addition to the helicopters traditional roles in troop transport, aerial reconnaissance, search and rescue, etc., new developments brought new uses for the military helicopter. For example:

The Air Force was using helicopters for missile site support and for recovery of drones.

The Army's helicopters were serving as assault troop transports and as missile platforms assault. Meeting informally with the Helicopter Council in April, 1961, the then Director of Aviation, Brigadier General Clifton F. von Kann, said: "Today the helicopter is the principal tool of Army battlefield mobility." He predicted that by 1970, 75% of the Army aircraft inventory will be helicopters.

The Navy's amphibious helicopters joined the fleet for anti-submarine warfare. These carrier-based helicopters are used to tow sonar equipment, to mine-sweep, and to detect and destroy enemy submarines. The Navy was also developing the Dash Weapon System, using drone anti-submarine helicopters.

In the Marine Corps, landing barges were replacing light assault transport helicopters.

The Coast Guard, the service that pioneered the use of the helicopter, continued to use rotary-wing craft for its overall rescue missions.

A survey made by the Helicopter Council in 1961 indicated that the commercial helicopter industry has become big business. The survey revealed the commercial helicopter business can be conservatively estimated at $50,000,000 annually. Many varieties of services were being performed by these

Col. Godfrey T. McHugh helps President Kennedy fasten seat belt.

commercial helicopters. Leading the diversified uses were construction work, oil and mineral exploration, agriculture, powerline and aerial patrols, and photography.

The 1961 revision of the Council's lists of Helicopter Operations—Commercial, Government and Executive—and the Helicopter Flight Schools revealed an increase in the number of operators and helicopters in all three categories. For example, in 1960 there were 193 commercial operators with 705 helicopters. In 1961: 265 operators, 822 helicopters. There was a noticeable increase in the number of corporations and companies using helicopters as airborne "executive suites," moving key personnel and industrial equipment to the right spot in the minimum amount of time.

In line with this increase in the number of operators, the 1961 edition of the Directory of Heliports/Helistops in the United States, Canada and Puerto Rico showed an increase of 48.9% during the year in the number of helicopter landing facilities. The directory indicated a definite trend—the increase in the number of hospitals and motels that have heliports—a trend that stresses the immediate need for city-center heliports.

To aid city planners and corporations in the establishment of heliports, the Council authorized a revision of its 1958 publication "Your Heliport Design Guide." The 1961 edition was scheduled for publication at year's end.

Today the Air Force has developed helicopter rescue and fire-fighting techniques to the state of a fine art. This was dramatically demonstrated by an impressive fire control and rescue at Wilmington, North Carolina, by an H-43B helicopter that just happened to be on the scene for a static display. And equally tragically demonstrated at crashes at Denver Airport, Chicago's O'Hare and Richmond's

Byrd Field when no helicopters were available. The Federal Aviation Agency was concerned over the inadequacy of crash-fire fighting equipment maintained on a number of major airports, and an official study of the problem was under consideration.

The Helicopter Council submitted a proposal to the FAA that thought be given to the use of helicopters in fire-fighting and rescue emergencies at commercial airports. An American Legion publication carried an editorial on the Council's proposal and urged the FAA to give serious consideration to acquisition of fire-fighting helicopters at major airports.

Another example of the American Legion's support of Council objectives was the adoption of Resolution No. 556 at its annual convention in Denver, Colorado in September. The Resolution reading:

"WHEREAS, The helicopter has proved itself a useful and versatile vehicle for both military and peaceful uses; and

"WHEREAS, There is need for increased emphasis on the many services the helicopter offers to enhance our way of life:

"NOW, THEREFORE, BE IT RESOLVED, By The American Legion in National Convention assembled in Denver, Colorado, September 10-14, 1961, does hereby reaffirm its position adopted at the 41st and 42nd National Conventions to the end that the American Legion continues to promote and encourage the development and use of helicopters and the passage of necessary ordinances and regulations as will permit their efficient operation."

Two major military design competitions were awarded during the year: the Tri-Service VTOL and the Army LOH.

The Army's LOH (Light Observation Helicopter) competition was to select a prototype four-passenger, turbine-powered helicopter as a replacement for the L-19's, H-13's and H-23's. Contracts were awarded to three companies. Following extensive tests and evaluation, a production order of 3,000 units will be made.

One of the standing projects of the Helicopter Council (extension of certificated helicopter services to areas other than New York, Chicago, and Los Angeles) moved forward this year with the announcement of hearings by the Civil Aeronautics Board of applicants for the District of Columbia Helicopter Service Case. This proposed service would provide the Nation's Capital with helicopter transportation between the District and Friendship, National and Dulles Airports.

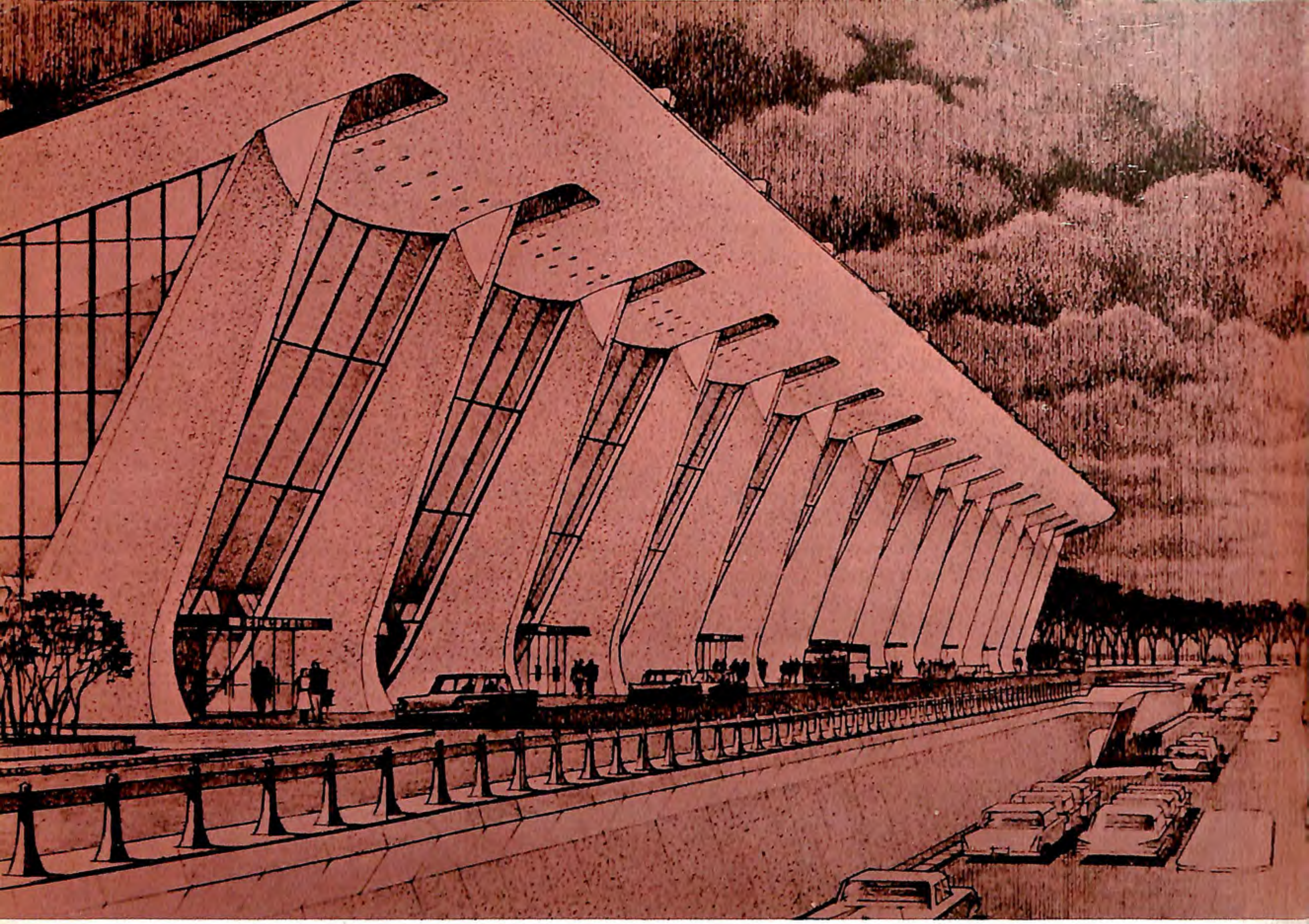
The announcement further pointed out the need for a municipal city-center heliport for Washington, D. C. At the request of the Civil Aeronautics Board, with the cooperation of the Aviation Committee of The Metropolitan Washington Board of Trade, the National Capital Planning Commission initiated a heliport site survey in the District of Columbia for submission to the District Commissioners for approval and action. In connection with this site survey, the National Capital Planning Commission conducted a helicopter noise level test with the aid of the FAA and the cooperation of helicopter manufacturers and military services. The purpose of this test was to evaluate the condition which might be found at any future heliport site in Washington, D. C.

The test found the helicopter noise was within acceptable limits, in fact, it was found to be lower than passenger trains, large trucks and fixed-wing airplanes already operating in the test area. The report concluded: "A heliport of this type could well be within acceptable limits and serve a much-needed service for the central business area of Washington, D. C."

The Helicopter Council was on record with the Federal Aviation Agency that the location of the heliport is crucial to the determination of the volume of traffic. The Council recommended that the heliport be within a few blocks of Washington's midtown business center and that the FAA operate the heliport in conjunction with its management of Washington National and Dulles Airports. This would then be the only FAA administered heliport in the country, and a model for the nation.

An Air Force directive and comments by Government officials cited the need for the U.S. to establish new world aviation records. To assist Council members in this endeavor, important to national prestige and a factor in the export market, the Council distributed a specially compiled directory of the Federation Aeronatique International Helicopter Records. During the year, eleven new international helicopter records in categories of speed, altitude, altitude with payload, distance over straight and closed courses were made by Council member companies. Five of these records were formerly held by the U.S.S.R.

During the year, San Francisco and Oakland Helicopter airlines inaugurated a scheduled air taxi service. At the end of the first five months, the airline was operating sixty-eight flights daily between five points in the San Francisco area, carrying an average of 150 passengers a day. The company estimated it would soon have a daily traffic figure of 200 passengers.



GOVERNMENT AND AVIATION

THE FIRST SESSION of the 87th Congress, longest in a decade, gave the Administration nearly every penny it sought for accelerated defense and civilian space program. Under the goading of President Kennedy and a new team of science advisors, a decision to try to send a manned mission to the moon before 1970 became a national goal. Congress responded quickly with a large down payment.

While the controversy raged over whether the U.S. should try to get back in the conventional armament business, Kennedy asked for a substantial increase in defense funds to help build up the nation's limited war capability. Endorsed by Congress, the boost gave the Army its long-cherished modernization budget.

At year's end, the analyzers were still trying to catalogue the new defense gains, but this much was clear: a number of Polaris submarines would be on station earlier, the nation's airlift capability would be enhanced and forces in the field would increase.

Approval of the $46.6 billion fiscal 1962 defense budget came late in the seemingly-endless session. In three revisions new obligational authority was boosted by some $5 billion over Eisenhower's request, and Congress, over the Administration's protest voted $780 million additional funds for continued procurement of long-range manned bombers and acceleration of the B-70 and Dyna-Soar programs.

By early fall it became apparent, however, that a ballooning national budget deficit would work against continued procurement of B-52's and a speed up of the other two Air Force programs, and, as anticipated, the Administration ruled as superfluous any increased funding. But even as the order was issued it was certain the B-70-manned-bomber issue would be a 1962 issue on Capitol Hill.

Requests to back up a beefed-up defense effort were delivered to Congress in three packages. The first totaled $1,954,000,000 with the bulk tagged for acceleration of the Navy's Polaris missile program. The accompanying message envisioned an increased non-nuclear capability but the outlined program did not back this up.

The turn toward a policy of backing up limited war talk with dollars came after the President warned that the Berlin crisis was the main international problem. Threading through Administration speeches and statements was a hope of creating a defensive alternative to meeting the Soviets in Berlin and elsewhere, if necessary, with other than massive nuclear retaliation.

The President's request in July for an additional $3,454,600,000 to build up limited war forces was promptly approved on Capitol Hill. Inside of 24 hours the Senate Armed Services Committee, in line with the new law requiring authorizations in advance of procurement appropriations, approved $958,570,000 for planes, ships, tactical missiles and spare parts, and Congress quickly followed suit.

Approved for military construction programs was $951,690,000, including a $12 million down payment for the Air Force to start facilities for construction of the solid booster assignment given to it under the expanded lunar program.

A reevaluation of the nation's space goals followed the pattern of the administration's defense reassessment. Initially, space planners cautiously endorsed a supplemental request of $125,000,000 mostly to speed up the big booster programs. Then, Kennedy's new team of technical advisors conferred, and the President proposed a $20-$40 billion program to put an American team on the moon in this decade. Congress swiftly approved a $1,784,300,000 fiscal 1962 authorization—a $600,000,000 increase over the outgoing Eisenhower Administration's appeal. The only conservative note was struck by some members of the Appropriations Committee who sought to trim $100,000,000 from the actual NASA appropriation.

ELSEWHERE, Congress quickly approved a requested change in the law making it possible for the President to appoint former Senate Majority Leader and now Vice President Lyndon Johnson as chairman of the revitalized National Aeronautics and Space Council. Dr. Edward Welsh, a Senate aide, was recruited as executive director and the new council undertook its first task of laying out the lunar program.

Also enacted was a compromise provision giving the Defense Department and the General Services Administration authority to draft regulations designed to assure that small business is fairly considered as in government contracting and subcontracting. The final version removed SBA's power to veto DOD-GSA regulations but requires SBA concurrence. Unresolved issues would be sent to the White House.

Congress approved an amendment to the defense appropriations bill permitting only the advertisements for recruitment, for scarce materials and the sale of surplus materials as allowable contract costs. And, before they departed, legislators routinely voted another extension of the 52% corporation tax, but failed to enact the President's tax reforms.

A number of unsettled issues automatically became the business of the second session. At the top of the aerospace industry list perhaps is a proposed modification of the Renegotiation Act. A preliminary study of the administration of the act was being prepared by the Joint Committee on Internal Revenue and Taxation. But whether any recommendations it might make for softening the act would gain acceptance in the House was an uncertainty as the year ended.

Another carry-over, the proposal to give NASA authority to indemnify contractors against "unusually hazardous" risks, was caught in the center of a controversy. Senators wanted to accept the legislation after inducing NASA to limit to $500,000,000 the government's liability for any one holocaust, but House Space Committee members quarreled with the idea of imposing federal tort limitations on the states.

Again nothing was done to resolve the issue of private versus government ownership of patents developed under government-financed contracts. But Congress adjourned with a prediction by Chairman John McClellan (D-Ark.) of a special patents subcommittee that legislators would have to undertake to settle the question by law in the second session. In the background the Administration was preparing its own recommendations for a government-wide uniform policy.

In other miscellaneous actions, the House passed a bill requiring contractors to file affidavits that they did not collude in their bids, but it was sidetracked in the Senate. Sen. John McClellan (D-Ark.), unimpressed with labor's no-strike pledge to the Administration, proposed legislation to outlaw work stoppages at defense sites; and Rep. A. S. Herlong (D-Fla.) introduced and then withdrew support of a bill to make defense and other government contractors liable for state and local taxes. The House and Senate Appropriations Committees trimmed $5 million from Aerospace Corporation's budget and set the stage for more extensive questioning of the role of non-profit corporations. A running-closed door inquiry of the nation's strategic missile program by the Senate Preparedness Subcommittee marked the waning days of the session.

Air transport legislation stalled almost on dead center. Except for extension of the Federal Airport Aid Act and enactment of new appropriations the bills that did pass were minor.

After being caught between advocates and opponents of advance contract authority, the Federal Airport Act was extended until June 30, 1964. New provisions emphasized safety and general aviation needs. Included was authorization for the requested new $75 million annual spending level, but the Appropriations Committees will review plans and approve funds annually before FAA makes its commitments. The contention was that this would hamstring planners, but it was the only bill House economizers would accept.

AFTER NEARLY losing its helicopter subsidy appropriation, CAB won new appropriations of $95,750,000 to meet all subsidy payments, including a fiscal 1961 supplemental. A $6 million limit was ordered on helicopter payments, and there were indications that the House Appropriations Committee might soften its threat to cut this industry completely off the subsidy roll. The Board was given $8.9 million to run the agency.

A total of $742,800,000 was approved for FAA, including $11,000,000 to fund the first half of a two-year supersonic transport feasibility study. Agency planners forecast the study might take a full $50,000,000 but Congress was on record with a demand that it be held to $20,000,000.

Congress rushed through a measure to deter the hijacking of commercial airliners by making it an act of piracy punishable in certain cases by death. At the same time a fuzzy jurisdictional question was brought into focus by extending to the airspace Federal jurisdiction over many other crimes.

Heeding the President, Congress also approved a two-year temporary reduction in the value of the goods U.S. citizens are permitted to bring into the U.S. duty-free. And, as a second program to help correct the imbalance of payments to the U.S., Congress adopted the Magnuson-Administration proposal for a U.S. Travel Service with a charter to lure foreign visitors to America.

Also enacted was another one-year extension of the 10% passenger transportation tax, continuation for another five years of the Commerce Department's authority to issue war risk insurance binders, and a bill providing a $1000 fine or one-year jail sentence for "practical joke" reports and five-years imprisonment or $5000 fine for willful, malicious false reports of bombs aboard airliners.

On the negative side Congress left uncompleted its work on a bill to continue the supplemental air carriers primarily as charter operations. The controversial issue was carried over after the Senate and House ran out of time trying to reconcile differences in their approaches. Interim operating authority, granted by Congress, was to expire in March, 1952.

Congress also deferred action on the Kennedy Administration's request to increase aviation gas levies and to extend current aviation gas taxes to untaxed jet fuels and to transfer receipts from the Highway Trust Fund to the Treasury's general receipts.

Most of the items in CAB's legislative program were untouched by legislators and they all were to be carried over. A Presidential request giving CAB Members more authority to delegate cases did win approval. Another somewhat controversial measure—FAA's plan to consolidate military and civil air traffic control functions under one roof—reached Congress too late for any consideration.

In a last-gasp action the House approved a resolution directing the House Commerce Committee to find out what, if anything, can be done about aircraft noise. The problem was passed to the Committee's Regulatory Agency Subcommittee as the curtain rang down on the session late in September.

AGRICULTURAL RESEARCH SERVICE

U.S. Department of Agriculture

Pilots of USDA's Agricultural Research Service flew more than twice as many miles during 1961 as they did the previous year assisting in the supervision of insect control and eradication, conducting experimental applications of insecticides, and performing insect and nematode damage detection surveys. The mileage flown in 1961 totaled 231,000 compared with 112,000 in 1960.

This increase in the use of aircraft occurred because a wet spring followed by drought in parts of Montana, North Dakota, and South Dakota encouraged the development of large grasshopper populations. Until July 1, only 21,632 acres of rangeland required treatment for grasshoppers, but from July 1 to September 15 another 498,312 acres, mostly in Montana, had to be treated.

About 340,000 acres were treated by aircraft in the continuing Federal-State campaign to eradicate the imported fire ant from nine southeastern States. Treatments in Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas raised the total of treated acres to more than 2,000,000 since the program was started in 1957.

Treating fire ant infestations by aircraft calls for precision flying, careful calibration, and uniform

Canine air passenger is checked by USDA veterinarian as guard against foreign animal diseases.

fire ants, and the insecticides were effective against both pests.

In central Arizona, an aggregate of 106,423 acres was treated by plane in the program to eradicate the pink bollworm of cotton. Either DDT or Sevin was applied nine times at six-day intervals in infested areas.

Thanks to a new device developed by ARS researchers, improved control of insect stowaways inside planes became possible. The device sprays insecticides, automatically or by remote control from small aerosols designed to treat 1,000 cubic feet of space. Sprayers are distributed to apply dosages evenly and exactly. The scientists foresee use of the new device in military and commercial aircraft on international flights and in domestic planes flying from areas where agricultural quarantines are in effect.

Two efficient ways to disperse granular insecticides or herbicides by airplanes—either from the wing or from a winglike attachment—were designed and tested in experiments by USDA scientists during 1961. A specially equipped low-flying plane harnesses air currents from either the wing or an attached airfoil and from the propeller to distribute granules evenly in swaths up to 45 feet wide.

The new designs may result in applicators that improve on the performance of conventional distributors designed originally to apply dusts, not granules. Granules have been found to drift less and fall more uniformly than dusts and sprays, and reduced drifting is an important safety factor in the use of toxic chemicals.

An airborne invasion by a destructive beetle closely related to the Japanese beetle and European chafer was thwarted by the spraying of all airplanes from Paris, France, to major airports in this country and Canada. This beetle is a major European plant pest but is not established in North America. It appeared early in April on airplanes arriving from Paris at Idlewild Airport, New York. Resembling the common June bug, the beetle is known to attack more than 60 crop, forest, and ornamental plants.

During the year a program was started by airport officials and ARS to apply long-lasting soil insec-

distribution of materials because every square yard of infested acreage must be treated if the program is to be successful, ARS officials point out.

An example of the discipline imposed on pilots is the need to avoid contamination of forage, which can result when granular insecticides of the type used against fire ants are applied to wet grass. Wet grass is characteristic of the windless early morning hours, usually the best time for aerial application.

Research by applicators in cooperation with ARS specialists was being done to develop methods of covering wider swaths and more practical pilot guidance aids to increase the efficiency of insecticide application.

Contract aircraft equipped to apply granulated insecticides treated 115,030 acres of Illinois, Kentucky, and Michigan farmland infested with Japanese beetles as part of the Federal-State effort to eradicate scattered infestations outside of federally-regulated areas covered by quarantine. The quarantine applies to all of seven and parts of eight other Eastern States where Jap beetles have been a problem for many years.

Aircraft were used to apply liquid insecticides against gypsy moth infestations in 47,663 acres of woodland in New York and Vermont. Both DDT and Sevin as sprays were applied in the long-range Federal-State program to eradicate this serious pest of shade and forest trees.

White fringed beetle infestations in Alabama, Arkansas, Tennessee, Louisiana, and Georgia were treated by air with granular insecticides. Part of the 17,000 acres treated was also infested with imported ticides to the grounds of all major airports in the U.S. as a secondary defense against the introduction and spread of soil-infesting pests of all kinds. It was hoped that the work will destroy insects before they get on outgoing planes and keep newly-arrived pests from becoming established on airport grounds.

An advance notice of agricultural quarantines was given to air travelers on a large scale for the first time in 1961. A small flyer containing an attractive illustration and a brief notice of U.S. agricultural quarantines was printed by USDA and distributed to international air passengers by American flag airlines and cooperating foreign lines operating service to this country.

At the same time, radio and television announcements about agricultural quarantines were made in this country, and the U.S. State Department began distributing notices to passport applicants. This combination effort was aimed at reducing the volume of prohibited agricultural material brought to the U.S. from abroad by tourists. During recent years, agricultural quarantine inspectors stationed at the Nation's airports, seaports, and border crossings report that they are stopping increased amounts of prohobited plant materials each year.

Of the more than 130,000 airplanes inspected under USDA quarantine regulations on arrival in the U.S. in 1961, about one out of every three was found to harbor agricultural pests and diseases. In cooperation with the U.S. Customs, more than 12,250,000 pieces of baggage and cargo were inspected, uncovering 46,782 prohibited lots of plant material.

ATOMIC ENERGY COMMISSION

During 1961, the Atomic Energy Commission continued research and development on the use of nuclear energy for rocket and ramjet propulsion, and for auxiliary power for space missiles systems.

Project Rover, a study of nuclear rocket propulsion, was being conducted by the Los Alamos Scientific Laboratory, operated for the Commission by the University of California.

On June 29, 1961, a SNAP isotopic generator was orbited with the Navy's TRANSIT IV-A navigational satellite. The event represented the world's first use of atomic power in space. The generator was supplying power to two of the satellite's four transmitters.

The manned aircraft propulsion program was terminated early in the year, following a decision by the President to cancel the development program for nuclear military aircraft.

Preliminary tests of the Kiwi-B 1A reactor began in October. The Kiwi-B 1A is the first in a new series of experimental reactors which are to be ground tested as a part of the joint Atomic Energy Commission-National Aeronautics and Space Administration program for the development of a nuclear rocket. It is the first of several reactor designs that will be tested and aimed at providing the design to be used in the NERVA engine. The tests were being run with gaseous hydrogen as a propellant and used a gaseous hydrogen cooled jet nozzle. Later tests would be conducted with liquid hydrogen as a propellant and a coolant of all critical components of the system. A full power test of the Kiwi-B 1A reactor was scheduled for November 7, but had to be postponed because of an accidental explosion of hydrogen gas early that day inside the movable shed which housed the reactor at the Jackass Flat area of the Atomic Energy Commission's Nevada Test Site. Cause of the explosion was not immediately known. No radiation was released and no nuclear incident was involved. Several men were injured, none very seriously. Walls of the light metal shed were destroyed. The delay caused by the accident was not expected to be of long duration.

Facilities work during 1961 included modification of a test cell for liquid hydrogen operation, partial construction of a second test cell, the start of construction of the first engine test stand, expansion of the Maintenance, Assembly, Disassembly (MAD) building, and design and engineering of a MAD building for the engine development tests.

In July, the Joint AEC-NASA Space Nuclear Propulsion Office contracted with Aerojet-General Corp. for the development of the first nuclear rocket engine using the technology developed in the KIWI effort. Westinghouse Electric Corp. was the major sub-contractor in this development.

Project Pluto is a program to demonstrate the feasibility of using a nuclear reactor as the heat source in a ramjet engine of a strategic missile. Under this program, the Commission's Lawrence Radiation Laboratory, operated by the University of California, conducted tests of the Tory IIA-1 reactor on May 14, September 28, October 5 and 6, 1961. During these power runs, at the Commission's Nevada Test Site, temperatures in excess of 2,000 degrees Fahrenheit were attained in the reactor core. The reactor has a design power level of 155,000 thermal kilowatts. Following the completed tests, the reactor was being disassembled in the special shielded disassembly building at the test site to permit detailed studies of its components.

The next reactor to be developed by the Laboratory will be the Tory II C, a reactor specifically designed to function under the full power and aerodynamic requirements of a nuclear ramjet propulsion system. Test facilities in the Project Pluto area of the test site were being expanded to accommodate the Tory II C reactor.

Work continued on a number of projects in the Commission's program for the development of systems for nuclear auxiliary power—SNAP. The aim of the SNAP program was to develop small, lightweight nuclear-powered electric generators for satellites, space vehicles and special applications. Two approaches to provide nuclear heat were under development; one uses the heat from the radioactive decay of radio-isotopes to generate electricity in thermocouples (as in SNAP-1A and SNAP-3), with the Martin Co. as the principal contractor. The other uses heat from very compact reactors to drive turbines (as in SNAP-2 and other even-numbered SNAP projects), with Atomics International as the principal contractor.

CIVIL AERONAUTICS BOARD

A number of important developments occurred in connection with the regulation and promotion of civil aviation during fiscal year 1961. Included among these was legislation enabling the Board to expedite its work, Board reorganization to promote efficiency, economic measures adapting routes to the competitive jet age and promoting sounder and more attractive rates, action concerning international aviation affairs, and continued attention to safety in the air.

A significant matter which will allow for greater efficiency in the dispatch of Board business was the President's Reorganization Plan No. 3 of 1961, submitted to the Congress and effective July 3, 1961. It provided for expeditious action through delegations of authority to appropriate Board personnel subject to discretionary review by the Board.

Organizational changes in the Board, effected during the year, were designed to improve the Board's operations both as to soundness and promptness of resolution. In the Office of the Chairman, the Executive Director's role in improving procedures and expediting the Board's ever-increasing workload was strengthened, a Planning Office was established to aid the Board in developing policies, a new office was established to maintain liaison with representatives of local communities, and the functions of the economic staff were realigned with the creation of the Bureau of International Affairs and the establishment of the Bureau of Economic Regulation. New procedure was also provided for the Chairman to assign cases nearing decision to individual members of the Board for preparation of the opinion and submission thereof to the Board for approval. In addition, a Practitioners' Advisory Committee was established to assist the Board in improving its procedural regulations. The committee explored a number of projects for procedural improvement including several projects to reduce the size of evidentiary records in route cases and to expedite decisions.

In the area of economic development, the fiscal year found U.S. trunk airlines, deep in the midst of reshaping their fleets and their operations, at a critical point in their history. The increased use of the larger jet equipment intensified competition. With respect to cargo, capacity increased substantially, due to the expanding use of combination jet aircraft with large cargo bins and to the conversion of piston aircraft for operation in all-cargo service.

The major activity in domestic trunkline route development was the certification of single-carrier service for the first time across the southern tier of states in the Southern Transcontinental Service Case. In the Pacific area, extensive route changes continued to be a subject for consideration under the Trans-Pacific Route Case. The Board approved a merger of Capital Air Lines and United Air Lines, the latter being the surviving company.

As to the short-haul, U.S.-local service carriers, the need for their operations generally continued to increase as trunklines acquired new and faster aircraft suitable for their expanded longhaul activities. The Board continued to investigate and review this situation as exemplified by its local area investigations and its "Use-It-Or-Lose-It" program.

In May, 1961, the Board and the FAA established a joint policy respecting the use and development of airports, expressing concern over the establishment of separate airports for communities sufficiently close to be better served through a joint airport. Actions implemented under the policy were expected to prove beneficial, particularly regarding local air services. The Board and the Bureau of Public Roads also developed liaison arrangements toward more frequent exchange of information and closer coordination respecting highway and air transport programs.

With regard to fares, in the domestic passenger market the Board permitted a further increase in the overall level of domestic passenger fares and more experimentation with low-cost promotional fares as a means of improving the industry's level of earnings. In the international market, economy class fares, which had been available on the Atlantic for several years, were introduced on routes across the Pacific and within the Western Hemisphere.

The Board devoted increasing attention to the

The Civil Aeronautics Board. Left to right, Whitney Gillilland, Chan Gurney, chairman Alan S. Boyd, vice chairman Robert T. Murphy, G. Joseph Minetti.

promotion of attractive yet sound cargo rates in both domestic and international transportation in order to develop cargo volume and take full advantage of the expanding capacity of new equipment.

The Board established an effective minimum rate floor for military traffic carried by commercial airlines in support of the objective of developing a modern and expanding airlift capacity.

Subsidy payments to eligible carriers was also a major area of attention for the Board. An important subsidy development in early 1961 was the establishment, for the first time, of a uniform or "class" subsidy rate which is applicable to all local service carriers. The Board continued to focus on maintaining the total subsidy bill within reasonable limits and achieving its reduction in the long range future. This program was furthered during the year through route alignments and other improvements including the acquisition of more modern aircraft pursuant to equipment loans guaranteed by the Board.

Generally, with respect to international aviation affairs, the Board was increasingly aware of the advancing competitive position of foreign flag carriers and in this regard during the year accomplished an extensive policy review in specific problem areas. It also participated in a number of negotiations and consultations with foreign governments.

Safety in the air continued to be a major matter of concern to the Board. In response to the rise of air traffic and the added complexity of equipment, it increased its endeavors respecting accident prevention studies and activities designed to overcome hazards before accidents might occur.

DEFENSE AIR TRANSPORTATION ADMINISTRATION

During 1961, the Defense Air Transportation Administration, with the cooperation of the Office of Civil and Defense Mobilization, continued its planning for the mobilization of civil aviation and its resources to meet wartime requirements in both domestic and international areas.

Programs were carried forward to assure the immediate readiness and availability of the Civil Reserve Air Fleet (CRAF) to supplement military airlift in case of a wartime emergency. Revisions to the CRAF allocation were made on a quarterly basis, to keep the fleet current and to phase in new and more modern aircraft as they became available. The last of the piston types of passenger aircraft were replaced by jets so that all CRAF requirements for passenger airlift were met with new and modern Boeing 707s and Douglas DC-8s. Several cargo aircraft of the DC-7CF freighter type were added to the fleet as they became available, as well as some new Canadair CL-44s, thus improving the cargo capability.

The War Air Service Program (WASP), comprising the civil air transport capability to meet the needs of the civil wartime economy, was further developed and a government-industry group drafted a standby contract outlining terms under which participation in the WASP can be readily implemented. The National Emergency Defense Airlift (NEDA) plan was further implemented by extending the national planning throughout the states and to local levels where designees will be in readiness to carry out the operational phases of this program.

During the year, the Aviation War Risk Insurance program was expanded to provide, among other things, for war risk insurance without premium to the Department of Defense for participants in the CRAF program and to the Department of State for American air carriers entering into certain agreements with the Department. Legislation was enacted extending for an additional five-year period the authority of the Secretary of Commerce to provide insurance and re-insurance under Title XIII of the Federal Aviation Act of 1958.

FEDERAL AVIATION AGENCY

Najeeb E. Halaby, a Los Angeles attorney and business executive with a distinguished record in aviation and Government service, was appointed Administrator of the Federal Aviation Agency and principal aviation advisor to the President early in 1961. Under his direction a major reorganization and modernization of FAA was begun on July 1. The new organization centralized authority for program development and policy making in Washington, and delegated operational responsibility to the field.

The reorganization also provided for three Deputies to assist the Administrator: The Deputy Administrator (a statutory position), a Deputy Administrator for Administration and a Deputy Administrator for Plans and Development.

The Deputy Administrator serves as general manager for Agency operations and is responsible for coordinating activities of the regional offices and the Air Traffic Service, Aviation Facilities Service, Flight Standards Service, Aviation Medical Service and International Aviation Service.

The Deputy Administrator for Administration is responsible for the Agency's administrative management programs and for supervision of the Office of Management Services, the Office of Budget and the Office of Personnel and Training.

The Deputy Administrator for Plans and Development coordinates long-range planning, conducts research and development programs and supervises the Office of Plans and the Aviation Research and Development Service.

The Deputy Administrator also is assisted by these staff offices in Washington: Office of the General Counsel, Office of Congressional Liaison and Office of Public Affairs. Attached to the office of the Administrator are The Military Advisor and the Board of General Advisors.

Under the reorganization the number of Regions was increased from six to seven and designated by geographical rather than numerical names. Each region is headed by an Assistant Administrator with the authority and responsibility for carrying out FAA programs and policies.

In 1961 FAA employed 43,000 people, about 40 percent of them in air traffic control.

One of the Administrator's first acts after taking over in March was to write a letter to the Nation's airmen asking for their suggestions on how the FAA could better serve the needs of civil aviation. He got a substantial and encouraging response to this letter.

Subsequently, in order to establish closer contact with the general aviation community, the Administrator instituted a series of Air-Share (Air your views —Share the benefits) meetings for pilots and others concerned, under the sponsorship of the Flight Standards Service. The meetings proved valuable, both to general aviation and the FAA.

The objective of the Air-Share meetings was to get from pilots their best thinking, based on their own experience, on how problems might be solved.

The meetings also were designed to develop within all flyers a genuine sense of participation in the solution of such problems and to better acquaint airmen with FAA services.

Because the first Air-Share meetings drew mainly fixed base operators, a series of week-end fly-ins were held to encourage attendance to the non-professional and student pilot. Halaby headed the FAA team at these sessions.

One result of these hanger-flying meetings was that many pilots and plane owners had personal discussions with the Administrator and other FAA officials on questions of general aviation airports, airspace problems, the use of air traffic control facilities and questions concerning certification, training, enforcement and rule making, medical examinations and safety.

On October 21, Air-Share meetings were held simultaneously in 88 cities to discuss changes in the Civil Air Regulations.

The Air-Share program involved four phases: (1) analysis of comments from the October 21 meetings; (2) a series of conferences to be held in the continental regions in March or April of 1962 when the Agency was to present its tentative position on those portions of the regulations it believes should be changed; (3) routine notice of proposed rule-making in the Federal Register with request for industry comment; (4) publication in the Federal Register of effective dates of amended regulations.

At the direction of President Kennedy, the Administrator set up a task force early in March to study and recommend national aviation goals for the next decade. On September 10, 1961, the report was made public. It advocated a comprehensive program for development of an aviation system that will contribute to the Nation's economy, defense and culture. Among its recommendations were: development within five years of a common air traffic management system; development of a supersonic civil transport to maintain U. S. leadership in commercial aviation; and acceleration of the growth of general aviation, declaring it to be an essential element of the national air transportation system.

Horizon also recommended immediate crystallization of plans for at least five new major airports for the country, including one in the New York area, 150 smaller fields for private and business flying and development of an air cargo industry.

A second study initiated by the President examined the problem of the safe and efficient use of the airspace.

The study was based on a scientific and engineering review of the nation's aviation facilities and related research and development programs. Beacon also included an analysis of the present system of air traffic control, the present and future needs of all users and all research and development programs relating to traffic control.

In an effort to develop the most effective methods for the adoption and enforcement of safety rules and regulations governing civil aviation, a consulting group was set up to make a thorough review of the present rule-making procedures, including the methods used to satisfy the requirements of the Federal Aviation Act of 1958 as well as the Administrative Procedure Act of 1946.

A number of aviation organizations were invited to submit their views on this subject, among them the Air Line Pilots' Association, Aircraft Owners and Pilots Association, Air Transport Association, National Business Aircraft Association and the General Aviation Council. A research team in the field interviewed FAA personnel, pilots, mechanics and other airmen who had constructive views to offer.

Adequacy of procedures was given close scrutiny to assure that all segments of aviation as well as the general public are given an opportunity to comment on FAA proposals if they wish to do so; that the public interest has been considered; that the rules and regulations take account of all pertinent information; that they are consistent with applicable laws; and that they provide the essential elements of due process.

The Federal Aviation Agency also started codifying the Civil Air Regulations and the Regulations of the Administrator to meet the needs of modern aviation. Objective of the program is not to change the regulations but to restate them in simple language so the aviation community can clearly understand what is legal and what is not within existing aviation laws. This is a long-range project requiring careful scrutiny of some six to seven thousand pages of regulatory material, then reducing them to a single document.

FAA also instituted Project Sean—System for the Collection and Analysis of Near-collision reports. This study, carried out under contract by the Flight Safety Foundation, provides for the development of a uniform, nation-wide system of reporting near-misses and related incidents by both civil and military pilots and aircrews, and also a system for periodic reporting of the data analysis.

The conclusions and recommendations of the Foundation's independent analysis will be used by the FAA in its own continuing campaign to improve air safety and will supplement FAA activities in the same area.

An outgrowth of Project Hummingbird was an FAA study, "A Technical Summary and Compilation of Characteristics and Specifications on Steep-Gradient Aircraft," which discussed in detail the helicopter, the compound aircraft, the tilt-rotor aircraft, tilt-wing plus deflected slipstream and the turbo-jet V/STOL. The report was prepared in cooperation with the National Aeronautics and Space Administration, the Department of Defense and private industry groups.

Project Little Guy was a study aimed at developing a simpler, more efficient cockpit for light aircraft, including the physical layout as well as the instrumentation. FAA's approach to the problem is new—to consider the pilot first and design the cockpit for his comfort and convenience. In the opinion of FAA engineers, this could reduce training time and increase the efficiency and safety of private flying.

In February, military flight service functions were transferred to the FAA from the Air Force for all military aircraft operating within the continental United States and its oceanic areas. This action was part of an overall FAA-Department of Defense plan labeled Project Friendship, first announced in September, 1959.

The plan, based primarily on economic considerations, called for FAA to assume certain functions and services common to the operations of both Agencies. Specifically, these involve the areas of military controller training, flight inspection of military air navigational aids and military air traffic control services and facilities.

A second step was taken in March when FAA trained 20 Air Force members in a prototype pro-

The Air Route Traffic Control Center at New York's International Airport.

gram of air traffic control. A 15-week course was planned in cooperation with the Department of Defense covering 10 weeks of academic and laboratory training in basic air traffic control instruction at FAA's Aeronautical Center, and 5 weeks of radar training at Keesler Air Force Base, Mississippi.

Results of the experiment were being evaluated at year-end. Adoption of the plan would mean that from 500 to 1,000 military controllers would be trained annually by FAA.

Requirements for airports are established by the National Airport Plan. It is submitted to Congress annually and contains a list of the projects the Administrator considers necessary to anticipate and meet the needs of civil aviation. The listings do not mean that either the local community or the Federal Government is committed to participate financially in the suggested improvements. The plan is rather a report to Congress and the public on the nation's airport needs. When funds are made available by Congress, FAA accepts applications from airport owners, and from these applications funds are allocated to specific locations.

Other rules stress that improvements must be made in the interests of safety. This puts emphasis on construction of runways and taxiways and the acquisition of additional land. The Federal Government will construct facilities to house air traffic control, weather or flight service activities, but airport owners are required to furnish the land. No funds will be permitted for airport buildings that are not related to the safety of people at the airport. Since fire and crash-rescue buildings are related to safety, they are eligible for Federal aid. The 1961 National Airport Plan listed 3,260 airports, heliports and seaplane bases eligible for Federal aid.

On September 30, President Kennedy signed the Federal Aid to Airports Bill which provided $75 million annually for the next three years for airport aid. For the first time, a minimum sum—$7 million annually—was earmarked for general aviation airports.

FAA's fiscal 1962 budget provided $11 million for technical research on a supersonic commercial transport plane. New policy making, advisory and operating organizations have been set up to manage this vital program.

A report to the Congress by the Federal Aviation Agency, the Department of Defense and the National Aeronautics and Space Administration declared that a supersonic transport was feasible and that it could be developed and flown by 1970-71. Toward this end, NASA planned to spend about $8.5 million for internal research in 1961.

The airplane would have a range of about 3,500 nautical miles, weigh approximately 400,000 pounds, have a hundred-foot wing span and a fuselage 200 feet long. It would carry from 100 to 150 passengers and cruise around 2,000 miles per hour at 70,000 feet.

The problem of crowded airspace was eased as a result of returning 3,790 square miles of restricted airspace to general use, making a total return of 28,901 square miles since May, 1959. Additional long and short range radars were installed in towers and Centers; the number of VORs and other major navigation aids was increased, and improved communications and weather service went into effect over the entire Federal Airways System. An intermediate airways system was established and the floor of the Continental Control Area was lowered from 24,000 to 14,500 feet.

The intermediate system, the third to be established by the FAA, provides a system of aerial express highways designed primarily to serve long and medium haul aircraft between 14,500 and 24,000 feet. The high altitude jet route system extends through the airspace above 24,000 feet and the low level system, which has been in operation for many years, lies below 14,500 feet. The intermediate airways system also includes the necessary airways to provide transition to and from the low and high altitude structures.

With the lowering of the floor of the Continental Control Area, all air traffic above 14,500 feet in the continental United States, excluding Alaska, will fly in controlled airspace.

Work was begun at Nashua, N. H., on a new, modern Air Route Traffic Control Center to serve 140,000 square miles of airspace covering practically all of New England. It was scheduled for commissioning in November, 1962.

Safety considerations prompted several FAA moves relating to pilots. The Administrator confirmed the ruling requiring airline pilots to retire at age 60. To encourage all general aviation pilots to acquire enough instrument flying skill to get themselves out of potentially dangerous weather situations, a Blue Seal is printed on pilots' certificates. This new program was spurred by the fact that weather accounts for 30 to 35 percent of the fatalities encountered in general aviation. A third FAA safety action requires that one pilot in the cockpit of an airline aircraft operating above 35,000 feet wear an oxygen mask at all times.

In 1960 the FAA reinstated its policy of requiring applicants for student and private pilot certificates to take their physical examinations from a designated Aviation Medical Examiner. By the end of 1961, the number of these examiners had risen to 5,000, a significant proportion of them experienced flight surgeons or pilots, or both.

To assure uniformity of physical examinations and to keep the examiners abreast of developments in aviation medicine, FAA conducted three-day seminars at medical schools throughout the nation. Emphasis in the seminars was given to physical factors important to safe flying, as well as to accident investigation techniques. FAA's experience with airline accidents has proved that the presence of an Aviation Medical Examiner at the scene of a crash can mark the difference between information gained or evidence lost. Consequently, Aviation Medical Examiners will now be called to take part in investigating fatal light plane accidents in order to determine whether pilot disability could have been a contributing factor.

After a series of FAA-industry conferences, a schedule was agreed upon for the installation of Distance Measuring Equipment (DME) in airline transports. DME offers the pilot continuous and exact knowledge of his airplane's position and progress. It enables him to go around a thunderstorm or a restricted area without losing his course. It also simplifies his procedures for entering and remaining within a holding pattern by indicating where turns are to be started regardless of wind conditions. DME also makes possible a reduction in separation standards, thereby reducing the size of the airspace block reserved around each aircraft. This, in turn, increases the number of aircraft that can be safely handled, permits more efficient use of altitudes, facilitates aircraft transition between routes and reduces holding delays.

Installation schedule was: All turbojets by July 1, 1962; all turboprops by January 1, 1963; all pressurized piston aircraft by July 1, 1963, and all other aircraft exceeding 12,500 pounds weight by January 1, 1964.

Use of portable FM radios on U.S. civil aircraft was prohibited after tests indicated that such radios could interfere with proper operation of the navigation system.

For the first time, rules were issued to standardize flight operations at airports served by FAA control towers. As of December 26, 1961, aircraft operating in the vicinity of such airports must observe limited airspeeds—156 knots (180 mph) for piston planes; 200 knots (230 mph) for turbine aircraft—and must be equipped with two-way radio. En route aircraft are prohibited, except with authorization, from flying through airspace extending up to 2,000 feet and five statute miles in horizontal radius from the center of the airport.

Arresting gear designed to stop large jet aircraft in an emergency was tested with an FAA Boeing 720 successfully at the Lakehurst Naval Air Test Facility, N. J. Tests were part of an FAA development effort to prevent aircraft accidents resulting from aborted takeoffs and landings that overshoot the runway. The equipment would also be effective when wheel braking might be ineffective on slippery runways or in a hydraulic system failure.

July 6, 1961, marked the 25th anniversary of the Federal air traffic control service. On that date in 1936 the "system" consisted of three Centers of extremely limited range at Newark, Chicago and Cleveland. The control personnel numbered 15 and that first year they handled more than 30,000 plane movements. Today, 36 Air Route Traffic Control Centers link an airways system that literally blankets the United States with navigation aids, and some 17,000 controllers handle close to 25,000,000 aircraft movements a year.

Legislation was introduced in Congress to establish a Federal Aviation Service, a reserve of civilian air traffic controllers and other specialists who would be placed in military status in time of war or any national defense emergency to assure uninterrupted air traffic control and other essential services.

Under the proposed legislation, FAS personnel would receive Civil Service pay and benefits and would also be eligible for certain military personnel rights and benefits while on military duty. Provision was made for retirement for FAS personnel in civilian status reaching the age of 50 who have completed 20 years in the Service. This also would apply to FAA employees not in the FAS who are engaged in the highly demanding air traffic control work, and to employees with a combination of 20 years service in FAS and in FAA traffic control.

The FAS is visualized as a force of some 28,000 men, of whom 17,000 would serve in air traffic control facilities and the remainder in the electronics and maintenance fields.

The British Royal Aircraft Establishment visual glide slope indicator lights were adopted by FAA in September 1960 as a national standard. The system consists of red and white light units arranged on each side of the runway, and since no equipment is required in the aircraft, the lights have a wide application. Pilots of light planes and those flying large transports both have found the lights valuable in making an approach to the runway at large commercial fields as well as medium and small airports. Tests of the new lights and the first operational installation at New York's LaGuradia Airport proved that the new system promotes safety by reducing the dangers of undershooting or overshooting the touchdown area. Since the lights can be seen in daytime or under conditions of limited visibility, they can be used by pilots an estimated 90 percent of the time.

Direction Finding Equipment was ordered for 100 selected FAA Flight Service Stations and airport control towers which are not equipped with radar, most of them in Alaska, the Western United States and some northeastern states.

A contract was signed for the development of a lightweight airplane cockpit voice recorded designed to aid airplane crash investigators in determining accident causes. The equipment will have a continuous record-and-erase feature that will retain the last 30 minutes of conversation.

Forty radar bright display systems were ordered. These give a bright and more useful presentation of traffic and can be used in a normally lighted room rather than the darkened room required for conventional radarscopes.

At year-end, these were FAA's Operating Services:

The Air Traffic Service assists the Administrator in developing the plans, standards and systems for control of air traffic.

The Aviation Facilities Service—the Agency's engineering and construction arm—plans and standardizes the installation and maintenance of the thousands of electronic, mechanical and other components used in each Region.

The Flight Standards Service establishes standards for certifying the safety of the entire air transportation system, including the airworthiness of aircraft and parts, the flight competence of airmen, the accuracy of navigation aids and the licensing of flight schools, ground schools and repair stations.

The Aviation Medical Service is concerned with the solution of medical problems peculiar to civil aviation. It develops and recommends to the Administrator the standards, rules and regulations governing the mental and physical fitness of airmen and other persons who support flight activity. In addition to medical certification of civil airmen and the maintenance and processing of their medical records, this Service designates and trains Aviation Medical Examiners. Any licensed physician may apply for this designation and, if qualified, receive FAA courses in civil aviation medicine and related fields.

International Aviation Service assists the Administrator in providing technical assistance to other nations in cooperation with the State Department's Agency for International Development. This Service is the point of contact with the International Civil Aviation Organization, and furnishes technical advice in the negotiation of agreements involving inter-governmental exchange of commercial air rights and the recognition of airworthiness of aircraft manufactured abroad. The Service is also the center for exchange of civil aeronautical information with foreign governments.

The Aviation Research and Development Service initiates, develops and coordinates FAA's research programs.

The Bureau of National Capital Airports directs the operations of the Federally-owned Washington National Airport and the planning, construction and operation of Dulles International Airport being built at Chantilly, Virginia.

June 16, 1961, marked the 20th anniversary of operations at Washington National Airport, the fourth busiest airport in the United States. It has been operated by the FAA at a profit to the U.S. Treasury for the past 10 years.

In a major program to increase safety for passengers and to make the airport easier and more convenient to use, $4.5 million was spent in 1961 on various improvements. The program included the design of a new access highway, enclosing, heating and air conditioning the passenger walkways and improved baggage handling.

A new taxiway, 75 feet wide and 1,600 feet long was constructed near the North Terminal. An extensive paving project widened taxi areas and lessened the danger of aircraft-to-aircraft or vehicular collision. In addition, bypass taxiways were constructed to facilitate the ground movement of airplanes preparing to take off.

Highly specialized rescue and firefighting equipment was purchased to bring the airport safety facilities up to the standard code of the National Fire Protection Association.

Work on Dulles International continued to progress in 1961 with all construction on schedule and some initial operating equipment on order. Opening date was tentatively scheduled for the end of 1962.

FEDERAL COMMUNICATIONS COMMISSION

The Commission's responsibilities during 1961 included control over non-Government use of radio for aviation communication, aeronautical radionavigation and other safety and operational applications in that industry.

The Aviation Radio Services included stations aboard aircraft and the necessary ground stations to serve them in communicating, navigating and other specialized uses. These stations are classed as air carrier aircraft, private aircraft, aeronautical enroute, aeronautical metropolitan, aeronautical utility mobile, airdrome control, flight test, flying school, radionavigation, aeronautical public service, aeronautical search and rescue mobile, and Civil Air Patrol. The administration of these services requires close coordination with various technical and policy-making groups, which are described below.

RADIO TECHNICAL COMMISSION FOR AERONAUTICS

The RTCA is a non-profit cooperative association of Government and industry organizations concerned with aeronautical telecommunications matters. The findings and reports of this organization are submitted to responsible agencies and are frequently used by Federal bodies as the basis for proposing regulatory measures affecting the aviation industry. The Commission is represented on the RTCA Executive Committee and on many of its special committees handling specific technical matters.

During the past year, Commission representatives took part in special committee consideration of such subjects as minimum performance standards for airborne radio receiving and transmitting equipment operating within the frequency range of 117.957-136.000 Mc; frequency requirements and utilization for common system air traffic control in the band 108-136 Mc; development of revised environmental test procedures for airborne electronic equipment; a study of utilization of the band 9300-9500 Mc for radionavigation; development of standardized procedures for measurement of RF energy emitted from aircraft radio receivers; and development of minimum performance standards for airborne receiving and direction finding equipment operating within the range of 200-415 kc.

AIR COORDINATING COMMITTEE

The ACC, which was abolished by Executive Order during the past year, was responsible to the President for coordinating Federal policy in the field of aviation. The duties of this group insofar as international aviation matters are concerned were largely assumed by the Interagency Group on International Aviation (IGIA). Matters concerning domestic policy were coordinated by direct liaison between responsible agencies as, for example, continued FAA-FCC cooperation in the matter of antenna structures.

INTERNATIONAL AVIATION COMMUNICATION COORDINATION

The Interagency Group on International Aviation (IGIA) formulates policies for the guidance of United States representatives to international meetings such as the International Telecommunication Union (ITU) and the International Civil Aviation Organization (ICAO). ICAO is a specialized agency of the United Nations. Its task is to recommend practices relative to international aviation matters, one of which is the use of radio.

The Commission participated during the year in preparing the United States position for the following ICAO meetings: Limited South American/South Atlantic (SAM/SAT) Regional Air Navigation Meeting; Rules of the Air and Communication (RAC/COM) Regional Air Navigation Meeting; Informal Rules of the Air and Air Traffic Services/Aeronautical Communications and Electronic Aids Meeting; Second ICAO Pacific Regional Air Navigation (PAC/RAN) Meeting; Fourth North Atlantic Regional Air Navigation (NAT/RAN) Meeting;

Seventh Session of the Communications Division Meeting (VII COM); Seventh Session of the Aerodromes, Air Routes and Ground Aids Division (AGA); and Fifth Personnel Licensing/Aviation Medicine (PEL/MED) Division Meeting.

Problems considered concerned such matters as views on developments in the VHF forward scatter technique for increasing coverage of air-ground communications; proposals with respect to functional use of the four teletypewriter channels of the ICAO North Atlantic cable system; proposed reply to comments by the Republic of the Philippines concerning distance measuring equipment specification contained in Amendment 35 to Annex 10 to the Convention on International Aviation; serious deficiencies in air navigation facilities and services in the various ICAO regions; and proposed reply to ICAO regarding recommendations on utilization of the band 9300-9500 Mc for marine and aeromobile radars.

RULE AMENDMENTS AND WAIVERS

The Commission continued to keep its applicable rules current with the expanding aviation industry. Some of the year's more significant rule changes follow:

Amendment of part 9 to specify the applicable technical standards for voluntary use of single sideband (SSB) emissions.

Making the frequency 122.6 Mc available for use by air carrier aircraft until July 1, 1962, to allow participation in an FAA direct pilot-to-weather forecaster test. It is intended to provide weather data to pilots and traffic controllers. One objective is to determine the best method for doing this.

Rulemaking which has been initiated but not yet finalized follows:

A new subpart to cover aviation developmental operations. It parallels existing developmental rules in other radio services. Authorizations for aviation stations engaged in developmental operation would be made on a temporary basis for a specific period of time, but in no event longer than one year.

Proposal to allow the use of the frequencies 4602.5 and 4630 kc by land and mobile stations of the Civil Air Patrol, the civilian adjunct of the Air Force, within certain specified states.

An amendment to permit activation of airport lights by means of radio signals transmitted from aircraft. This would make it possible for pilots to turn on landing and related lights at airfields which are not normally manned during the hours of darkness.

Proposal to make frequencies available for an aviation service at terminal areas for use by stations located aboard ground vehicles (including aircraft on the ground) or carried by persons performing functions of service and supply to aircraft on the airdrome.

CURRENT AND FUTURE PROBLEMS

As previously reported, 2 Mc of non-Government aviation frequencies have been relinquished, along with 3 Mc of space by Government users, for Government and non-Government use in air traffic control. This required reassignment of frequencies to about 800 non-Government ground aviation stations, with close liaison with Canada in areas where such reassigned frequencies might result in interference to stations of either country. Most of the necessary reassignments have been completed; however, problems with reference to possible interference between stations in Canada and this country require continuous study and coordination.

FOREST SERVICE

U.S. DEPARTMENT OF AGRICULTURE

In 1961 the Forest Service continued to rely on expanding use of aircraft in the job of protecting and managing the 186 million acres of land under its supervision in 43 states and Puerto Rico. On the 155 National Forests and 18 newly established National Grasslands, aircraft were used extensively in fire detection and suppression, the detection and control of forest insects and diseases, range and forest reseeding projects, and aerial surveys and map making.

Aircraft were used to fight forest fires for a record 48,069 hours of flying time in 1960. This was 47 per cent more than in 1959 and nearly three times the 1956 use. Fixed wing aircraft flew 38,838 hours and helicopters 9,231 hours, compared to only 26,030 and 6,716 hours respectively in 1959. Commercial and privately owned aircraft under contract accounted for 83 per cent of the total flying time.

Passengers carried in aircraft increased 67 per cent from 1959 to a new total of 59,758 and the weight of cargo more than doubled to 2,786,371 pounds. In this vital fire work, helicopters carried about 10,000 more passengers than fixed wing aircraft.

The helicopter proved itself the star performer in the forest fire fighting effort. New methods and techniques which can be applied to fires with this vehicle have done much to keep timber damage smaller than was previously possible. Helicopters provide rapid transport of men and equipment to remote and inaccessible danger points on forest fires which otherwise could only be reached after long hikes that exhaust fire fighters before their work even begins. In initial attach, men were placed on fires by helicopters and moved from one fire to another in a fraction of the time required by other means. This tactic saved thousands of acres during the epidemic of lightning-caused fires in the Northwest during August. Other tasks for which helicopters proved indispensable were: making long fire hose lays over steep and rugged terrain, dropping fire retardant with pin-point accuracy, and supplementing ground and fixed wing airplane detection maneuvers.

No other method of fighting forest fires, however, has made as rapid progress as the dropping of fire retardants from aerial tankers. From a small beginning in 1956 when 123,700 gallons of retardant were dropped on 24 fires, air tankers have become a major forest fire-fighting tool. Almost 6,000,000 gallons were dropped on 1,050 fires in 1960. These figures are about double those for the previous year.

Forest fire casualty is helicopter-lifted to ambulance.

During serious fires, aircraft play a major part in the massive suppression techniques that are required. On one day during the 1960 fire season 320 aircraft were mobilized and used. These included 80 air tankers and 61 helicopters. Helicopters flew about 20 per cent of the total air time put in on fire work in 1960.

In 1961, aircraft were most extensively employed on big fires in the western states of Oregon, Washington, California, Idaho, Montana, Utah, Arizona and Wyoming. In the last two years, 28 initial attack air tanker bases have been established in these states.

Both fixed wing airplanes and helicopters continue to serve an essential role in forest insect and disease control activities. Trained aerial observers covered millions of acres of forest lands in both types of aircraft detecting and evaluating outbreaks of bark beetles, defoliating insects, and disease infections.

Aerial application of insecticides to wipe out defoliator epidemics on Federal and non-Federal land covered less than 100,000 acres in 1961. For 1962, however, the Forest Service anticipated extensive spraying operations against the spruce budworm, jack pine budworm and other leaf-feeding insects.

Sagebrush eradication is accomplished by aerial spraying.

Range management activities, as in recent years, continued to benefit from the use of aircraft. More than 116,000 acres of National Forest western rangeland were sprayed with herbicides to control undesirable plants, and more than 23,000 acres were seeded to grass from the air.

The use of aerial photography for mapping and other forest resource planning and utilization continued to grow. In fiscal year 1961, the Forest Service began photographic coverage of 53,788 square miles to aid in both timber management and mapping.

FISH AND WILDLIFE SERVICE

DEPARTMENT OF INTERIOR

During 1961, Fish and Wildlife Service used aircraft in enforcing federal fish and wildlife laws, taking waterfowl inventories, big game surveys, aerial hunting to control large predators, developmental work on national wildlife refuges such as aerial seeding and spraying, collection of fishery statistics, aerial reconnaissance of wildlife areas, and hauling supplies and personnel to and from isolated field stations.

The Service operated a fleet of 41 aircraft composed of 15 Cessnas (1 170 and 14 180s), 9 Grumman Gooses, 15 Pipers (Pacers and Supercubs), and 2 Navion.

The maintenance of Service aircraft, with the exception of those in Alaska, was handled through commercial shops. The aircraft in Alaska were maintained in the Service's own repair shops, with some work being handled on a commercial basis.

In 1961, the Fish and Wildlife Service had 65 employees holding the Letter of Flight Authority. These pilots were all Civil Service qualified as Game Management Agents, Refuge Managers, Fishery or Wildlife Biologists, Animal Control Biologists, and in a few instances in Alaska as Pilot-Mechanics. Practically all Service pilots were trained wildlife or fishery personnel. The use of aircraft provided these men with additional speed and mobility so they could better handle the job of protecting and managing the country's wildlife resources.

NASA Administrator James E. Webb presents first U.S. manned space capsule, Mer-

NATIONAL AIR MUSEUM

SMITHSONIAN INSTITUTION

Since events of historic flight significance are increasingly in the field of space flight, the new exhibits and accessions of the National Air Museum, for the year of 1961 included many items associated with the exploration of and research in space travel, both manned and unmanned. An outstanding example was the Mercury spacecraft, "Freedom 7" in which astronaut Alan B. Shepard, Jr. made the first U.S. sub-orbital flight on May 5. In addition, a full-size Polaris, the Navy's submarine launched rocket, was transferred to the National Aeronautical Collections to join the Atlas, the Vanguard and the Jupiter-C.

In view of the expanded scope of interest, the name of the former Aircraft Building, which houses the exhibits was changed to the Air and Space Building.

One might assume from the above that the interest and energies of the staff of the Air Museum were being directed in a considerable degree to only those items associated with the space effort. Such is not the case at all. A far greater amount of research and collection of historic materials was still in the area of atmospheric flight. Materials directly related to the flights of the Wright Brothers were still being recovered as a part of a continuing program of expanding available knowledge of the early days of flight. Through the active assistance of such groups as the "Early Birds," the remaining members of the Lafayette Escadrille and others, additions numbering in the hundreds of items became a part of the National Aeronautical Collection.

A source of pride for the Smithsonian Institution in 1961 was the steadily increasing number of visitors to the exhibits in the Air and Space Building. The annual rate reached just over a million.

In addition to the previously mentioned items which became a part of the National Collection in 1961, note should be taken of: the "Que Sera Sera," the first airplane to land at the South Pole, a trans-

cury Freedom 7, to the National Air Museum of The Smithsonian Institution.

fer from the Navy; a gift of 150 early Pilot and Engine Manuals from the Shell Companies Foundation; the first camera to take pictures of the earth from a stabilized platform in space from the General Electric Company; fully instrumented flight spares of two of this country's most successful space vehicles: Explorer I, first U.S. satellite to be placed in orbit, and the Pioneer IV, deep space probe, now in orbit around the sun—from the Jet Propulsion Laboratories through the National Aeronautics and Space Administration.

POST OFFICE DEPARTMENT

Nearly one and one-half billion pieces of airmail and air parcel post were handled in the domestic airmail service during fiscal year 1961, according to preliminary figures of the Post Office Department. The weight of this airmail exceeded 111 million pounds.

Over $50 million in service mail payments were made to 45 air carriers for the transportation of over 121 million mail ton-miles in the domestic service. There were nine carriers engaged exclusively in Alaskan operations and two carriers operating entirely within the new State of Hawaii. In addition to the service mail pay, subsidy mail payments were made to certain air carriers by the Civil Aeronautics Board.

First class mail transported by air totaled almost 30 million mail ton-miles. Payment to the airlines involved in this program amounted to more than $5.5 million during fiscal year 1961.

An increase of more than twelve percent over previous year figures was recorded in the volume of foreign mail. This included airmail from the United States to and from United States possessions and territories, and to and from United States military post offices located in foreign countries. In addition, there was more than 33 million pounds of first class military mail transported by air to overseas installations.

Approximately 5.3 percent of the total foreign airmail from the United States to other countries, except Canada, was transported by foreign flag carriers. Separate figures were maintained with respect to dispatch of airmail destined to Canada, and they revealed that about 58 percent was transported by Canadian flag carriers.

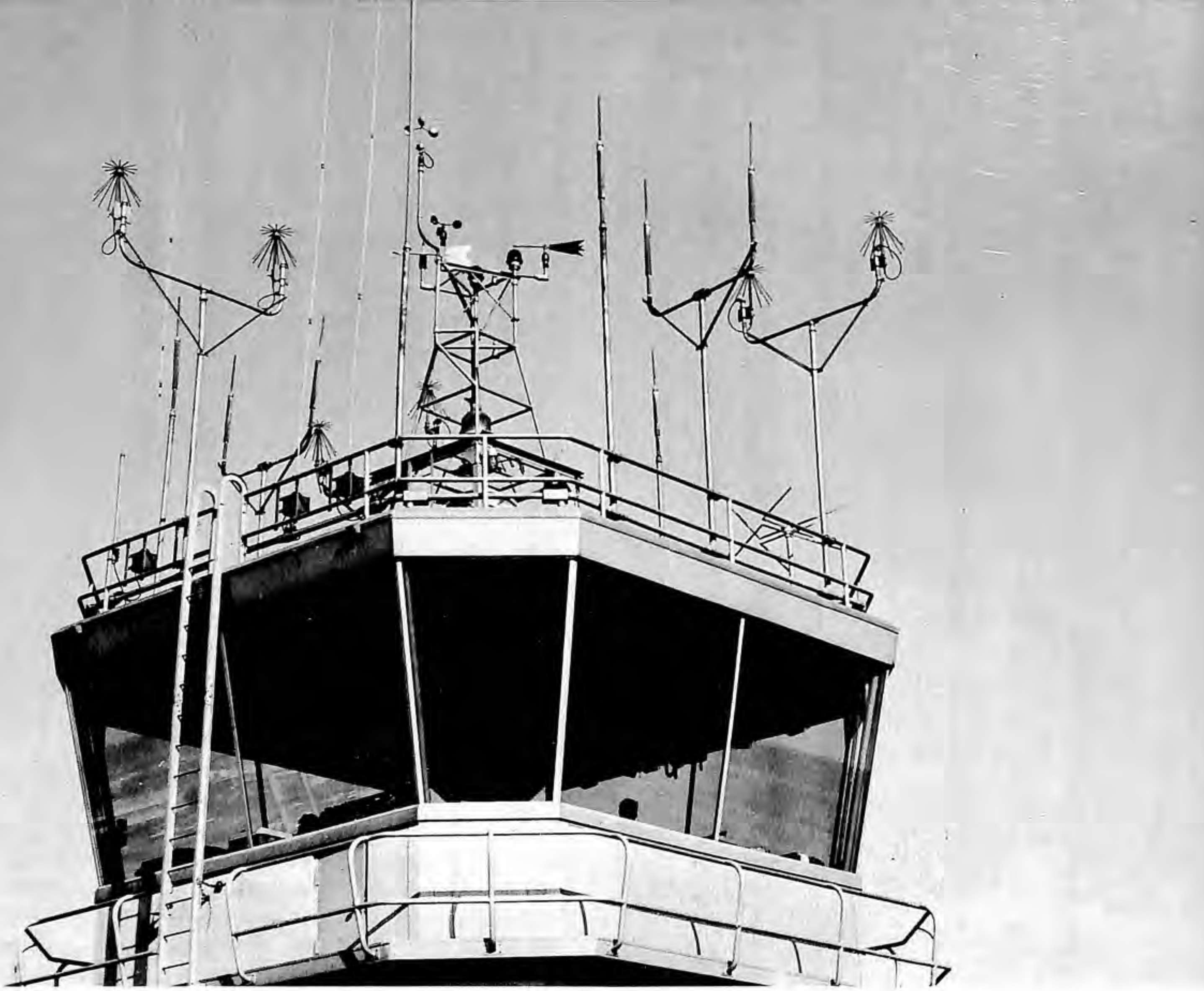
DEPARTMENT OF COMMERCE

WEATHER BUREAU

Modernization of the aviation services of the Weather Bureau continued in 1961 with further gains in the fields of weather measurements, analyses, forecasts, warnings, and communications. The outstading gain in analysis resulted from new capabilities for obtaining operationally useful information from ocean and other sparse weather reporting areas through the use of meteorological satellites.

With approximately 3,600,000 surface observations, 80,000 radiosonde and rawinsonde probes of the upper atmosphere, 400,000 radar observations and a large increase in the number of pilots' inflight weather reports, the atmosphere was kept under closer surveillance than ever before.

Greater radar coverage was provided by the progressive installation of the powerful new WSR-57 weather radars, with 250-mile radius of coverage With 29 sets in operation and more to be installed, this weather eye continuously surveyed weather blind spots between observing stations and detected the development and movement of squall lines, thunderstorms, tornadoes and other conditions of concern to aviation. FAWS Centers received radar



Anemometers and wind vanes of U.S. Weather Bureau top control tower at Washington National Airport.

reports by teletypewriter to assist in their continuous weather watch.

Sophisticated automatic weather observation stations were installed at several places. Developmental work continued on these automated weather observers, which provide a continuous record of wind, pressure, temperature and other elements at airports.

Improved equipment for upper-air soundings resulted in increased height and accuracy of upper-wind reports—a special benefit for the now-common high-level turbine-powered aircraft flights, for which a special High Altitude Forecast Service was maintained.

Weather communications improvement in 1961 included the expansion of the Weather Bureau's national weather facsimile network to a number of additional Weather Bureau offices, and the transmission of radar charts and weather depiction charts especially for service to aviation. Also, further improvements were made in the Service A weather teletypewriter system to provide more rapid and orderly receipt of the aviation weather reports.

Approximately 1,450,000 aviation forecasts were prepared by 28 Aviation Weather Forecasting Centers in the 50 states. Forecasts prepared for additional terminal locations, pilots' automatic aviation telephone services, and continuous transcribed weather broadcasts increased the number prepared by 50,000 over the previous year.

Weather briefings were provided for approximately 154,000 international flights and for about 6,800,000 domestic flights. A decrease was shown in actual international flight briefings as related to the use of larger capacity aircraft on overseas hauls, the use of a single airline company dispatcher to obtain briefing for multiple flights, and the operation of a closed circuit TV system by the Weather Bureau to provide mass briefing in the New York area.

In the field of flight weather briefing, the Weather Bureau has trained, examined, and certificated approximately 4,100 Federal Aviation Agency Flight Service Specialists at 339 FAA stations in weather briefing work to enable them to participate more effectively in pre-flight and in-flight briefing. Those certificated translate Pilot Reports (PIREPS) and

Weather Bureau observations and forecasts as they apply to specific flight problems.

Mass dissemination weather briefing services were expanded by the addition of continuous aviation weather broadcasts over 42 more FAA L/MF radio facilities and automatic telephone answering systems at 16 more WBAS locations, bringing national network totals to 61 and 44, respectively. Unforeseen delays in delivery of equipment and obtaining satisfactory space and working requirements in some FAA facilities delayed the anticipated completion of the 86 network broadcasts.

A year-long test program of direct voice communications between the airborne pilot and the aviation forecaster was inaugurated in two areas on July 1, 1961, in cooperation with the FAA. Weather Bureau forecasters stationed in the Washington, D. C. Air Route Traffic Control Center and the Kansas City Weather Bureau Forecast Center will answer specific questions of the airborne pilot regarding unusual and hazardous weather and provide service as required to aid the airborne pilot and FAA Air Traffic controllers.

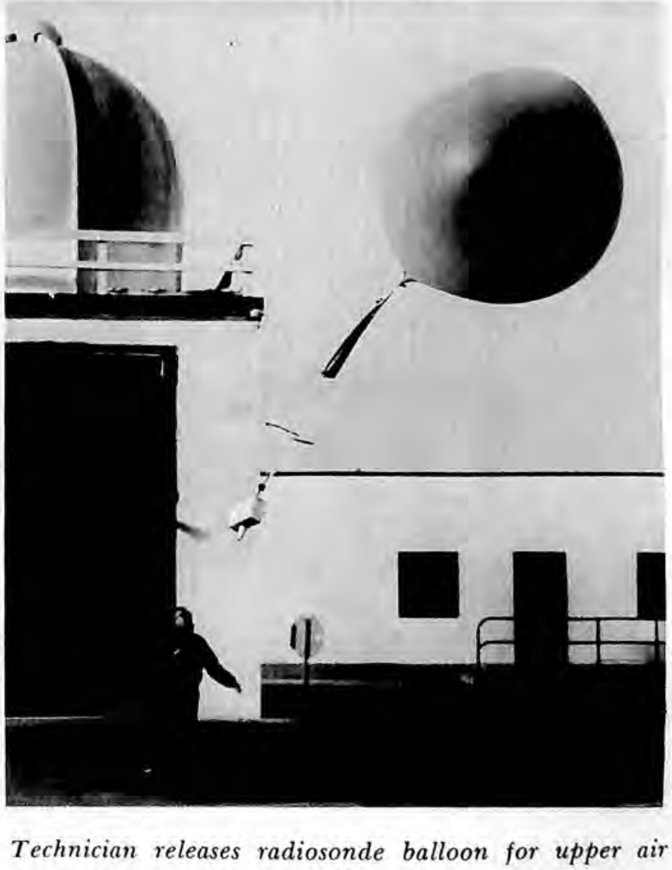
Procedures for in-flight weather safety service were modified with the term "flash advisory" being replaced by two categories—"SIGMET" and "ADVISORY FOR LIGHT AIRCRAFT." *SIGMET* advises airmen in flight of severe or extreme weather conditions potentially hazardous to *all* aircraft *ADVISORIES FOR LIGHT AIRCRAFT* advises airmen in flight of weather conditions of less severity than SIGMET but which may be hazardous to light aircraft. Both types of advisories are broadcast by FAA on NAVAID voice channels.

Weather support problems that will arise by 1970 in connection with supersonic civil air transport aircraft were being studied. These problems include the relation of the sonic boom to atmospheric conditions, the winds and turbulence at the projected 80,000 foot cruising level, and the need to avoid hail and other hazards during high-speed climb and descent.

Weather satellite TIROS I, launched April 1, 1960, by the National Aeronautics and Space Administration, sent back more than 20,000 pictures in its operational lifetime. From information provided by TIROS II, launched November 23, 1960, more than 400 cloud analyses, including pictures of ice in the Gulf of St. Lawrence in the spring of 1961, were used operationally. TIROS III, launched by the National Aeronautics and Space Administration on July 12, 1961, coincided with the 1961 hurricane season and revealed much significant information of tropical storms.

Each new satellite had added refinements in its instrumentation. The first TIROS carried two television cameras, with the necessary power and communications equipment. The second TIROS contained two radiation experiments in addition to the two television cameras. The third TIROS has two cameras, three radiation experiments, and improved remote control programming equipment for operating the cameras and other electronic instruments in the satellite.

The outstanding success of the three TIROS satellites suggests the immense possibilities of a whole system of weather satellites. Plans for a National Operational Meteorological Satellite System were developed by the Weather Bureau in cooperation with the Department of Defense, Federal Aviation Agency, and the National Aeronautics and Space Administration. The plan recommended the launching of five NIMBUS satellites between mid-1962 and December 1963. After 1963, the plan called for two NIMBUS satellites in orbit most of the time, doubling the frequency of observations and permitting the photography of clouds 24 hours a day. Later, a more sophisticated series of satellites, called AEROS, will be launched in equatorial orbits that will keep them continuously above a single spot on earth. A few orbiting AEROS satellites would provide continuous surveillance of the weather outside of the polar regions.



Technician releases radiosonde balloon for upper air readings.

AIRCRAFT IN PRODUCTION

AERO COMMANDER 500A

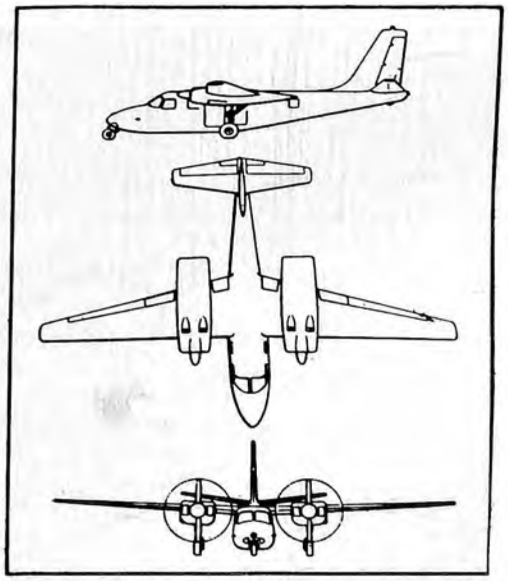
AERO COMMANDER, INC., Bethany, Oklahoma

SPECIFICATIONS

Span 49 ft. 6 in.; Length 35 ft. 1¼ in.; Height 14 ft. 6 in.; Empty Weight 4255 lb.; Wing Loading 24.5 lb. per sq. ft.; Power Loading 12.01 lb. per bhp; Engines 2 Continental IO-470-M fuel injection; 260 hp normal rated, or 260 hp at 2625 rpm takeoff; Fuel Capacity 156 gal.; Propeller Hartzell, 2 blade, full feathering; Wing Area 255 sq. ft.; Aileron Area 20.52 sq. ft.; Flap Area 21.20 sq. ft.; Fin Area 24.00 sq. ft.; Rudder Area 15.4 sq. ft.; Stabilizer Area 33.06 sq. ft.; Elevator Area 20.54 sq. ft.

PERFORMANCE

Maximum Speed 228 mph at sea level; Cruise Speed 217 mph at 70 percent power at 10,000 ft.; Landing Speed 100 mph; Rate of Climb 1510 fpm at sea level; Service Ceiling 23,200 ft.; Range with Maximum Payload 1800 mi.; Range with Maximum Fuel Load 1800 mi.; Grosses 6250 lbs.



AERO COMMANDER 500B

AERO COMMANDER, INC., Bethany, Oklahoma

SPECIFICATIONS

Span 49 ft. 6 in.; Length 35 ft. 1¼ in.; Height 14 ft. 6 in.; Empty Weight 4300 lb.; Wing Loading 26.47 lb. per sq. ft.; Power Loading 11.63 lb. per bhp; Engines 2 Lycoming IO-540-B1A fuel injection, 290 hp normal rated, or 290 hp at 2575 rpm takeoff; Fuel Capacity 156 gal.; Propeller Hartzell, 3 blade, full feathering; Wing Area 255 sq. ft.; Aileron Area 20.52 sq. ft.; Flap Area 21.20 sq. ft.; Fin Area 24.00 sq. ft.; Rudder Area 15.4 sq. ft.; Stabilizer Area 33.06 sq. ft.; Elevator Area 20.54 sq. ft.

PERFORMANCE

Maximum Speed 228 mph at sea level; Cruise Speed 218 mph at 70 percent power at 10,000 ft.; Landing Speed 100 mph; Rate of Climb 1450 fpm at sea level; Service Ceiling 20,500 ft.; Range with Maximum Payload 1250 mi.; Range with Maximum Fuel Load 1250 mi.; Grosses 6750 lbs.

AERO COMMANDER 560F

SPECIFICATIONS

Span 49 ft. 6 in.; Length 35 ft. 1¼ in.; Height 14 ft. 6 in.; Empty Weight 4650 lb.; Wing Loading 29.41 lb. per sq. ft.; Power Loading 10.71 lb. per bhp; Engines 2 Lycoming IGO 540 fuel injection, 340 hp normal rated, or 350 hp at 3400 rpm takeoff; Fuel Capacity 223 gal.; Propeller Hartzell, 3 blade, full feathering; Wing Area 255 sq. ft.; Aileron Area 20.52 sq. ft.; Flap Area 21.20 sq. ft.; Fin Area 24.00 sq. ft.; Rudder Area 15.4 sq. ft.; Stabilizer Area 33.06 sq. ft.; Elevator Area 20.54 sq. ft.

PERFORMANCE

Maximum Speed 248 mph at sea level; Cruise Speed 232 mph at 70 percent power at 10,000 ft.; Landing Speed 100 mph; Rate of Climb 1720 fpm at sea level; Service Ceiling 21,900 ft.; Range with Maximum Payload 1500 mi.; Range with Maximum Fuel Load 1500 mi.; Grosses 7500 lbs.

AERO COMMANDER 680F

SPECIFICATIONS

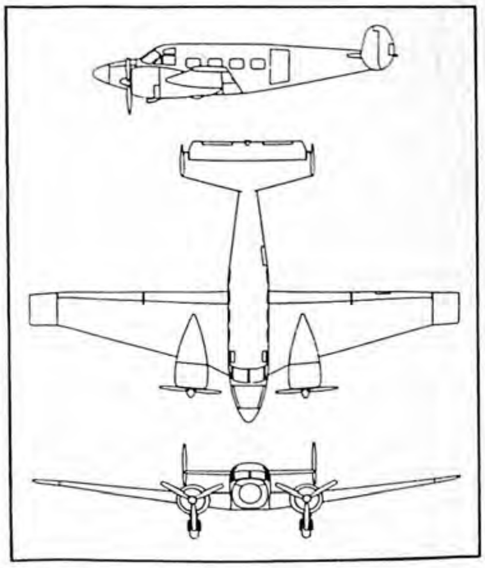
Span 49 ft. 6 in.; Length 35 ft. 1¼in.; Height 14 ft. 6 in.; Empty Weight 4800 lbs.; Wing Loading 31.37 lb. per sq. ft.; Power Loading 10.51 lb. per bhp.; Engines 2 Lycoming IGSO-540 fuel injection, 380 hp normal rated, or 380 hp at 3400 rpm takeoff; Fuel Capacity 223 gal.; Propeller Hartzell, 3 blade, full feathering; Wing Area 255 sq. ft.; Aileron Area 20.52 sq. ft.; Flap Area 21.20 sq. ft.; Fin Area 24.0 sq. ft.; Rudder Area 15.4 sq. ft.; Stabilizer Area 33.06 sq. ft.; Elevator Area 20.54 sq. ft.

PERFORMANCE

Maximum Speed 290 mph at 15,500 ft.; Cruise Speed 244 mph at 70 percent power at 10,000 ft.; Landing Speed 105 mph; Rate of Climb 1660 fpm at sea level; Service Ceiling 28,500 ft.; Range with Maximum Payload 1400 mi.; Range with Maximum Fuel Load 1400 mi.; Grosses 8000 lbs.

BEECHCRAFT SUPER G18S

BEECH AIRCRAFT CORP., Wichita 1, Kansas



REMARKS

The eight-place Super G18S executive transport offers walk-around cabin comfort, new "sky-wide" picture windows, air-stair door entrance and dependability of experience-proved Pratt & Whitney 450 horsepower engines. Produced since 1954, the Super 18 is an advanced configuration of the Beechcraft Model 18, of which nearly 7,000 units of commercial and military models have been produced. Equipped with three-blade Hartzell propellers, the Super G18S allowable gross weight has been increased to 9,700 pounds and useful weight to 3,790. A standby power increase of 22.2 percent is gained by addition of optional JATO (standby rocket power) equipment. Weather-avoidance radar, Geisse safety gear and Cagle brakes are also optional.

SPECIFICATIONS

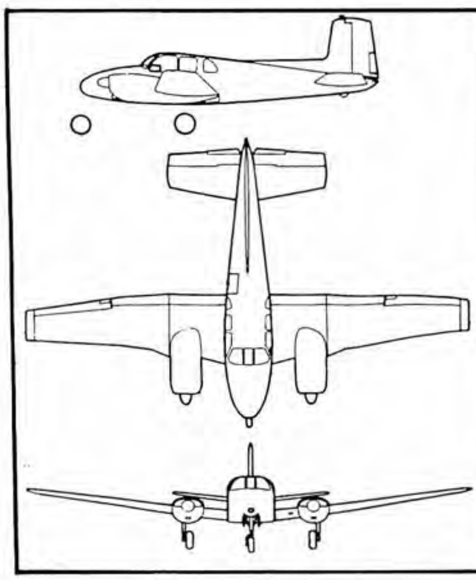
Span 49 ft. 8 in.; Length 35 ft. 2½ in.; Height 9 ft. 8 in.; Empty Weight 5910 lb.; Gross Weight 9700 lb.; Wing Loading 26.9 lb. per sq. ft.; Power Loading 10.78 lb. per bhp.; Engines Two Pratt & Whitney R-985 AN-14B 450 hp at 2300 rpm takeoff; Fuel Capacity 395 gal.; Propeller Hartzell hydromatic 3-blade, all-metal, full feathering; Gear conventional; Wing Area 360.7 sq. ft.; Aileron Area 17.48 sq. ft.; Flap Area 28.12 sq. ft.; Fin Area 20.08 sq. ft.; Rudder Area 13.50 sq. ft.; Stabilizer Area 49.58 sq. ft.; Elevator Area 22 sq. ft.

PERFORMANCE

Maximum Speed 233 mph at 450 hp at 2300 rpm at 4500 ft.; Cruise Speed 214 mph at 300 hp at 2000 rpm at 10,000 ft.; Landing Speed 84 mph; Rate of Climb 1410 fpm at Sea Level at 9700 lb. gross; Range with Maximum Payload 1585 mi. at 10,000 ft., 200 hp; 45 min. reserve.

BEECHCRAFT J50 TWIN-BONANZA

BEECH AIRCRAFT CORP., Wichita I, Kansas



REMARKS

The Beechcraft Twin-Bonanza offers a spacious cabin with six individual chairs, middle aisle and air-stair door. Two Twin-Bonanza models were produced: the J50, powered with twin 340 horsepower Lycoming engines, supercharged with fuel injection; and the D50E, with 295 horsepower high-compression engines, 6,300-pound gross weight and 4,100-pound empty weight. The Twin-Bonanza is designed and tested in excess of the load factors required of utility category aircraft. Special features include automatic, high pressure, continuous flow oxygen system; all internal and external parts corrosion proofed; cabin heater and automatic ventilating system and complete soundproofing. Optional equipment includes standby rocket power (JATO), weather-avoidance radar and Cagle brakes installations.

SPECIFICATIONS

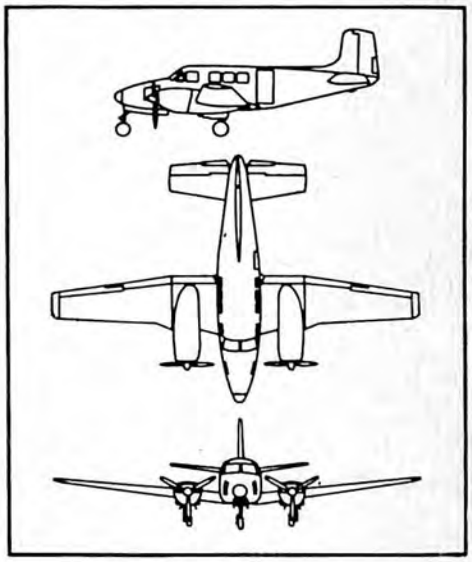
Span 45 ft. 11⅜ in.; Length 31 ft. 6½ in.; Height 11 ft. 4 in.; Empty Weight 4460 lb.; Gross Weight 7300 lb.; Wing Loading 26.4 lb. per sq. ft.; Power Loading 11.4 lb. per bhp.; Engines Two Supercharged Lycoming IGSO-480-A1 B6 with fuel injection, 320 hp normal rating, or 340 hp at 3400 rpm takeoff; Fuel Capacity 230 gal. with optional tanks; Propeller Hartzell, 3-blade constant speed, hydraulically operated, full feathering; Wing Area 277.06 sq. ft.; Aileron Area 13.89 sq. ft.; Flap Area 37.80 sq. ft.; Fin Area 14.25 sq. ft.; Rudder Area 12.77 sq. ft.; Stabilizer Area 47.25 sq. ft.; Elevator Area 17.49 sq. ft.

PERFORMANCE

Maximum Speed 235 mph at 3200 rpm at 12,000 ft.; Cruise Speed 223 mph at 238 hp at 2750 rpm at 15,200 ft.; Landing Speed 82.5 mph; Rate of Climb 1270 fpm at Sea Level; Service Ceiling 29,150 ft.; Range with Maximum Fuel Load 1650 mi.

BEECHCRAFT L-23F COMMAND TRANSPORT

BEECH AIRCRAFT CORP., Wichita 1, Kansas



REMARKS

Designed to meet a military requirement for a larger multipurpose transport in the L-23 series, the prototype six-seven place Army L-23F first flew August 28, 1959. First units entered Army service in 1959. The Federal Aviation Agency and Japan's Civil Aviation Bureau also operate L-23Fs. L-23F production continued for the U.S. Army in 1960.

SPECIFICATIONS

Span 45 ft. 10.5 in.; Length 33 ft. 4 in.; Height 14 ft. 2 in.; Empty Weight 4740 lb.; Gross Weight 7700 lb.; Wing Loading 27.6 lb. per sq. ft.; Power Loading 12 lb. per bhp; Engines Two Lycoming IGSO-480-A1A6 supercharged, with fuel injection, 320 hp normal rated; Fuel Capacity 230 gal.; Propeller Hartzell three-blade, hydraulic controlled constant speed, full feathering; Wing Area 280 sq. ft.; Aileron Area 13.8 sq. ft.; Flap Area 29.3 sq. ft.; Fin Area 14.25 sq. ft.; Rudder Area 12.77 sq. ft.; Stabilizer Area 47.25 sq. ft.; Elevator Area 17.87 sq. ft.

PERFORMANCE

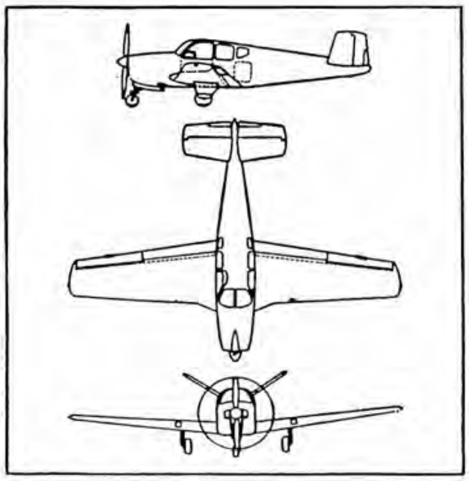
Maximum Speed 239 mph at 320 hp at 3200 rpm at 12,000 ft.; Cruise Speed 214 mph at 224 hp at 2750 rpm at 15,200 ft.; Landing Speed 80 mph; Rate of Climb 1300 fpm at Sea Level; Service Ceiling 27,000 ft.; Absolute Ceiling 28,500 ft.; Range with Maximum Payload 1445 mi.; Range with Maximum Fuel Load 1445 mi.

BEECHCRAFT N35 BONANZA

BEECH AIRCRAFT CORP., Wichita I, Kansas

REMARKS

Since its first flight in December, 1945, more than 6,800 Beechcraft Bonanzas have been manufactured. The Model N35 offers a power increase to 260 horsepower, gross weight increased to 3,125 pounds with additional 152 pounds of useful load, improved vision through installation of large rear windows and optional fuel capacity increased to 78 gallons. Optional features include autopilot, super soundproofing, rotating beacon, vacuum system and fifth seat arrangement.



SPECIFICATIONS

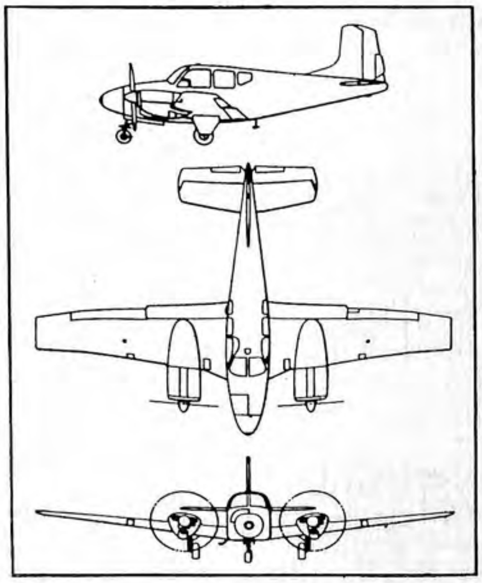
Span 33 ft. 5½ in.; Length 25 ft. 2 in.; Height 6 ft. 6½ in.; Empty Weight 1855 lb.; Gross Weight 3125 lb.; Wing Loading 17.3 lb. per sq. ft.; Power Loading 12.0 lb. per bhp; Engine (standard) Continental IO-470-N with fuel injection 260 hp at 2625 rpm, all operations; Fuel Capacity 49 gal. (78 gal. with optional tanks); Propeller Beech hydraulically controlled, variable pitch; Gear tricycle, fully retractable; Wing Area 181.0 sq. ft.; Fin-Stabilizer Area 23.8 sq. ft.; Rudder-Elevator Area 12 sq. ft.

PERFORMANCE

Maximum Speed 205 mph at 260 hp at 2625 rpm at Sea Level; Cruise Speed 195 mph at 195 hp at 2450 rpm at 7000 ft.; Landing Speed 60 mph; Rate of Climb 1150 fpm at Sea Level; Service Ceiling 19,200 ft.; Maximum Range 1215 mi. at 10,000 ft. at 159 mph.

BEECHCRAFT B95A TRAVEL AIR

BEECH AIRCRAFT CORP., Wichita 1, Kansas



REMARKS

A new high gross weight gives the Beechcraft Model B95A Travel Air, presented early in 1961, an increased useful load of nearly 200 pounds over earlier models. Fuel injection twin Lycoming engines, larger rear cabin windows, new "air cushion" flaps and fully-reclining, track-mounted individual seats were additional improvements. The Travel Air will fly four or five people and their luggage more than 1,000 miles nonstop with an average fuel consumption of 18 gallons an hour and requires a takeoff or landing run of only 1,000 feet at its maximum gross weight.

SPECIFICATIONS

Span 37 ft. 10 in.; Length 25 ft. 4 in.; Height 9 ft. 6 in.; Empty Weight 2555 lb.; Gross Weight 4200 lb.; Wing Loading 21.1 lb. per sq. ft.; Power Loading 11.7 lb. per bhp; Engines Two Lycoming IO-360-B1A, 180 hp normal rates; Fuel Capacity 112 gal.; Propeller 72 in. 2-blade Hartzell, hydraulically controlled, continuously variable pitch, full feathering; Wing Area 199.2 sq. ft.; Aileron Area 11.5 sq. ft.; Flap Area 21.3 sq. ft.; Fin Area 16.97 sq. ft.; Rudder Area 6.63 sq. ft.; Stabilizer Area 27.4 sq. ft.; Elevator Area 15.0 sq. ft.

PERFORMANCE

Maximum Speed 210 mph at 180 hp at 2700 rpm at Sea Level; Cruise Speed 200 mph at 135 hp at 2450 at 7500 ft.; Landing Speed 70 mph; Rate of Climb 1250 fpm at Sea Level; Service Ceiling 18,100 ft.; Absolute Ceiling 19,700 ft.; Range with Maximum Fuel Load 1170 mi.

BEECHCRAFT MODEL 65 QUEEN AIR

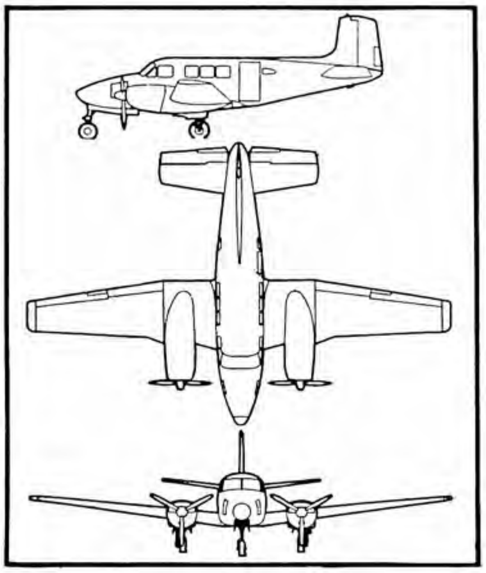
BEECH AIRCRAFT CORP., Wichita I, Kansas

REMARKS

Introduced in 1960, the Beechcraft Model 65 Queen Air is a completely new, six- to eight-place, twin-engine executive transport offering individual reclining chairs and custom interior arrangements designed to match the passenger comfort features of the modern airliner. The Queen Air in just two years of production has been widely accepted by U.S. corporations and both government and civilian customers of 14 nations in Europe, South America and Asia. The Queen Air offers optional factory-installed standby rocket power (JATO), Cagle brakes, oxygen system and weather-avoidance radar.

SPECIFICATIONS

Span 45 ft. 10.5 in.; Length 33 ft. 4 in.; Height 14 ft. 2 in.; Empty Weight 4660 lb.; Gross Weight 7700 lb.; Wing Loading 27.8 lb. per sq. ft.; Power Loading 12.03 lb. per bhp; Engines Two Lycoming Six Cylinder Fuel Injection IGSO-480-A1 B6 Supercharged; 340 hp at 3400 rpm takeoff; Fuel Capacity 230 gal.; Propeller Two Hartzell 3-blade, full-feathering Aluminum alloy, constant speed, hydraulically controlled; Wing Area 277.06 sq. ft.; Aileron Area 13.8 sq. ft.; Flap Area 29.3 sq. ft.; Fin Area 14.25 sq. ft.; Rudder Area 12.77 sq. ft.; Stabilizer Area 47.25 sq. ft.; Elevator Area 17.87 sq. ft.



PERFORMANCE

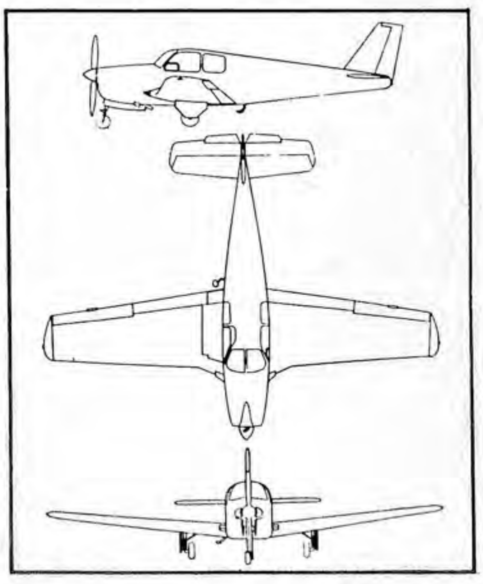
Maximum Speed 239 mph at 320 hp at 3200 rpm at 12,000 ft.; Cruise Speed 214 mph at 224 hp at 2750 rpm at 15,200 ft.; Landing Speed 80 mph; Rate of Climb 1300 fpm at Sea Level; Service Ceiling 31,300 ft.; Absolute Ceiling 32,700 ft.; Range with Maximum Payload 1220 mi. (45 min. reserve); Range with Maximum Fuel Load 1220 mi. (45 min. reserve).

BEECHCRAFT A33 DEBONAIR

BEECH AIRCRAFT CORP., Wichita 1, Kansas

REMARKS

The single-engine, low-wing, four-place Debonair grew steadily in popularity during its second year of production. The 225 horsepower fuel injection Continental engine provides economical operation. Styling distinction, large luggage space, durability and ease of flying are standout features. The Debonair is licensed at maximum gross weight in the utility category and is built and tested with an ultimate design load factor of 6.6 times its gross weight. Third side window, autopilot and auxiliary wing fuel tanks are optional.



SPECIFICATIONS

Span 32 ft. 10 in.; Length 25 ft. 6 in.; Height 8 ft. 3 in.; Empty Weight 1745 lb.; Wing Loading 16.9 lb. per sq. ft.; Power Loading 13.3 lb per bhp; Engines Continental Six-Cylinder Fuel Injection IO-470-K, 225 hp normal rated; Fuel Capacity 70 gal.; Propeller Hartzell 84 in., hydraulically controlled, continuously variable pitch; Wing Area 177.6 sq. ft.; Aileron Area 11.5 sq. ft.; Flap Area 21.3 sq. ft.; Fin Area 9.1 sq. ft.; Rudder Area 4.6 sq. ft.; Stabilizer Area 12.16 sq. ft.; Elevator Area 15 sq. ft.

PERFORMANCE

Maximum Speed 195 mph at 225 hp at 2600 rpm at Sea Level; Cruise Speed 185 mph at 169 hp at 2450 rpm at 7000 ft.; Landing Speed 60 mph; Rate of Climb 960 fpm at Sea Level; Service Ceiling 18,400 ft.; Absolute Ceiling 20,500 ft.; Range with Maximum Payload 1160 mi.; Range with Maximum Fuel Load 1160 mi.

BEECHCRAFT MODEL 55 BARON

BEECH AIRCRAFT CORP., Wichita 1, Kansas

REMARKS

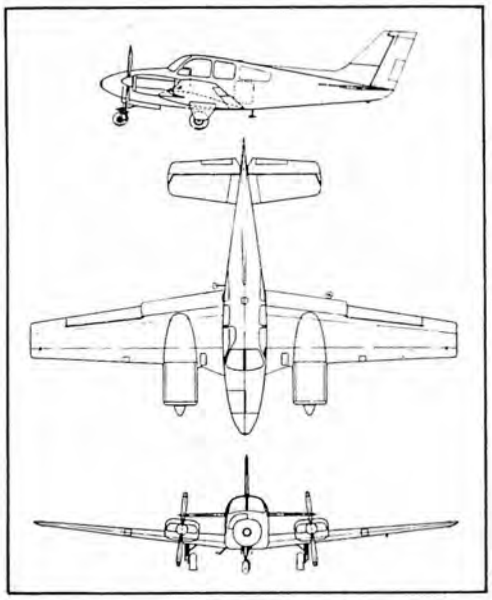
An enthusiastic reception was accorded Beechcraft's newest airplane, the Beechcraft Model 55 Baron, presented to the business airplane market in 1961. High cruise speed and long range were acclaimed by owners of the five-place, twin-engine Baron. Outstanding single-engine performance and high gross weight were also star attractions. Swept-back tail and flat engine nacelles contribute to clean aerodynamic design. Cabin appointments feature fully reclining chairs, large windows and full-size fifth seat.

SPECIFICATIONS

Span 37 ft. 10 in.; Length 26 ft. 8 in.; Height 9 ft. 7 in.; Empty Weight 2,960 lb.; Gross Weight 4,880 lb.; Wing Loading 24.5 lb. per sq. ft.: Power Loading 9.4 lb. per bhp; Engines Two 6-cylinder Continental IO-470-L rated at 260 at 2,625 rpm all operations, fuel injection; Fuel Capacity 140 gal.; Propeller two-blade, constant speed, full-feathering, hydraulically controlled; Wing Area 199.2 sq. ft.; Aileron Area 11.4 sq. ft.; Flap Area 25.7 sq. ft.; Fin Area 11 sq. ft.; Rudder Area 11.6 sq. ft.; Stabilizer Area 31.8 sq. ft.; Elevator Area 16.2 sq. ft.

PERFORMANCE

Maximum Speed 236 mph at 260 hp at 2,625 rpm at Sea Level; Cruise Speed 225 mph at 195 hp at 2,450 rpm at 7,000 ft.; Landing Speed 76 mph; Rate of Climb 1,700 fpm at Sea Level; Service Ceiling 20,000 ft.; Absolute Ceiling 21,200 ft.; Range with Maximum Fuel Load 1,225 mi. (with 45-minute reserve).



BELL XV-3 (MODEL 200)

BELL HELICOPTER COMPANY, Fort Worth 1, Texas

REMARKS

The XV-3 was first VTOL of fixed-wing, tilting prop-rotor design to achieve full in-flight conversion. It is being developed by Bell for the Army and in 1961 was undergoing NASA tests. The XV-3 has been converted fully in flight more than 100 times.

SPECIFICATIONS

Span 31 ft. 3 in.; Length 30 ft. 4 in.; Height 13 ft. 9 in.; Empty Weight 4089 lb.; Rotor Diameter 23 ft.; Wing Loading 40 lb. per sq. ft.; Power Loading 9.1 lb. per bhp; Engines (1) P&W R985, 450 hp normal rated, or 450 hp at 2300 rpm takeoff; Fuel Capacity 100 gal.; Propeller 23 ft. dia.; Wing Area 116 sq. ft.; Aileron Area 9.4 sq. ft.; Flap Area 10 sq. ft.; Fin Area 32.8 sq. ft.; Rudder Area 5.5 sq. ft.; Stabilizer Area 32.6 sq. ft.; Elevator Area 13.9 sq. ft.

PERFORMANCE

Maximum Speed 150 mph; Cruise Speed 130 mph at 400 hp at 310 Rotor/2200 Engine rpm at 7500 ft.; Rate of Climb 1000 fpm at 4000 ft.; Service Ceiling 12,000 ft.; Absolute Ceiling 15,000 ft.; Range with Maximum Payload 140 mi.; Range with Maximum Fuel Load 325 mi.

BELL 47G-2A; H-13H SIOUX (ARMY)

BELL HELICOPTER COMPANY, Fort Worth 1, Texas

REMARKS

Model 47G-2A is latest version of the 47G-2, most widely-used commercial helicopter in the world. Utilizing longer main rotor blades and longer fuselage, plus increased horsepower, the 47G-2A can carry 325 pounds more payload than the 47G-2.

The new model features spacious cabin comfort for pilot and two passengers, is rugged, dependable and has low operating cost. It's ideal for crop-dusting, surveying, powerline patrol, offshore oil work, ranching, law-enforcement, mapping and many other jobs.

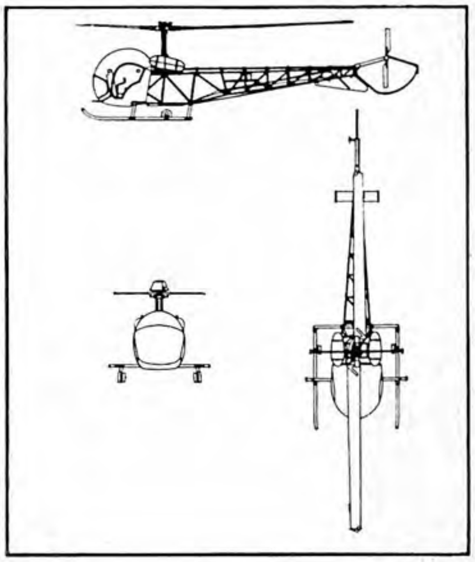
Military version of the 47G-2A's predecessor 47G-2 is the Army's H-13H Sioux, used for evacuation, observation, reconnaissance, training and other duties.

SPECIFICATIONS

Main Rotor Diameter 37 ft. 2 in.; Length 31 ft. 7 in.; Height 9 ft. 4 in.; Empty Weight 1638 lbs.; Maximum Gross Weight 2850 lbs.; Useful Load 1212 lbs.; Engine One Lycoming VO-435, 250 hp at 3200 rpm; 240 hp takeoff; 220 hp maximum continuous; Fuel Capacity 43 gal.

PERFORMANCE

Maximum Speed (VNE) 105 mph at Sea Level; Maximum Recommended Cruise Speed at 3000 ft.: 95 mph (at 2050 lbs. gross wt.) and 86 mph (at 2850 lbs. gross wt.); Service Ceiling 17,200 ft. (at 2050 lbs.) and 9000 ft. (at 2850 lbs.); Hovering Ceiling IGE 13,000 ft. (at 2050 lbs.) and 4500 ft. (at 2850 lbs.); Range with no reserve 243 miles (at 2050 lbs.) and 202 miles (at 2850 lbs.)



BELL 47G-3B

BELL HELICOPTER COMPANY, Fort Worth 1, Texas

REMARKS

The turbo-supercharged 47G-3B made headlines shortly before its introduction to the commercial market in 1961 by proving it had a whole new range of high-altitude capabilities. In tests in the Pikes Peak area the ship was hovered out of ground effect over an 11,837-foot elevation at a gross weight of 3,472 pounds—more than double its basic empty weight of 1,713 pounds.

SPECIFICATIONS

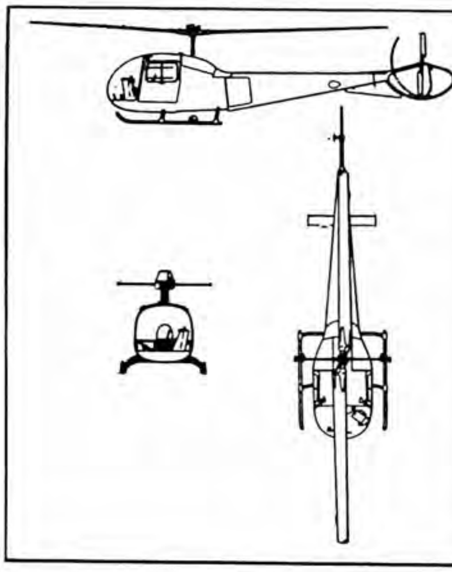
Main Rotor Diameter 37 ft. 2 in.; Length 31 ft. 7 in.; Height 9 ft. 4 in.; Empty Weight 1713 lbs.; Maximum Gross Weight 2,850 lbs.; Useful Load 1137 lbs.; Engine Lycoming TVO-435, 260 hp at 3200 rpm, 220 hp maximum continuous; Fuel Capacity 41 gal.

PERFORMANCE

Maximum Speed (VNE) 105 mph (at 5000 ft.); Maximum Recommended Cruise Speed (at 5000 ft.) 95 mph at 2250 lbs.; 90 mph at 2650 lbs.; 87 mph at 2850 lbs.; Service Ceiling 20,000 ft. plus; Hovering Ceiling IGE 20,000 ft. plus at 2450 lbs.; 18,000 ft. at 2850 lbs.; Hovering Ceiling OGE 18,700 ft. at 2450 lbs.; 15,000 ft. at 2850 lbs.; Range (no reserve, 5000 ft.) 216 miles at 2450 lbs., 192 miles at 2850 lbs.

BELL 47J-2 RANGER; H-13J (AIR FORCE); HUL-1 (NAVY AND COAST GUARD)

BELL HELICOPTER COMPANY, Fort Worth 1, Texas



REMARKS

The 47J-2 Ranger set two world records in 1961. The Ranger is a deluxe, four-place ship, plushest commercial helicopter in the world. Aside from its beauty and comfort, the Ranger, since it went on the civilian market in 1957 as the 47J, has proved its high performance capabilities throughout the world on jobs ranging from executive transport in metropolitan centers to gruelling work in isolated polar regions and equatorial jungles. President Eisenhower was the first U.S. chief executive to fly by helicopter when he rode the Air Force version of the Ranger (H-13J) in 1957. Navy and Coast Guard models of the Ranger (HUL-1) are used as utility helicopters.

SPECIFICATIONS

Main Rotor Diameter 37 ft. 2 in.; Length 32 ft. 5 in.; Height 9 ft. 4 in.; Empty Weight 1730 lbs.; Maximum Gross Weight 2850 lbs.; Useful Load 1120 lbs.; Engine One Lycoming VO-540, 305 hp at 3200 rpm; 260 hp takeoff; 220 hp maximum continuous; Fuel Capacity 48 gal. (with optional larger tanks).

PERFORMANCE

Maximum Speed (VNE) 105 mph; Maximum Recommended Cruise Speed (at 5000 ft.) 103 mph at 2220 lbs. Gross Wt. and 93 mph at 2850 lbs. Gross Wt.; Service Ceiling 17,800 ft. (at 2220 lbs. Gross Wt.) and 12,100 ft. (at 2850 lbs. Gross Wt.); Hovering Ceiling IGE 15,400 ft. (at 2220 lbs. Gross Wt.) and 9,100 ft. (at 2850 lbs. Gross Wt.); Range with no reserve 288 miles (at 2220 lbs. Gross Wt.) and 260 miles (at 2850 lbs. Gross Wt.).

BELL 204
HU-1 IROQUOIS SERIES (ARMY)

BELL HELICOPTER COMPANY, Fort Worth 1, Texas

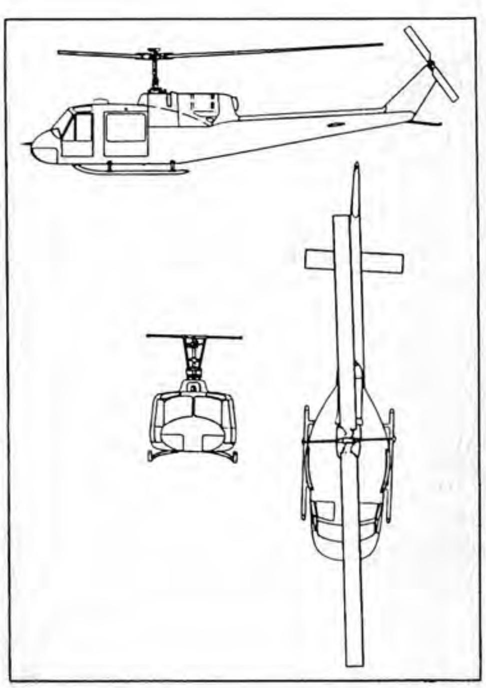
REMARKS

The HU-1 Iroquois Series Bell makes for the U.S. Army has made more rotary-wing news since its inception than any other model in helicopter history. It won industry-wide design competition in 1955, was the Army's first production-line turbine-powered helicopter and in 1960 set six world rotary-wing records with headline-making performances under adverse conditions in Texas summer temperatures.

The Iroquois features speed, easy field maintenance and ruggedness. It has been called the most thoroughly-tested helicopter model in the world, having survived the torture of prolonged sub-zero maneuvers in the Arctic and in 120-degree Arizona desert heat. The Army has awarded Bell multi-million-dollar contracts for undisclosed numbers of the Iroquois, which can outclimb some World War II fighter planes. It now is operational with the Army. Designed as a six-place ship originally, the Army has hauled as many as 10 combat troops on maneuvers. Iroquois Models HU-1A and HU-1B are now operational with the Army, and the advanced YHU-1D went into Phase I flight test program in 1961. The latter model will carry a pilot and 12 fully-equipped soldiers. Bell in 1961 received a $54,000,000 order from the U.S. Army for 274 HU-1Bs and eight HU-1Ds and a $4,100,000 order from the Australian government for Model 204B ships, basically same as the U.S. Army's HU-1B. Bell in 1961 signed manufacturing licensing agreements for 204B production with Mitsui & Co., Ltd. of Japan and Costruzioni Aeronautiche Giovanni Agusta of Italy.

SPECIFICATIONS

Rotor Diameter 44 ft.; Length 42 ft. 8 in.; Height 11 ft. 4 in.; Engine—HU-1A One Lycoming T53-L-1A, 860 hp at 6400 rpm; HU-1B One Lycoming T53-L-5, 960 hp at 6400 rpm; 204B One Lycoming T53-L-9, 1100 hp at 6600 rpm; Maximum Gross Weight HU-1A, 7200 lb.; HU-1B and 204B, 8500 lb.; Useful Load HU-1A, 3261 lb.; HU-1B, 4131 lb.; 204B, 4182 lb.; Empty Weight HU-1A, 3939 lb.; HU-1B, 4369 lb.; 204B, 4318 lb.



PERFORMANCE

Maximum Recommended Cruise Speed: HU-1A, 121 mph; HU-1B and 204B, 128 mph; Maximum Speed VNE: HU-1A, 121 mph; HU-1B, 139 mph; 204B, 145 mph; Service Ceiling: HU-1A, 13,600 ft.; HU-1B, 14,400 ft.; 204B, 16,900 ft. NRP; Hovering Ceiling IGE: HU-1A, 15,000 ft.; HU-1B, 15,400 ft.; 204B, 17,400 ft. MRP; Range (no reserve) In Statute Miles: HU-1A, 248; HU-1B and 204B, 288; Fuel Tank Capacity: HU-1A, 155 gal.; HU-1B and 204B, 165 gal.

BOEING 707 MODEL 120 JET TRANSPORT

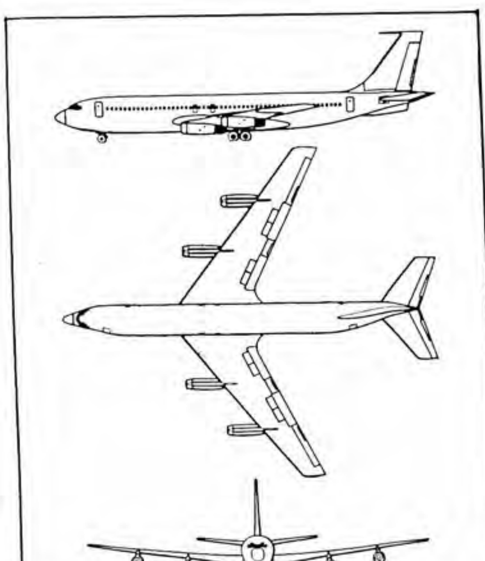
THE BOEING COMPANY, Seattle 24, Washington

REMARKS

The first production airplane of the Boeing 707 commercial jet series made its maiden flight December 20, 1957, with Pan American World Airways putting the airplane into trans-oceanic service October 26, 1958, and American Airlines following with transcontinental service January 25, 1959.

The prototype jet airliner, built as a private venture by Boeing at a cost of more than $16,000,000, amassed more than 1000 hours in its first four years of flight testing, while the first three of the production airplanes used for Civil Aeronautics Administration certification testing raised the overall total to more than 1650 hours. In addition, the new jet transports benefited by the thousands of hours of flight time logged by their military counterpart, the Boeing KC-135 jet multipurpose tanker-transports which went into service in 1957.

Including the prototype, there are nine Boeing jet airliners; the others are the 707-120, the 707-120B, the 707-220, the 707-320, the 707-320B, the 707-420, the 720 and the 720B. Weighing in at 248,000 pounds as compared with the prototype's 190,000, the -120 is principally intended for continental use. The -220 is identical in airframe and body size to the -120, but is powered by Pratt & Whitney JT4 turbojet engines, larger and of greater thrust than the JT3. The "B" airplanes use Pratt & Whitney JT3D turbofan engines.



SPECIFICATIONS (-120)

Span 130 ft. 10 in.; Height 42 ft.; Length 144 ft. 6 in.; Engines Four Pratt & Whitney JT3C-6 turbojet, more than 10,000 lb. thrust; Gear tricycle, main undercarriage units, four-wheel trucks, dual nose wheels.

PERFORMANCE

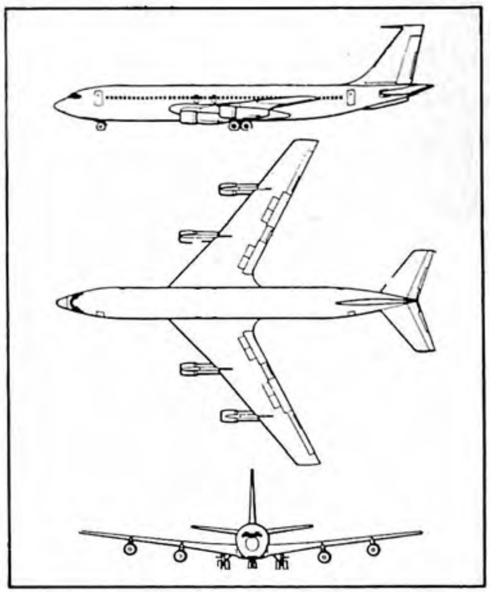
Cruise Speed 591 mph; Cruising Altitude 25,000 to 40,000 ft.

BOEING 707 INTERCONTINENTAL JET TRANSPORT

THE BOEING COMPANY, Seattle 24, Washington

REMARKS

The -320 and the -420 are the Intercontinental 707s, which partially fulfill the growth potential Boeing designed into the basic 707 series. Weighing more than 295,000 pounds, they are 8 feet, 5 inches longer overall than the -120, -220, and 720, have 11 feet 7 inches more wingspan, and 500 square feet of additional wing area. Fuselage diameter, 148 inches, is the same in all models. Only difference between the -320 and -420 is the engines, the former using Pratt & Whitney JT4s and the latter Rolls-Royce "Conways."



SPECIFICATIONS (INTERCONTINENTAL)

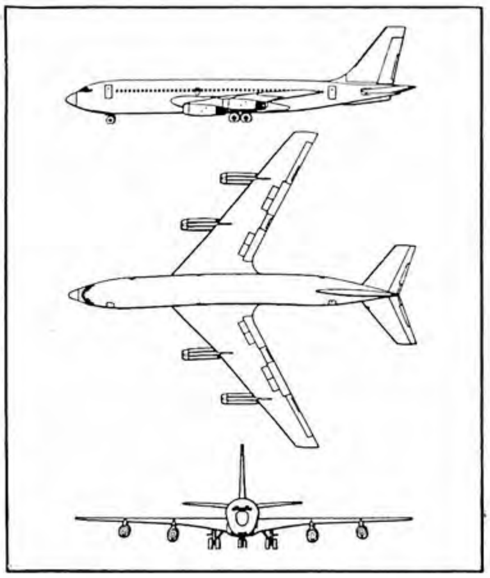
Span 142 ft. 5 in.; Height 42 ft.; Length 152 ft. 11 in.; Engines Four Pratt & Whitney JT4 or Rolls Royce Conway turbojets, more than 10,000 lb. thrust; Gear tricycle, main undercarriage units, four-wheel trucks, dual nose wheels.

PERFORMANCE

Cruise Speed 591 mph; Cruising Altitude 25,000 to 40,000 ft.

BOEING 720B JET TRANSPORT

THE BOEING COMPANY, Seattle 24, Washington



REMARKS

Designed to operate profitably in the medium range area, the Boeing 720 combines low cost with excellent operational flexibility. Associated with its capability to operate over existing route segments is the ability of the 720 to utilize present runways and terminal facilities throughout the entire airline system. The 720 offers a high level of safety, ease of maintenance and inspection, long life, minimum structural weight and reliability based on experience and extensive test programs. The seats are mounted on continuous tracks recessed in the floor, allowing use of four, five and six-abreast seating. In less than ten minutes each row of seats and its accompanying overhead service unit can be repositioned or replaced. Windows are spaced at 20-inch intervals to insure an unobstructed view regardless of seat spacing. This flexibility permits a choice of seating combinations ranging from the luxurious four-abreast interior to the six-abreast, 165-passenger tourist arrangement.

SPECIFICATIONS

Span 130 ft. 10 in.; Length 136 ft. 2 in.; Height 41 ft. 6.5 in.; Empty Weight 104,763 lb.; Engines Four Pratt & Whitney JT3C-7; Fuel Capacity 10,092 gal.; Wing Area 2433 sq. ft.

PERFORMANCE

Maximum Speed more than 600 mph; Maximum Range 3300 mi.; Cruising Altitude 15,000 to 40,000 ft.

BOEING KC-135A JET TANKER-TRANSPORT

THE BOEING COMPANY, Seattle 24, Washington

REMARKS

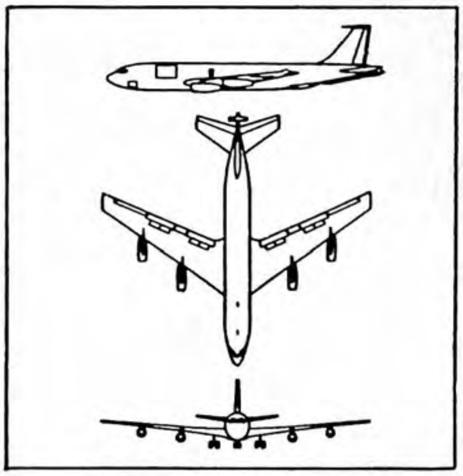
KC-135s are now in service with the Air Force, replacing the KC-97 as the Air Force's standard multi-purpose aerial refueling tanker-transport. The last of 888 KC-97s built by Boeing at Renton was rolled out only moments before the first appearance of the KC-135. The high-speed Flying Boom refueling equipment with which the KC-135 is equipped was flight-tested earlier on the Boeing 707 prototype. Soon after being placed in operational status with SAC, the KC-135 set a series of new records. More than 500 have been delivered to the Strategic Air Command. First of the C-135A transports, externally the same as the KC-135 except for the absence of the flying boom, was delivered to MATS in June. C-135Bs, also ordered in 1961, will be turbofan-powered.

SPECIFICATIONS

Span 130 ft. 10 in.; Length 136 ft. 3 in.; Sweepback 35 deg.; Height 38 ft. 5 in.; Weight more than 250,000 lb.; Engines Four Pratt & Whitney J57 turbojet, 10,000 lb. thrust class; Gear tricycle, main undercarriage units, four-wheel trucks, dual nose wheels.

PERFORMANCE

Speed more than 600 mph; Ceiling more than 35,000 ft.; Range more than 4000 mi.



BOEING B-52H MISSILE PLATFORM BOMBER

THE BOEING COMPANY, Seattle 24, Washington

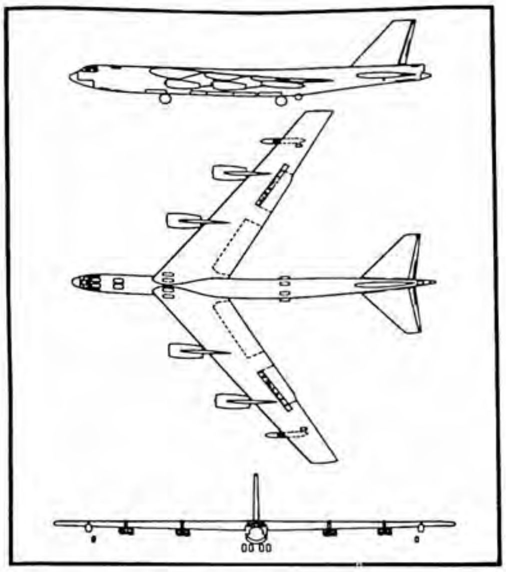
REMARKS

The first production model of the B-52G was rolled from the Boeing plant in Wichita, Kansas, July 23, 1958.

The new Stratofortress can span oceans and return to bases in the United States without refueling, and will carry two GAM-77 "Hound Dog" air-to-surface missiles which can be released hundreds of miles from their targets. The missiles are in addition to the Stratofort's prime bomb load which can be saved for still another target.

A new fuel system and new type of engine enable the B-52G to fly at sustained speeds in excess of 650 miles an hour without the range-limiting fuel efficiency penalty associated with bombers capable of brief supersonic dashes. Principal feature of the fuel system is the wing in which integral tank construction forms virtually one huge fuel tank of the entire wing.

The B-52F was phased out in 1959. Production on the "G" continued through 1960 when it was replaced by the new "H" model, the first of which was rolled out late in the year. The "H" model has all of the capabilities of the "G", plus other advancements, including Pratt & Whitney TF33 turbofan engines which stretches the bomber's unrefueled range of "more than 9000 miles" by a good margin.



SPECIFICATIONS

Span 185 ft.; Length 157 ft. 6.9 in.; Sweepback 35 deg.; Height 40 ft. 8 in.; Weight more than 450,000 lb.; Engines Eight Pratt & Whitney TF33 turbojet, more than 10,000 lb. thrust class; Gear eight main wheels in tandem with single outrigger wheels near wing tips.

PERFORMANCE

Very high-speed, long-range heavy bomber with a service ceiling over 50,000 feet, speed more than 650 miles per hour, and unrefueled range of more than 9,000 miles.

BOEING RB-47E MEDIUM BOMBER

THE BOEING COMPANY, Wichita, Kansas

REMARKS

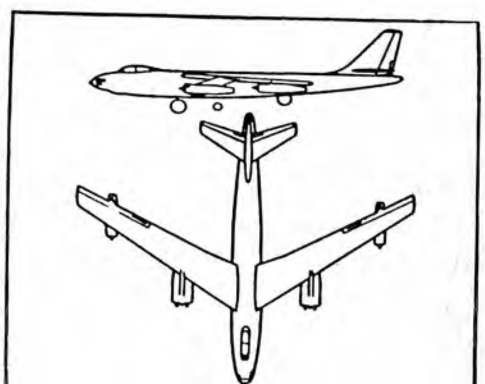
The first XB-47 flight took place December 17, 1947, and more than 1300 have been built. The RB-47E differs from the standard model in having a longer nose, more windows, and air-conditioned camera compartment in place of bomb bay. Crew for this model are pilot, copilot riding in tandem, and observer-photographer. Among the features of the B-47 are the thin flexible wings which have a drooped appearance on the ground changing to a slight dihedral in flight. A B-47 set a new jet endurance record during 1954 with a 21,000 mile flight in 47 hours and 35 minutes with the aid of aerial refueling. Crew: three.

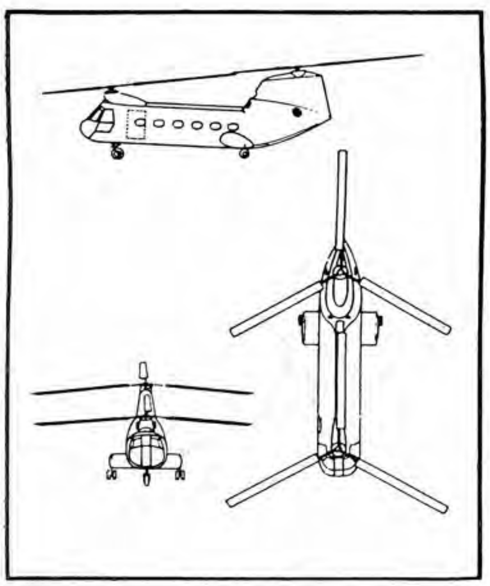
SPECIFICATIONS

Span 116 ft.; Sweepback 35 deg.; Length 107 ft.; Height 28 ft.; Gross Weight more than 200,000 lb.; Normal Bomb Load more than 20,000 lb.; Engines Six General Electric J47, 6000 lb. thrust normal rated; Provisions for 33 external ATO units, 1000 lb. each and water injection systems providing 17 percent power increase; Gear dual main wheels in tandem with a single outrigger under each inboard pod.

PERFORMANCE

Maximum speed more than 600 mph; Service Ceiling over 40,000 ft.; Range more than 3000 mi.





VERTOL 107

VERTOL DIVISION, THE BOEING COMPANY, Morton, Pennsylvania

REMARKS

The Boeing Vertol 107 is a multi-purpose transport helicopter powered by two General Electric T58 gas turbine engines. It was designed for commercial or military use and is available in airliner or utility versions. The Boeing Vertol 107 cruises at 155 miles an hour and can operate with the same safety as twin-engine airplanes over built-up areas. Forerunner of the production models is the Boeing Vertol 107 prototype which first flew in April, 1958. Slightly different in detail from production-line Boeing Vertol 107s, the prototype gave a preview of the multi-engine reliability, built-in flotation, and low vibration and sound levels that are features of Boeing Vertol 107s now in production. Other features of the Boeing Vertol 107 include the unequalled loading flexibility, all-weather day-and-night operational capability, straight-in loading through a rear-fuselage ramp, isolation of engine and drive shafts from the cabin, and, for airline operations, a removable baggage unit that fits into the rear fuselage. Boeing Vertol 107s have been ordered by commercial airlines and military services in North America, Europe and Asia. A special version of the 107, designated HRB-1 Sea Knight, won the U.S. Navy competition for a Marine assault transport helicopter.

SPECIFICATIONS

Rotor Diameter 50 ft.; Fuselage Length 44 ft. 7 in.; Gross Weight 19,000 lbs.; Engines two General Electric T58 gas turbines.

PERFORMANCE (UTILITY VERSION)

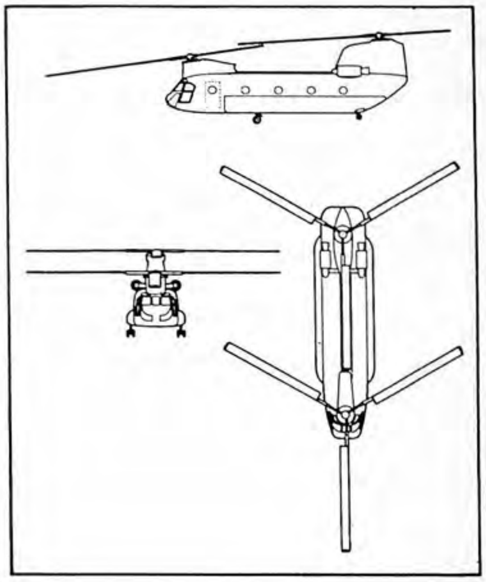
Cruising Speed 150 mph; payload 7,600 lbs for 100 N. mi. range mission.

VERTOL HC-1B CHINOOK

VERTOL DIVISION, THE BOEING COMPANY, Morton, Pennsylvania

REMARKS

The powerful yet compact Boeing Vertol HC-1B Chinook is in production for the U.S. Army as a primary tactical transport aircraft to replace the Army's fleet of piston-engine transport helicopters. The Chinook can carry 33 fully equipped troops along with troop commander, or 24 litter patients and attendants. Maximum payload is more than seven tons. It can accommodate any component of the helicopter-transportable version of the Pershing missile system. It has a straight-in rear-loading ramp, a sealed fuselage that makes possible water-landings, and excellent control features for cross-wind and turbulent conditions. Powered by two Lycoming T-55 engines each producing 2,200 shaft horsepower, it cruises at 150 miles an hour. The Chinook's rear-loading ramp, which is operated hydraulically, can be left open in flight so that loads longer than the cabin can be carried. It can also be opened in flight for air-dropping troops or supplies. The aircraft is also capable of serving as a "flying crane" for lifting externally carried loads by means of the cargo-hook installed in the bottom of the fuselage. The Chinook's control system incorporates the Army Signal Corps-developed Universal Flight Control System and the Boeing Stability Augmentation System, which give the HC-1B Chinook stability characteristics similar to fixed-wing aircraft. By mid-1961 a total of 28 Chinooks had been ordered for the U.S. Army.



SPECIFICATIONS

Maximum Height (from ground) 18 ft. 7 in.; Rotors two three-bladed rotors (in tandem) each 59 ft. in diameter; Gross Weight 33,000 lbs.; Cabin Length 30 ft.; Engines two Lycoming T-55 gas turbines each producing 2200 shaft horsepower.

PERFORMANCE

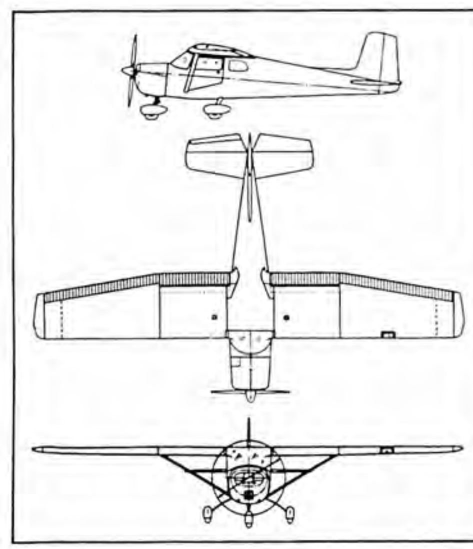
Cruising Speed 150 mph; Payload more than 6 tons for 100 N. mi. radius mission.

CESSNA MODEL 150

CESSNA AIRCRAFT CO., Wichita, Kansas

REMARKS

The sporty Model 150 in Cessna's "Anniversary Fleet" features a host of new '62 advancements including increased cruise and climb performance, redesigned with tips, and will be the only airplane in the low-priced field offering optional "family seating" for four persons. The 150 is available in three versions; the standard, the intercity commuter, and the trainer. Engineering design refinements in the '62 Model 150 have increased the cruise speeds and rate of climb. Completely redesigned wing tips incorporate faired navigation lights, smoother contours, and surface. In addition to a standard adjustable back seat the new 150 has a large airplane capability with an optional "family seat" quickly installed behind the two regular seats. The family seat, which has a capacity of 80 pounds, makes the 150 the lowest cost two to four place airplane on the market. Standard on the all metal 150 are Land-O-Matic gear and Para-Lift Flaps.



SPECIFICATIONS

Span 33 ft. 6 in.; Length 21 ft. 6 in.; Height 7 ft. 10 in.; Empty Weight 945 lb.; Gross Weight 1500 lb.; Wing Loading 9.4 lb. per sq. ft.; Power Loading 15 lb. per bhp; Engine Continental 0-200A; 100 rated hp at 2750 rpm takeoff; Fuel Capacity 26 std. 38 opt. gal.; Propeller Fixed Pitch Metal; Wing Area 160 sq. ft.; Aileron Area 17.88 sq. ft.; Flap Area 17.24 sq. ft.; Fin Area 7.79 sq. ft.; Rudder Area 6.32 sq. ft.; Stabilizer Area 17.38 sq. ft.; Elevator Area 11.14 sq. ft.

PERFORMANCE

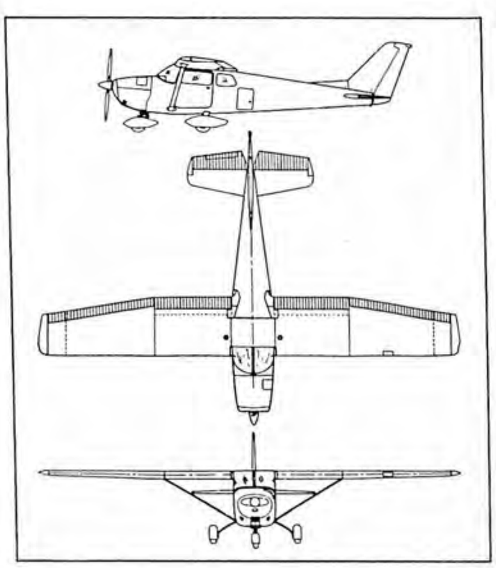
Maximum Speed 127 mph at 100 hp at 2750 rpm at Sea Level; Cruise Speed 125 mph at 75 percent power at 2650 rpm at 7500 ft.; Landing Speed 50 mph with flaps down; Rate of Climb 760 fpm at Sea Level; Service Ceiling 15,600 ft.; Range with Maximum Payload 500 mi.; Range with Maximum Fuel Load 945 mi.

CESSNA MODEL 172

CESSNA AIRCRAFT CO., Wichita, Kansas

REMARKS

The 1962 Cessna Model 172 has many new and expanded features including an increased gross weight and useful load, optional seating for six persons, new wing tips plus new interior and exterior styling. Gross weight of the airplane has increased expanding the useful load from 949 to 990 pounds. Available for the first time is a new "family seat" with a capacity of 120 pounds. The seat may be quickly installed behind the present rear seats, converting the airplane into a five or six passenger vehicle. New wing tips incorporate faired navigation lights and squared trailing edges for aerodynamic cleanliness. A new sleek nose spinner complements the redesigned exterior color design. The all-metal 172 and its companion model, the Skyhawk, are the only airplanes in their class offering high wing stability so popular with businessman pilots. Also featured are the Cessna "Land-O-Matic" gear, for simplified landings and ground handling, and large "Para-Lift" flaps for increased lift or easy descents. The 172 is also available as a float plane.



SPECIFICATIONS

Span 36 ft. 2 in.; Length 26 ft. 6 in.; Height 8 ft. 11 in.; Empty Weight 1260 lb.; Gross Weight 2250 lb.; Wing Loading 12.9 lb. per sq. ft.; Power Loading 15.5 lb. per bhp; Engine Continental 0-300-C; 145 rated hp at 2700 rpm takeoff; Fuel Capacity 42 gal.; Propeller Fixed Pitch Metal; Wing Area 175 sq. ft.; Aileron Area 18.3 sq. ft.; Flap Area 21.23 sq. ft.; Fin Area 10.76 sq. ft.; Rudder Area 7.28 sq. ft.; Stabilizer Area 19.72 sq. ft.; Elevator Area 14.87 sq. ft.

PERFORMANCE

Maximum Speed 139 mph at 145 hp at 2700 rpm at Sea Level; Cruise Speed 131 mph at 75 percent power at 7000 ft.; Landing Speed 52 mph with flaps down; Rate of Climb 700 fpm at Sea Level; Service Ceiling 14,550 ft.; Range with Maximum Payload 535 mi.; Range with Maximum Fuel Load 780 mi.

CESSNA SKYHAWK

CESSNA AIRCRAFT CO., Wichita, Kansas

REMARKS

Cessna's 1962 deluxe Skyhawk features increased gross weight and useful load, redesigned wing tips and speed fairings, plus completely new styling inside and out. Gross weight of the new airplane has increased over previous models expanding the useful load for the Skyhawk from 880 to 920 pounds. The expanded load carrying capability has been accomplished while retaining the airplane's top performance. Wing tips incorporate faired navigation lights and squared trailing edges for aerodynamic cleanliness. Speed fairings have new needle-nose sharpness complementing the sleek nose spinner. A newly designed "family seat" with a capacity of 120 pounds may be quickly installed behind the present rear seats, converting the airplane into a five or six passenger vehicle. Standard equipment on the Skyhawk includes an engine-driven vacuum system with horizon and directional gyros, a turn and bank indicator, rate of climb, sensitive altimeter, clock, outside air temperature gauge, wheel speed fairings, wing strut fairings, landing and taxilight, sun visors, tow bar, and navigation, lights. The all-metal Skyhawk features high wing stability, "Land-O-Matic" gear, for simplified landings and takeoffs, and large "Para-Lift" flaps. The Skyhawk is also available as a float plane.

SPECIFICATIONS

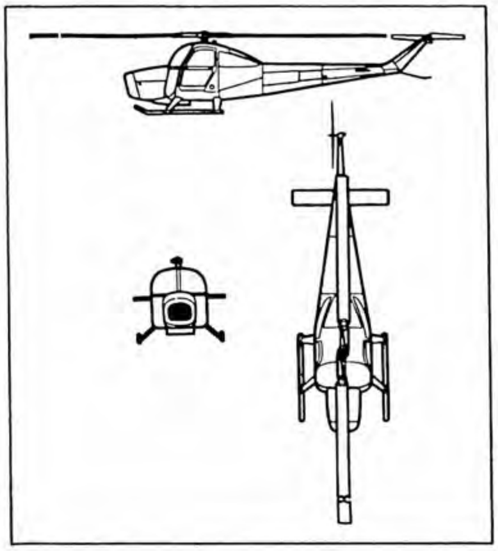
Span 36 ft. 2 in.; Length 26 ft. 6 in.; Height 8 ft. 11 in.; Empty Weight 1330 lb.; Gross Weight 2250 lb.; Wing Loading 12.9 lb. per sq. ft.; Power Loading 15.5 lb. per bhp; Engine Continental 0-300-D; 145 rated hp at 2700 rpm takeoff; Fuel Capacity 42 gal.; Propeller Fixed Pitch Metal; Wing Area 175 sq. ft.; Aileron Area 18.3 sq. ft.; Flap Area 21.23 sq. ft.; Fin Area 10.76 sq. ft.; Rudder Area 7.28 sq. ft.; Stabilizer Area 19.72 sq. ft.; Elevator Area 14.87 sq. ft.

PERFORMANCE

Maximum Speed 140 mph at 145 hp at 2700 rpm at Sea Level; Cruise Speed 132 mph at 75 percent power at 7000 ft.; Landing Speed 52 mph with flaps down; Rate of Climb 700 fpm at Sea Level; Service Ceiling 14,550 ft.; Range with Maximum Payload 540 mi.; Range with Maximum Fuel Load 780 mi.

CESSNA SKYHOOK

CESSNA AIRCRAFT CO., Wichita, Kansas



REMARKS

Cessna Aircraft Company's 1962 Anniversary Model Skyhook is the newest in-production rotary wing vehicle in the world. The new Skyhook is a four-place rotary-wing aircraft which embodies capabilities previously unavailable in light rotary-wing vehicles. Significant is the aircraft's stability, comparable to that of fixed-wing aircraft, which greatly simplifies handling characteristics. This stability, combined with the Skyhook's superior performance, qualifies the aircraft for the widest range of missions at high operational efficiency. Exceptional features of the new Skyhook include the largest cabin area of any four-place rotary-wing aircraft; 360° Omni-Vision in all directions; luxurious "executive interiors" which provide passenger comfort and complement the aircraft's modern design; excellent cabin heating as standard equipment; unusually wide doors for quick and easy loading and unloading, and spacious baggage and cargo facilities within the cabin. A combination utility and executive interior is available offering even greater mission utility. By quickly installing the large detachable pneumatic tires, the Skyhook is easily moved when on the ground. Mechanical simplicity is the keynote of design in the Skyhook. Every Skyhook system reflects engineering mindfulness of maintenance, performance, and operating simplicity. A minimum of moving parts throughout the drive system plus the simplified Cessna design rotor head promote maximum effectiveness in each of these areas. The Skyhook is the first and only rotor craft certificated for the IFR operation by the FAA.

SPECIFICATIONS

Length 510 in.; Height 101 in.; Empty Weight 2080 lb.; Gross Weight 3100 lb.; Fuel Capacity 60 gal.; Lifting Rotor Diameter 35 ft.; Tail Rotor Diameter 7 ft.; Engine Continental Supercharged FSO 526-A, 270 hp at 3000 rpm and 3200 rpm to 8,500 ft.

PERFORMANCE

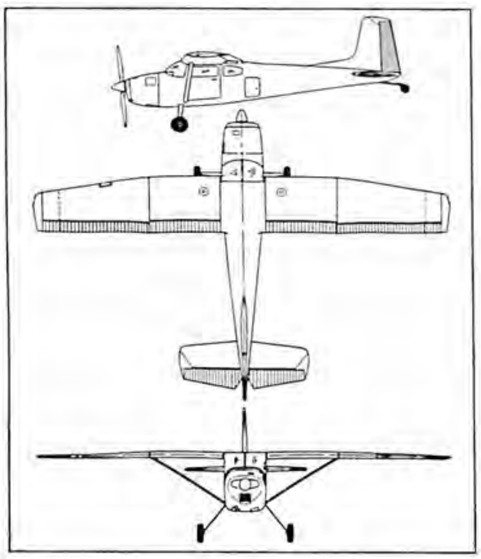
Maximum Speed 108 mph; Cruising Speeds 90-120 mph; Rate of Climb 1030 fpm at 8000 ft.; Hovering Ceiling 9,600 ft.; Range with Maximum Fuel Load 260 mi.

CESSNA MODEL 180

CESSNA AIRCRAFT CO., Wichita, Kansas

REMARKS

New features promoting increased versatility, range, and simplicity are the keynote of Cessna's Anniversary Model 180 for business and utility missions. A new fuel system in the new 180 increases usable fuel for greater range. Of the 65 gallons total capacity of the standard tanks, 60 gallons are usable in all flight attitudes. The new system increases the 180's range nearly ten percent. Also available as optional equipment is a long range fuel system which provides a total capacity of 84 gallons with 79 gallons usable in all flight attitudes. An auxiliary "family seat" available for installation behind the normal rear seats, provides transportability for additional persons. "Family seat" capacity is 120 pounds. Designed for rugged work-horse utility or charter missions, the 180 utilizes high wing stability for precise control and maximum lift. Perfectly matched to its mission are the Cessna Para-Lift flaps for maximum flexibility and safety under all conditions and the unsurpassed spring steel gear for ideal operation on every type of field. The 180 is certificated for amphibian operations, floats, and skis. First introduced in 1953, the 180 has been popular in both domestic and foreign markets for its excellent rough terrain capabilities as a passenger and cargo carrier. Since its introduction more than 4,000 units have been sold.

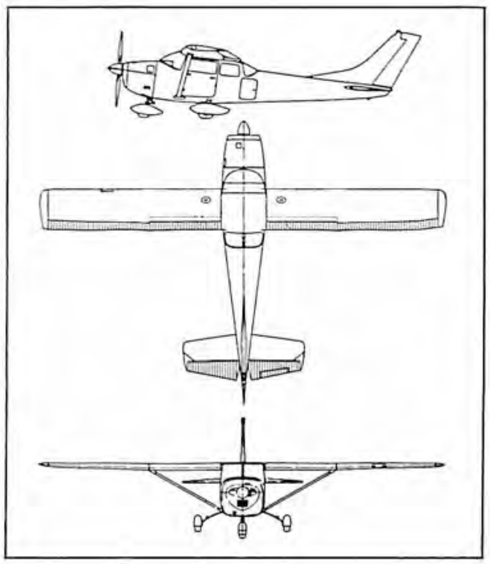


SPECIFICATIONS

Span 36 ft. 2 in.; Length 25 ft. 6 in.; Height 7 ft. 6 in.; Empty Weight 1515 lb.; Gross Weight 2650 lb.; Wing Loading 15.2 lb. per sq. ft.; Power Loading 11.5 lb. per bhp; Engine Continental 0-470-R; 230 rated hp at 2600 rpm takeoff; Fuel Capacity 65 std. 84 opt. gal.; Propeller Constant Speed; Wing Area 175 sq. ft.; Aileron Area 18.3 sq. ft.; Flap Area 21.23 sq. ft.; Fin Area 11.07 sq. ft.; Rudder Area 7.29 sq. ft.; Stabilizer Area 20.94 sq. ft.; Elevator Area 13.18 sq. ft.

PERFORMANCE

Maximum Speed 170 mph at 230 hp at 2600 rpm at Sea Level; Cruise Speed 162 mph at 75 percent power at 6500 ft.; Landing Speed 57 mph with flaps down; Rate of Climb 1130 fpm at Sea Level; Service Ceiling 21,500 ft.; Range with Maximum Payload 695 mi.; Range with Maximum Fuel Load 1215 mi.



CESSNA MODEL 182

CESSNA AIRCRAFT CO., Wichita, Kansas

REMARKS

The Cessna Model 182 and its companion model the Skylane set new standards for airplanes in their price and performance class. The 182 sports a new fuselage with higher, wider and longer cabin, 360° Omni-Vision cabin, increased gross weight and useful load, new fuel system, aileron control system, a redesigned panel with new lighting system, increased sound proofing and a host of other features. Gross weight of the 182 has increased 150 pounds to 2,800 pounds. The useful load has been expanded 140 pounds. Sophisticated refinements include relocation of radio speaker, interior lights, and extended window contour. Accentuating the "Anniversary Fleet" look are completely new color styling schemes inside and out. For the first time the 182 will feature an electric motor-driven flap actuator system. This and other new features on the 182 permits a completely flat floor between pilot and co-pilot seats and affords uncluttered foot and leg room in the cockpit. The wider cockpit and between seat area permits occupants to easily change seats while in flight. Complete redesign of the nose gear steering system combines two functions of rudder trim and nose gear steering into one simplified unit.

SPECIFICATIONS

Span 36 ft. 2 in.; Length 27 ft. 4 in.; Height 9 ft.; Empty Weight 1545 lb.; Gross Weight 2800 lb.; Wing Loading 16.0 lb. per sq. ft.; Power Loading 12.2 lb. per bhp; Engine Continental 0-470-R; 230 rated hp at 2600 rpm takeoff; Fuel Capacity 65 std. 84 opt. gal.; Propeller Constant Speed; Wing Area 175 sq. ft.; Aileron Area 18.3 sq. ft.; Flap Area 20.67 sq. ft.; Fin Area 11.62 sq. ft.; Rudder Area 6.95 sq. ft.; Stabilizer Area 20.94 sq. ft.; Elevator Area 15.13 sq. ft.

PERFORMANCE

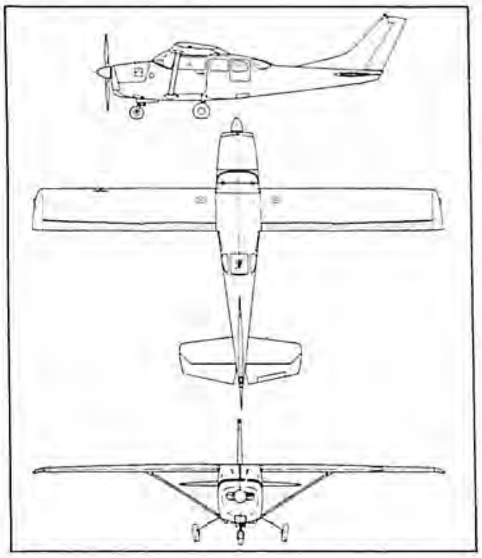
Maximum Speed 167 mph at 230 hp at 2600 rpm at Sea Level; Cruise Speed 159 mph at 75 percent power at 6500 ft.; Landing Speed 55 mph with flaps down; Rate of Climb 980 fpm at Sea Level; Service Ceiling 18,900 ft.; Range with Maximum Payload 685 mi.; Range with Maximum Fuel Load 1190 mi.

CESSNA MODEL 210

CESSNA AIRCRAFT CO., Wichita, Kansas

REMARKS

The all-new 1962 four-place Model 210 features a higher, wider, longer cabin section for passenger comfort and 360° Omni-Vision. The Anniversary Model 210 with high stability wings features a completely new fuselage, control system, fuel system, instrument panel, hydraulic system, exterior and interior styling, nose gear steering and rudder trim and more useful load. Company officials describe the new 210 as "the most stable, comfortable, and easy-to-fly, high-speed, single-engine airplane in the air." The new fuselage is wider, longer, more spacious. The floorboard has been lowered, the panel is lower, and the floor is completely flat. Combined with the expanded cabin area is a rear, wrap-around, "360° Omni-Vision" windshield offering panoramic view throughout the aircraft. A new tailcone, with added strength and weight reduction, utilizes a stronger frame forming a strong, light, semi-monocoque constructed cone. A new friction-free control system completely eliminates the control tee by rerouting countrol cables to promote smoother action and simplify servicing. A new fuel system increases usable fuel from 55 gallons to 63½ gallons. The new 210 has 3,000 pound gross weight with increased useful load of 90 pounds. Engine improvements on the 210 include a new integral type engine mount, a new fuel distribution valve, engine controls, heater system and relocation of engine oil drain plug. Larger size 6.00 x 6 wheels and tires are utilized on the main gear to improve handling and landing characteristics on rough fields. A new and more simple light-weight hydraulic system incorporates an "open center" power pack which does not require an accumulator for operation.



SPECIFICATIONS

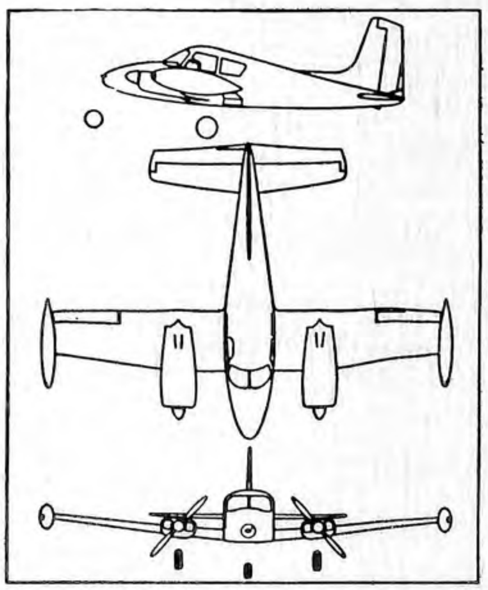
Span 36 ft. 7 in.; Length 27 ft. 4 in.; Height 9 ft. 9 in.; Empty Weight 1750 lb.; Gross Weight 3000 lb.; Wing Loading 17.1 lb. per sq. ft.; Power Loading 11.5 lb. per bhp; Engine Continental 6 cylinder, fuel injection 10-470-S; 260 rated hp at 2625 rpm takeoff; Fuel Capacity 65 std. 84 opt. gal.; Propeller Constant Speed; Wing Area 175.5 sq. ft.; Aileron Area 18.3 sq. ft.; Flap Area 20.77 sq. ft.; Fin Area 11.62 sq. ft.; Rudder Area 6.95 sq. ft.; Stabilizer Area 20.94 sq. ft.; Elevator Area 15.13 sq. ft.

PERFORMANCE

Maximum Speed 198 mph at 260 hp at 2625 rpm at Sea Level; Cruise Speed 189 mph at 75 percent power at 7000 ft.; Landing Speed 60 mph with flaps down; Rate of Climb 1270 fpm at Sea Level; Service Ceiling 20,300 ft.; Range with Maximum Payload 845 mi.; Range with Maximum Fuel Load 1530 mi.

CESSNA U-3B

CESSNA AIRCRAFT CO., Wichita, Kansas



REMARKS

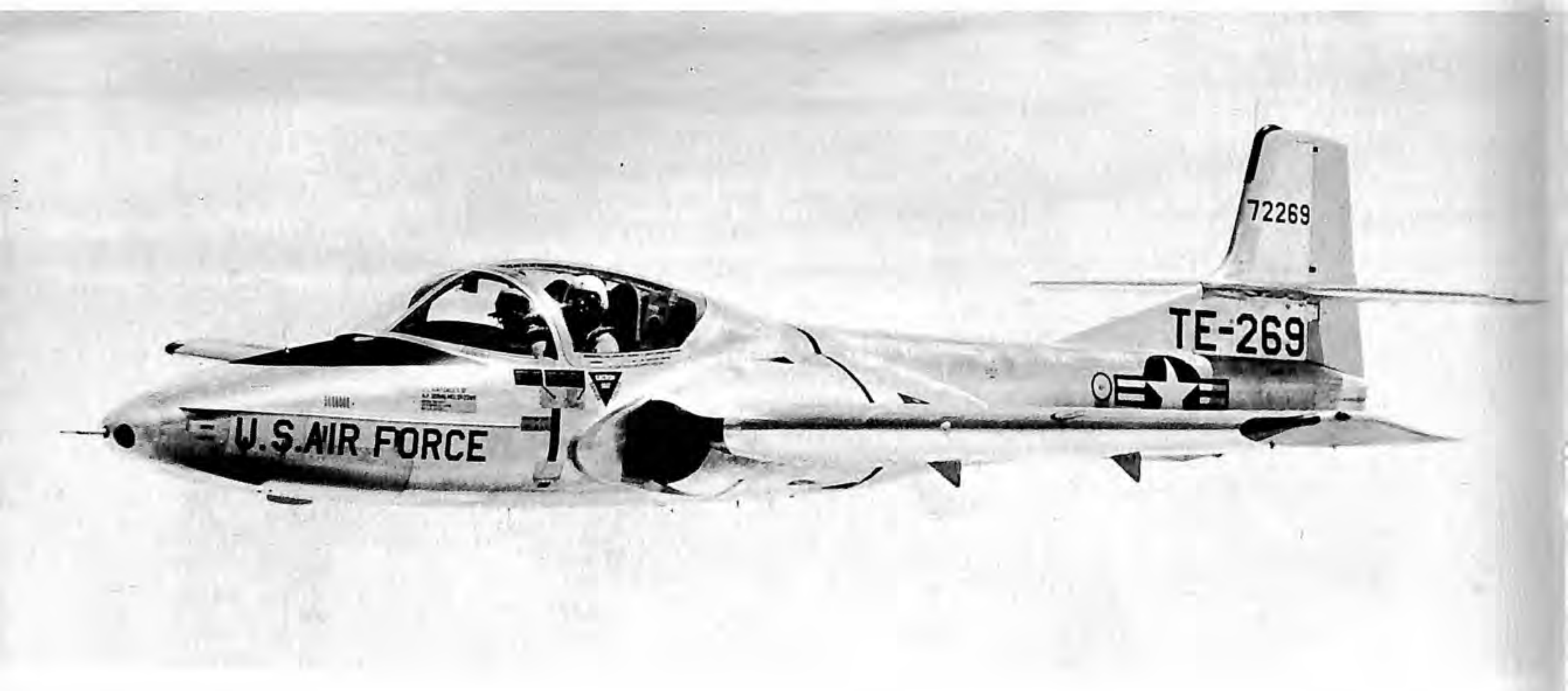
The U-3B is an off-the-shelf version of the Cessna Model 310 and was purchased by the Air Force to meet the need for low-cost and low-maintenance administrative and light cargo transportation. The Air Force currently has received 195 of the light twins. The aircraft are partially supported by Cessna commercial dealers which eliminates large and expensive spare parts inventories by the Air Force.

SPECIFICATIONS

Span 36 ft.; Length 26 ft.; Height 10 ft. 6 in.; Empty Weight 3330 lb.; Gross Weight 4990 lb.; Wing Loading 27.6 lb. per sq. ft.; Power Loading 10.05 lb. per bhp; Engines Two Continental IO-470-M, 260 hp at 2600 rpm takeoff; Fuel Capacity 130 gal.; Propeller Two-bladed Hartzell full feathering, constant speed; Wing Area 175 sq. ft.; Aileron Area 13.4 sq. ft.; Flap Area 22.9 sq. ft.; Fin Area 14.32 sq. ft.; Rudder Area 11.78 sq. ft.; Stabilizer Area 32.15 sq. ft.; Elevator Area 22.1 sq. ft.

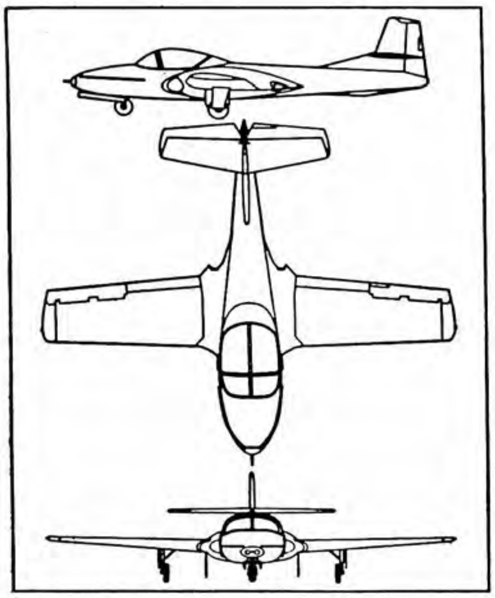
PERFORMANCE

Maximum Speed 202 knots at 260 hp at 2600 rpm at Sea Level; Cruise Speed 188 knots mph at 70 percent hp at 8000 ft.; Landing Speed 70 knots (single-engine go around); Rate of Climb 1720 fpm at Sea Level; Service Ceiling 20,000 ft.; Absolute Ceiling 22,400 ft.; Range with Maximum Fuel Load 1,000 naut. mi.



CESSNA T-37B

CESSNA AIRCRAFT CO., Wichita, Kansas



REMARKS

The Cessna T-37 twin-jet intermediate trainer is in use at Air Force Training schools throughout the United States, and has been instrumental in introducing jets into the earliest phases of flight training. The aircraft features side-by-side seating of student and instructor, a feature which has had notable effects of speeding training, increasing effectiveness and building confidence. More than 600 have been built for the USAF. A quantity of T-37's also have been delivered to the Peruvian Air Force for training, marking the first sale of the aircraft outside the U.S.

SPECIFICATIONS

Span 33 ft. 10 in.; Length 29 ft. 4 in.; Height 9 ft. 3 in.; Empty Weight 4056 lb.; Wing Loading 35.7 lb. per sq. ft.; Power Loading 3.2 lb. per lb. of thrust; Engines Two Continental J69-T25s, 880 lb. thrust normal rated, or 1025 lb. thrust at 21,730 rpm takeoff; Fuel Capacity 321 gal.; Wing Area 183.9 sq. ft.; Aileron Area 11.3 sq. ft.; Flap Area 15.1 sq. ft.; Fin Area 11.5 sq. ft.; Rudder Area 6.2 sq. ft.; Stabilizer Area 34.9 sq. ft.; Elevator Area 11.6 sq. ft.

PERFORMANCE

Maximum Speed 408 mph at Military Power at 21,730 rpm at 35,000 ft.; Cruise Speed 368 mph at normal rated power at 20,700 rpm at 35,000 ft.; Gross Weight Landing Speed 85 mph; Rate of Climb 3200 fpm at S. L.; Service Ceiling 39,200 ft.; One-half fuel Absolute Ceiling 44,000 ft.; Range with Maximum Payload 796 mi.; Range with Maximum Fuel Load 796 mi.

CESSNA L-19 BIRD DOG

CESSNA AIRCRAFT CO., Wichita, Kansas

REMARKS

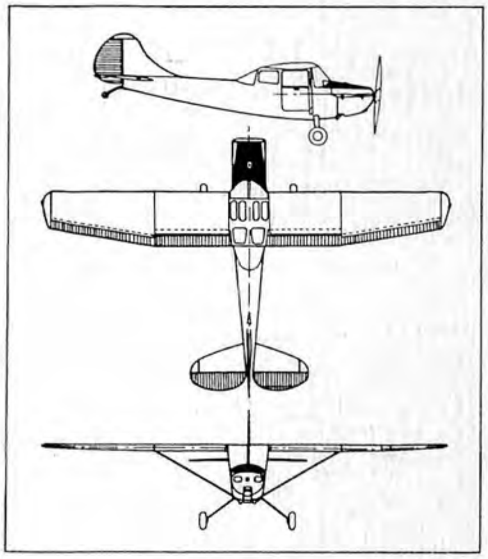
The famous L-19 Bird Dog will return to production in the spring of 1962 to fulfill a U.S. Army contract for 70 aircraft. First deliveries will be made in June, 1962, and the contract will extend through May, 1963. The first L-19's were produced in 1950 and put to immediate use in Korea where they were used to spot enemy troop concentrations, direct ground operations, evacuate wounded, and carry ammunition and other vital cargo. Between 1950 and 1959, more than 3,000 L-19's were built. Many went to overseas governments and are still in use throughout the world. The L-19 is still the main observation aircraft used by the U.S. Army.

SPECIFICATIONS

Span 36 ft.; Length 25 ft. 9 in.; Height 7 ft. 6 in.; Empty Weight 1614 lb.; Wing Loading 12.4 lb. per sq. ft.; Power Loading 10.1 lb. per bhp; Engines Continental O-470-15, 213 hp at 2600 rpm takeoff; Fuel Capacity 40 gal.; Propeller all-metal constant-speed; Wing Area 174 sq. ft.; Aileron Area 18.3 sq. ft.; Flap Area 21.24 sq. ft.; Fin Area 9 sq. ft.; Rudder Area 9.42 (with tab) sq. ft.; Stabilizer Area 19.23 sq. ft.; Elevator Area 15.95 (with tab) sq. ft.

PERFORMANCE

Maximum Speed 116 mph at 80 percent hp at 2300 rpm at 5000 ft.; Cruise Speed 91.7 knots at 29 hp at 1900 rpm at 5000 ft.; Landing Speed 49 mph; Rate of Climb 1150 fpm at Sea Level; Service Ceiling 20,000 ft.; Range at Cruising Speed with Maximum Fuel Load 590 mi.



CESSNA SKYLANE

CESSNA AIRCRAFT CO., Wichita, Kansas

REMARKS

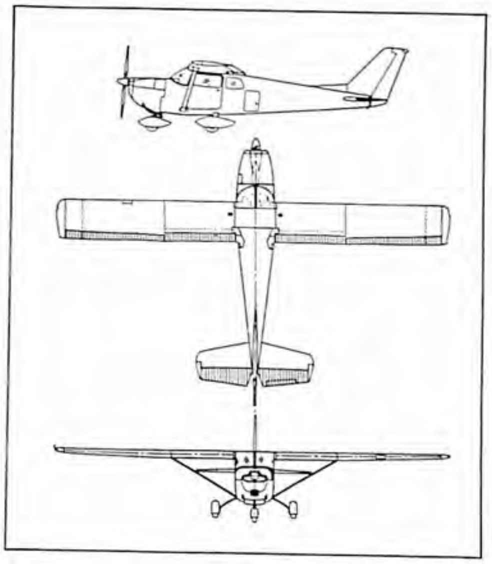
New, all new from stem to stern, best describes the 1962 Anniversary Fleet Skylane. The new aircraft has a totally new fuselage with higher, wider, and longer cabin, new control pedestal, 360° Omni-Vision, increased gross weight and useful load, new fuel system, plus dozens of other advanced features. The new Skylane has superior flight stability which must be experienced in flight. A new fuselage incorporates new methods of construction and design. It is four inches wider at hip and shoulder levels, the floor has been lowered and leveled and the cabin lengthened. The redesigned tail cone is lighter while offering increased strength and incorporates a radio rack immediately aft of the baggage compartment. The new Skylane has 360° Omni-Vision visibility with large windows and windshields completely encompassing the cabin area. Combined with new features the Skylane offers Land-O-Matic gear and Cessna high stability wings. An entirely new control system in which control cables have been rerouted promotes easy servicing and noticeably smoother action. A new fuel system in the new airplane offers 60 usable gallons in all flight regimes from the 65 gallon fuel capacity. A host of new design features are being offered on the 182 and Skylane which make them the most advanced in their class. Wing tips and speed fairings have been redesigned for 1962. Tips have faired navigator lights and squared trailing edges. Speed fairings are needle-nose sharp. A new fixed stabilizer with forward edge attached to the fuselage and incorporating an adjustable trim tab on the right elevator is one of these features. Trim wheel and indicator are located on the control pedestal beneath the center of the panel. Gross weight of the new airplane has been increased 150 pounds with a boost in useful load of 140 pounds.

SPECIFICATIONS

Span 36 ft. 2 in.; Length 27 ft. 4 in.; Height 9 ft.; Empty Weight 1625 lb.; Gross Weight 2800 lb.; Wing Loading 16.0 lb. per sq. ft.; Power Loading 12.2 lb. per bhp; Engine Continental 0-470-R; 230 Rated hp at 2600 rpm takeoff; Fuel Capacity 65 std. 84 opt. gal.; Propeller Constant Speed; Wing Area 175 sq. ft.; Aileron Area 18.3 sq. ft.; Flap Area 20.67 sq. ft.; Fin Area 11.62 sq. ft.; Rudder Area 6.95 sq. ft.; Stabilizer Area 20.94 sq. ft.; Elevator Area 15.13 sq. ft.

PERFORMANCE

Maximum Speed 170 mph at 230 hp at 2600 rpm at Sea Level; Cruise Speed 162 mph at 75 percent power at 6500 ft.; Landing Speed 55 mph with flaps down; Rate of Climb 980 fpm at Sea Level; Service Ceiling 18,900 ft.; Range with Maximum Payload 695 mi.; Range with Maximum Fuel Load 1215 mi.



CESSNA SKYLARK

CESSNA AIRCRAFT CO., Wichita, Kansas

REMARKS

Cessna's 1962 Anniversary Fleet Skylark features a constant speed propeller, increased gross weight and useful load, new wing tips and speed fairings, temperature control cowl flaps, new windshield and entirely new interior and exterior styling. The constant speed propeller automatically changes pitch maintaining selected RPM settings regardless of engine power changes, thus providing the ultimate in performance in the economy four-place class. The system utilizes boosted hydraulic oil from the engine oil system. New split type cowl flaps in the '62 Skylark permit simple and precise control of engine temperatures for optimum performance. Restyling of the wing tips incorporates faired navigation lights and squared trailing edges for optimum aerodynamic cleanliness. Speed fairings, redesigned to needle-nose sharpness, reduce drag and complement sleek lines characteristic of the Cessna Anniversary Fleet. The Skylark's windshield contour has been flattened for streamlining. New magnetic fuel level gauges are utilized in the Skylark replacing the thermal type gauges of previous models. The magnetic gauges reflect fuel level variations immediately. A newly designed "family seat" with a rated capacity of 120 pounds may be easily installed behind the rear passenger seat allowing the Skylark to transport up to six passengers.

SPECIFICATIONS

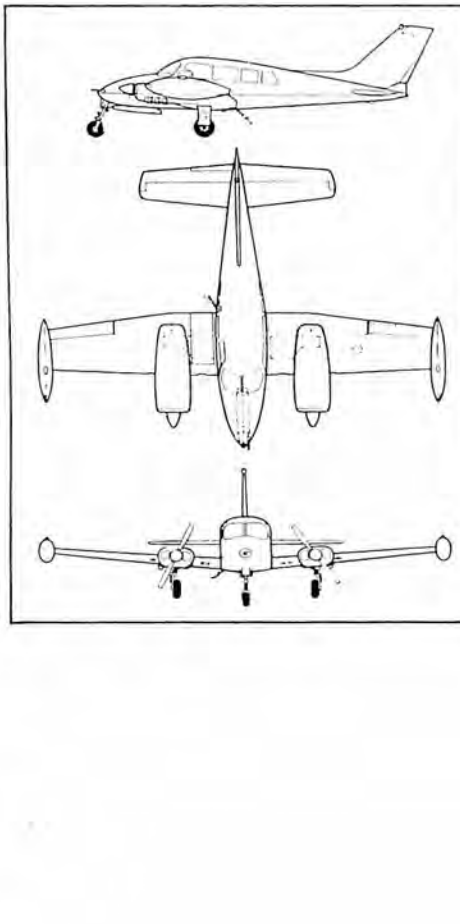
Span 36 ft. 2 in.; Length 26 ft. 6 in.; Height 8 ft. 11 in.; Empty Weight 1410 lb.; Wing Loading 14.1 lb. per sq. ft.; Power Loading 14.0 lb. per bhp; Engine Continental GO-300-E; 175 Rated hp at 3200 rpm takeoff; Fuel Capacity 52 gal.; Propeller Constant Speed; Wing Area 175 sq. ft.; Aileron Area 18.3 sq. ft.; Flap Area 21.23 sq. ft.; Fin Area 10.76 sq. ft.; Rudder Area 7.28 sq. ft.; Stabilizer Area 19.72 sq. ft.; Elevator Area 14.87 sq. ft.

PERFORMANCE

Maximum Speed 150 mph at 175 hp at 3200 rpm at Sea Level; Cruise Speed 142 mph at 75 percent power at 7000 ft.; Landing Speed 54 mph with flaps down; Rate of Climb 950 fpm at Sea Level; Service Ceiling 17,800 ft.; Range with Maximum Payload 550 mi.; Range with Maximum Fuel Load 720 mi.

CESSNA SKYNIGHT

CESSNA AIRCRAFT CO., Wichita, Kansas



REMARKS

A new "turbocharged" 265 mph executive twin named the Skynight heads Cessna's 1962 Anniversary Fleet. The new airplane is a fast, roomy five-passenger twin which is the first plane of its kind offering "turbocharged" power to the general aviation market. The Skynight is designed to "fly long distances at altitudes topping weather thus offering business executives fast, all-weather transportation where flying is at its finest," according to Frank Martin, Cessna Marketing Division manager. This performance is available because "turbochargers" provide full 260 horsepower at altitudes up to 16,000 feet. As air density decreased with altitude exhaust driven turbo superchargers compress inlet air for each engine permitting full horsepower performance. With full throttle, an automatic control maintains maximum manifold pressure to 16,000 feet assuring optimum engine efficiency. This new Skynight performance capability is translated into greater safety for aircraft operations at high altitude airports throughout the world. "Cessna has engineered the Skynight for complete dual safety with two generators, two vacuum pumps, two vacuum systems, two engine driven fuel pumps backed up by two auxiliary electric fuel pumps and completely dual ignition for each engine," according to Martin.

SPECIFICATIONS

Span 36 ft.; Length 29 ft. 6 in.; Height 10 ft. 4 in.; Empty Weight 3190 lb.; Gross Weight 4990 lb.; Wing Loading 28.5 lb. per sq. ft.; Power Loading 9.6 lb. per bhp; Engines two Continental 6 cylinder, Fuel Injection TISO-470-B; 260 rated hp at 2625 rpm takeoff; Fuel Capacity 102 std. 133 opt. gal.; Propeller Constant Speed, full feathering; Wing Area 175 sq. ft.

PERFORMANCE

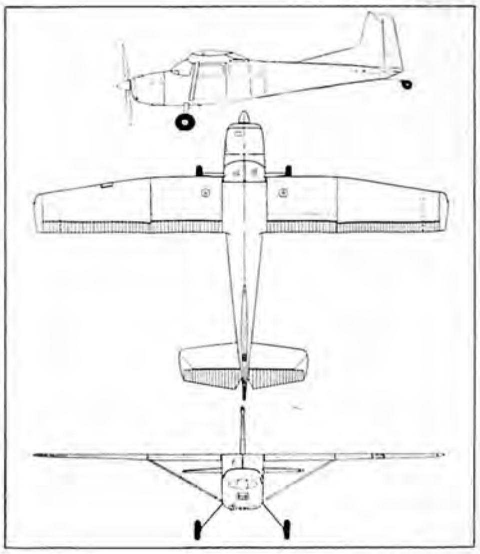
Maximum Speed 265 mph at 260 hp at 16,000 ft.; Cruise Speed 245 mph at 75 percent Power at 19,500 ft.; Landing Speed 76 mph with flaps down; Rate of Climb (single) 400, (twin) 1850 fpm at Sea Level; Service Ceiling (single) 17,300, (twin) 27,200 ft.; Range with Maximum Payload 855 mi.; Range with Maximum Fuel Load 1430 mi.

CESSNA 185 SKYWAGON

CESSNA AIRCRAFT CO., Wichita, Kansas

REMARKS

The rugged 1962 Cessna Skywagon, built to carry more than its own weight, is sporting new wing tips, fuel gauge, friction lock throttle, and several optional seating configuration including a 6-place version plus completely new interior and exterior. A thoroughly rugged utiliplane, the Skywagon packs heavy payloads into and out of small or unimproved fields, lakes, or snowbound outposts. With a gross weight of 3,200 pounds and an empty weight of 1,520 pounds, the Skywagon carries 109.5% of its own weight, outstanding performance by any standards. Assuring complete efficiency in its multi-mission capability is the advantage of high wing stability, rugged conventional landing gear, and Cessna Para-Lift flaps. Unsurpassed for lift, stability, and control, the Cessna high wing combines with the chrome vanadium spring steel gear and large single slotted flaps to form a perfect combination for versatility with dependability. New wing tips of the Skywagon incorporate faired navigation lights and squared trailing edges. A new fuel flow gauge for maximum accuracy in fuel management and a new throttle control with push-pull action and friction lock are utilized. The 185 is available in five different interior arrangements to meet individual mission requirements. A detachable Cargo-Pack compartment for further expansion of Skywagon capabilities expands the Skywagon's cargo carrying area 21.5 cubic feet. The Cargo-Pack is quickly detached or installed for versatile utilization. Floats, skis, or spray attachments are available as optional equipment for the 185.



SPECIFICATIONS

Span 36 ft. 2 in.; Length 25 ft. 6 in.; Height 7 ft. 7 in.; Empty Weight 1520 lb.; Gross Weight 3200 lb.; Wing Loading 18.4 lb. per sq. ft.; Power Loading 12.3 lb. per bhp; Engine Continental 6-cylinder, Fuel Injection 10-470-F; 260 rated hp at 2625 rpm takeoff; Fuel Capacity 65 std. 84 opt. gal.; Propeller Constant Speed; Wing Area 175 sq. ft.; Aileron Area 18.3 sq. ft.; Flap Area 21.23 sq. ft.; Fin Area 13.86 sq. ft.; Rudder Area 7.29 sq. ft.; Stabilizer Area 20.94 sq. ft.; Elevator Area 13.18 sq. ft.

PERFORMANCE

Maximum Speed 176 mph at 260 hp at 2625 rpm at Sea Level; Cruise Speed 167 mph at 75 percent Power at 7000 ft.; Landing Speed 62 mph with flaps down; Rate of Climb 1000 fpm at Sea Level; Service Ceiling 17,300 ft.; Range with Maximum Payload 730 mi.; Range with Maximum Fuel Load 1235 mi.

CESSNA MODEL 310G

CESSNA AIRCRAFT CO., Wichita, Kansas

REMARKS

Cessna's Anniversary 310G for 1962 is offered at a new low price of $59,950 and features the "ultimate in flight and ground handling characteristics" plus increased gross weight and useful load, improved landing gear, cabin comfort additions, and all-new styling of interiors and exteriors. New "stabili-tip" wings have sharp, flight sweep lines and tip tanks canted 35° upward from horizontal. The tip tanks serve as the aircraft's main fuel supply with auxiliary tanks in the wings. More than greatly altering the appearance of the new plane, the dihedral effect of "stabili-tip" wings in combination with changes in the stabilizer incidence, make it easier to fly and far smoother for passenger comfort under all flight conditions. With the new 310G pilots can hold headings or make corrections utilizing only rudder. In a bank or gliding turn, the 310G will hold a steady bank ange of 30° to 45° with ailerons centered. Gross weight of the new 310G has been expanded to 4990 pounds with an increase of 155 pounds useful load. Promoting the flight-sweep design of the 310G, Cessna engineers have designed the plane to accentuate thrust, eliminate drag, and simplify control. The new 310G utilizes two six-cylinder flat horizontal-opposed air-cooled Continental IO-470-D fuel injection engines. The new 310G is capable of speeds up to 240 mph with an optimum range of 1,300 miles. The new airplane has a service ceiling of 21,500 feet and a higher single-engine service ceiling of 8,000 feet. Its normal sea level rate of climb is 1,750 fpm with an outstanding single-engine rate of climb of 400 fpm. Five seating arrangements including four five-place and one four-place are offered, including a lounge type arrangement with reclining couch.

SPECIFICATIONS

Span 37 ft. 5 in.; Length 29 ft. 6 in.; Height 9 ft. 11 in.; Empty Weight 3045 lb.; Wing Loading 28.5 lb. per sq. ft.; Power Loading 9.6 lb. per bhp; Engines Two Continental I-0470-D; 6 cylinder Fuel Injection; 260 hp at 2625 rpm takeoff; Fuel Capacity 102 std., 133 opt. gal.; Propeller constant speed—full feathering; Wing Area 175 sq. ft.; Aileron Area 13.4 sq. ft.; Flap Area 22.9 sq. ft.; Fin Area 14.32 sq. ft.; Rudder Area 11.76 sq. ft.. Stabilizer Area 32.15 sq. ft.; Elevator Area 22.10 sq. ft.

PERFORMANCE

Maximum Speed 240 mph at 520 hp at 2625 rpm at Sea Level; Cruise Speed 223 mph at 75 percent hp at 6500 ft.; Rate of Climb 1750 (twin), 400 (single) fpm at Sea Level; Service Ceiling 21,500 (twin), 8,000 (single) ft.; Range with Maximum Payload 780 mi.; Range with Maximum Fuel Load 1300 mi.

LANCER MODEL 402

CHAMPION AIRCRAFT CORP., Osceola, Wisconsin

REMARKS

A new light twin, initial deliveries scheduled for early 1962.

SPECIFICATIONS

Span 34.45 ft.; Length 22 ft. 3 in.; Height 10 ft.; Empty Weight 1700 lb.; Power Loading 12.25 lb. per bhp; Engines Two Continental O-200, 100 hp normal rated; Fuel Capacity 60 gal.; Propeller Sensenich 69/57; Wing Area 170.22 sq. ft.

PERFORMANCE

Maximum Speed 130 mph at 75 percent hp at 7500 ft.; Cruise Speed 124 mph at 75 percent hp at 7500 ft.; Landing Speed 48 mph; Rate of Climb 1200 fpm at Sea Level; Service Ceiling 17,500 ft.; Absolute Ceiling 19,000 ft.; Range with Maximum Payload 744 mi.; Range with Maximum Fuel Load 744 mi.

CHAMPION CHALLENGER

CHAMPION AIRCRAFT CORP., Osceola, Wisconsin

SPECFICIATIONS

Span 34.45 ft.; Length 22.08 ft.; Height 6.87 ft.; Engine O-320-A (Continuous) 150 hp; Wing Loading 9.18 lb. per sq. ft.; Power Loading 11.0 lb. per hp; Wing Area 170.22 sq. ft.; Gross Weight 1650 lb.; Empty Weight 1050 lb.; Useful load 600 lb.; Service Ceiling 17,500 ft.; Absolute Ceiling 19,150 ft.

PERFORMANCE

Cruise Speed 125 mph; Rate of Climb 1145 fpm; Range at 75 percent power at 8000 ft. 510 mi.

CHAMPION TRI-TRAVELER

SPECIFICATIONS

Span 33 ft. 5 in.; Length 21 ft. 8 in.; Height 8 ft. 8 in.; Empty Weight 968 lb.; Gross Weight 1450 lb.; Useful Load 482 lb.; Baggage 50 lb.; Wing Loading 8.8 psf; Power Loading 16.50 php.

PERFORMANCE

Maximum Speed 135 mph; Cruising Speed 108 mph; Landing Speed 42 mph; Rate of Climb 900 fpm; Cruising Range 500 miles; Fuel Capacity 26 gal.

CHAMPION TRI-CON "95"

SPECIFICATIONS

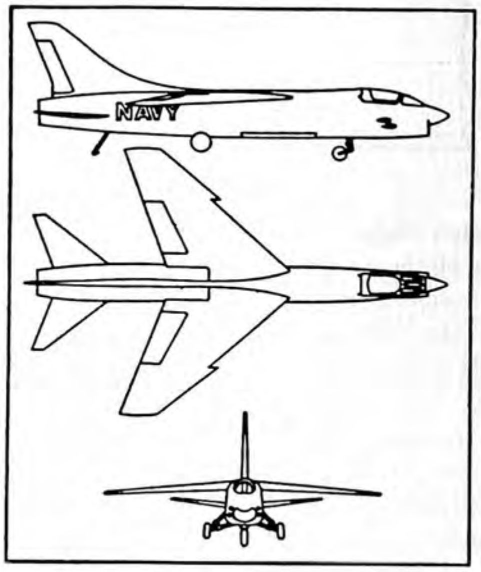
Span 33 ft. 5 in.; Length 21 ft. 8 in.; Height 7 ft. 6 in.; Engine Continental C-90-12F, 95 hp; Wing Loading 8.8 psf; Power Loading 16.5 php; Gross Weight 1450 lb.; Useful Load 482 lb.

PERFORMANCE

Maximum Speed 138 mph; Cruise Speed 108 mph; Rate of Climb 900 fpm; Landing Speed 42 mph; Cruising Range 500 mi.

CHANCE VOUGHT F8U-2

CHANCE VOUGHT CORP., A SUBSIDIARY OF LING-TEMCO-VOUGHT, INC., Dallas, Texas



REMARKS

The first production model F8U-2 made its initial flight at the Chance Vought Corporation plant at Dallas on August 20, 1958. Capable of speeds approaching Mach 2, the F8U-2 is an advanced version of the F8U-1 Crusader, but has a more powerful engine and improved fire control and radar systems. Two fixed low-aspect-ratio fins have been added under the tail section and two small afterburner airscoops have been mounted atop the tail cone. Like the F8U-1, the carrier-based F8U-2 has a two position wing, making it possible for the fighter to achieve very high speeds and yet land on a small area of carrier deck. Armament consists of Sidewinder guided missiles, four 20-millimeter cannons and a capability for carrying 32 2.75-inch rockets. The F8U-2, now out of production, is operational in Fleet units.

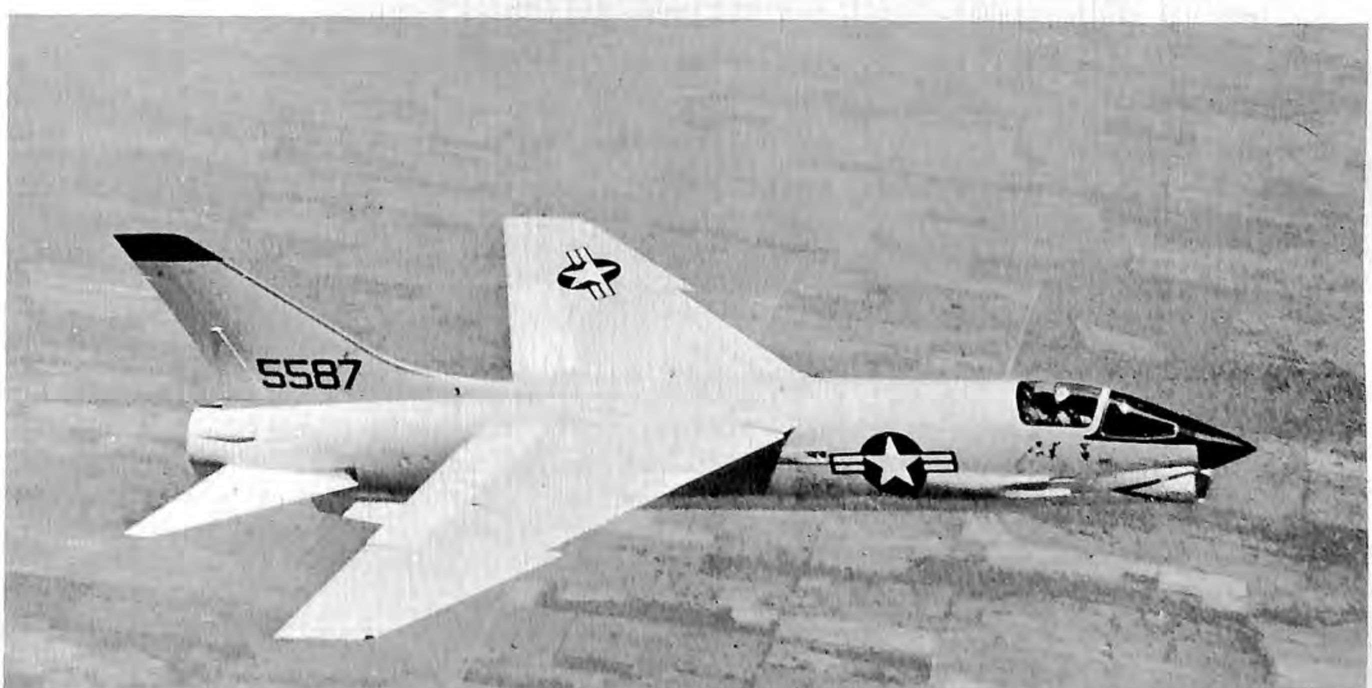
The F8U-1 Crusader also is operating with Fleet squadrons both on land and at sea. The high-performance aircraft, also out of production, saw service in both the Lebanon and Formosan areas. First flight of the high-wing fighter was on March 25, 1955. Armament consists of Sidewinder missiles, four 20-millimeter cannon and a capability for carrying 32 2.75-inch rockets.

SPECIFICATIONS

Span 35 ft. 8 in.; Length 54 ft. 2.75 in.; Height 15 ft. 9.1 in.; Engine One Pratt & Whitney J-57-P-16.

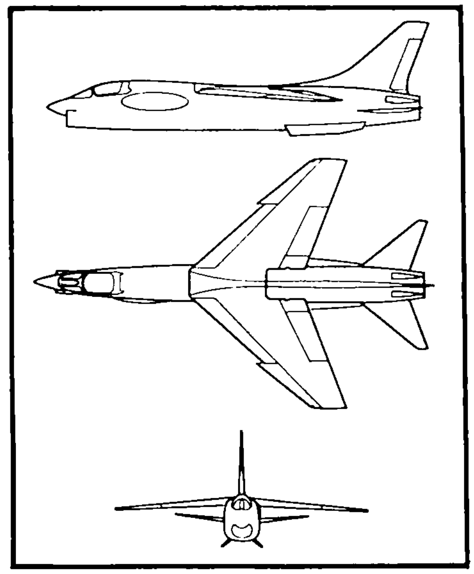
PERFORMANCE

Maximum speed approaching Mach 2.



CHANCE VOUGHT F8U-2N

CHANCE VOUGHT CORP., A SUBSIDIARY OF LING-TEMCO-VOUGHT, INC., Dallas, Texas



REMARKS

Chance Vought Aircraft's F8U-2N Crusader, an all-weather interceptor capable of speeds in the near-Mach 2 range, joined the Fleet late in 1960.

First flown in February, 1960, the "2N" is a more powerful aircraft than its F8U-1 and F8U-2 fighter predecessors and has an increased ability to detect and destroy targets at night or in bad weather. It has been replaced on the production line by the all-weather F8U-2NE.

The F8U-2N is powered by a Pratt & Whitney J-57-P20 engine with a thrust rating in excess of 15,000 pounds. It is armed with four Sidewinder guided missiles, 20 mm. cannon, and is equipped with an improved radar and fire control system. It also has provisions for additional armament and for advanced missiles now under development.

A Chance Vought-developed autopilot relieves the pilot of many routine flight tasks, and allows him to concentrate on his mission. Fuel capacity has been increased over that of the long-range F8U-2, which can remain aloft more than three hours without refueling. Other improvements include revised interior and exterior lighting systems and new instrumentation. Like the F8U-2, the "2N" has ventral fins mounted under the tail section to provide increased stability at the high speeds the aircraft is capable of reaching and a two-position wing.

Since the experimental version of the airplane—the XF8U-1—made its first flight March 25, 1955, Crusaders have set the first national speed record in excess of 1,000 miles an hour and became the first aircraft to span the nation faster than the speed of sound. They also won the Collier Trophy for outstanding aviation achievement and the first Certificate of Merit ever awarded by the former Navy Bureau of Aeronautics, now the Bureau of Naval Weapons.

SPECIFICATIONS

Span 35 ft. 8 in.; Length 54 ft. 2.75 in.; Height 15 ft. 9.1 in.; Engine One Pratt & Whitney J-57-P20.

PERFORMANCE

Maximum Speed near Mach 2.

DOMAN D-10A

DOMAN HELICOPTERS, INC., Danbury, Connecticut

REMARKS

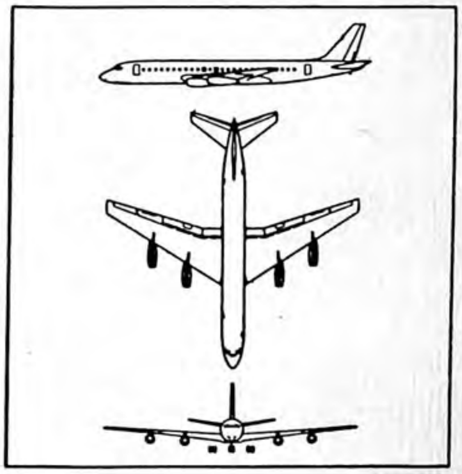
The Model D-10A is being produced in Italy by Aeronautica Sicula, S.p.A. under license. The D-10A features a simplified rotor system that is completely enclosed, self lubricated, and simple in fabrication, operation and maintenance. Blade flapping and drag hinges, dampers, and grease fittings, long employed in conventional rotors are completely eliminated on the D-10A. All moving parts, including controls, are located in the rotor head and are protected from the elements. No post flight maintenance is required.

SPECIFICATIONS

Length 38 ft.; Height 10 ft. 5 in.; Main Rotor Diameter 48 ft.; Tail Rotor Diameter 10 ft.; Engine Lycoming ISO-720-A1A, 525 hp at 3300 rpm takeoff; Fuel Capacity 118 gal.; Empty Weight 3327 lb. Maximum Gross Weight 5500 lb.

PERFORMANCE

Maximum Speed 104 mph; Cruise Speed 95 mph; Range with Standard Fuel Load 354 mi.; Service Ceiling 21,000 ft.



DOUGLAS DC-8 JET TRANSPORT

DOUGLAS AIRCRAFT CO., INC., Santa Monica, Calif.

REMARKS

All models of the DC-8 have identical dimensions, differing only in weight, resulting from more fuel capacity and structural accommodations for the added fuel on intercontinental models. Four powerplants may be selected: Pratt & Whitney JT3C, JT3D and JT4A for domestic models and JT3D, JT4A and Rolls-Royce Conway for intercontinental versions. First flight was May 30, 1958; first delivery in June, 1959; certification August, 1959.

SPECIFICATIONS

Span 142.4 ft.; Over-All Length 150 ft. 6.362 in.; Height 42 ft. 3.589 in.; Manufacturing Empty Weight domestic 119,997 lb. for JT3C to 125,956 lb. for JT4A, overwater 126,400 lb.; T. O. Gross Weight domestic JT3C 265,000 lb. to 273,000 lb., JT4A 276,000 lb., intercontinental 300,000 lb. to 310,000 lb., extended range 315,000 lb.; Wing Loading 95.5-113.6 lb. per sq. ft.; Engines Four Turbojet; Fuel Capacity domestic 17,600 gal. or 118,950 lb., intercontinental 23,079 gal. or 156,750 lb.; Wing Area 2772.5 sq. ft.; Aileron Area 161.6 sq. ft.; Flap Area 456.9 sq. ft.; Fin Area 222.9 sq. ft.; Rudder Area 128.8 sq. ft.; Stabilizer Area 391.2 sq. ft.; Elevator Area 167.9 sq. ft.

PERFORMANCE

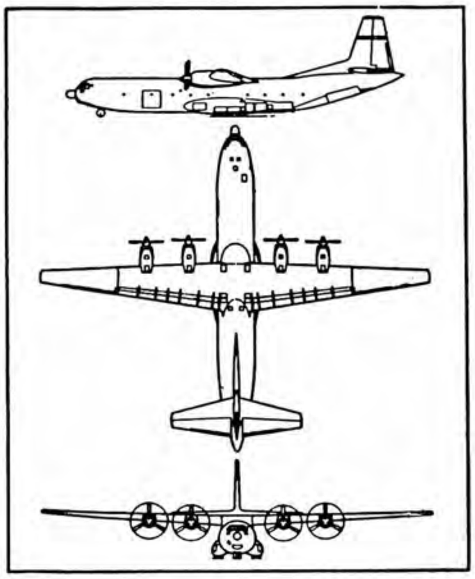
Speed 550 to 600 st. mph; Stall Speed at Maximum Landing Weight 114 to 118 st. mph; Design Landing Weight 189,000 to 199,500 lb.; Cruise Altitude 25,000 to 42,000 ft.; Take-off Distance 7600 to 10,200 ft.; Payload 32,000 to 40,000 lb.; Range 5690 to 6050 st. mi.

DOUGLAS C-133A HEAVY CARGO TRANSPORT

DOUGLAS AIRCRAFT CO., INC., Santa Monica, Calif.

REMARKS

The C-133A and C-133B are capable of transporting any missile in the United States arsenal, including intercontinental ballistic missiles. It also can carry virtually all of Army field force equipment. Costly disassembly of large vehicles and equipment is unnecessary, and vehicles are ready for use upon arrival. Two cargo entrances permit simultaneous front-and-rear loading into the 13,000-cubic-foot capacity cabin which is pressurized to maintain a sea level cabin up to 16,000 feet and varying to a 10,000-foot cabin altitude at 35,000 feet. First C-133B flight was October 31, 1959. The C-133B, developed for the Military Air Transport Service, is produced at the Douglas Long Beach Division.



SPECIFICATIONS

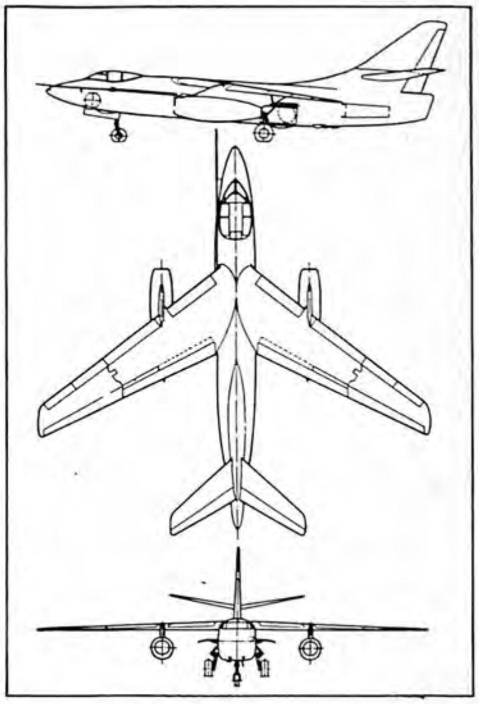
Span 179 ft. 7.86 in.; Length 157 ft. 6.44 in.; Height 48 ft. 9 in.; Empty Weight 120,363 lb.; Wing Loading 107.0 lb. per sq. ft.; Power Loading 9.73 lb. per eshp; Engines T34-P-9W, 5650 eshp normal rated, or 7500 eshp at 11,000 rpm takeoff; Fuel Capacity 18,112 gal.; Propeller C-W CT735 S-B100, 1060-25C5-12 Electric, Full Feathering, Reversible; Wing Area 2673.1 sq. ft.; Aileron Area 142 sq. ft.; Flap Area 496.5 sq. ft.; Fin Area 354.3 sq. ft.; Rudder Area 182.4 sq. ft.; Stabilizer Area 459.2 sq. ft.; Elevator Area 341.5 sq. ft.

PERFORMANCE

Maximum Speed 312 knots at Military Power at 286,000 lb. gr. wt. at 8700 ft.; Cruise Speed 284 knots at approximately 90 percent normal rated power at altitudes varying from 17,000 ft. at 280,000 lb. to 35,000 ft. at 130,000 lb.; Landing Speed 117 knots at 250,500 lb.; Rate of Climb 1280 fpm at S.L. MIL power, at 286,000 lb.; Service Ceiling 20,950 ft., at MIL power at 286,000 lb.; Absolute Ceiling 22,500 ft. at MIL power at 286,000 lb.; Range with Maximum Payload 1973 n. mi., 90,015 lb. cargo; Range with Maximum Fuel Load 3858 n. mi., 42,481 lb. cargo; Design Range 3500 n. mi., 51,200 lb. cargo.

DOUGLAS A3D-2 SKYWARRIOR ATTACK BOMBER

DOUGLAS AIRCRAFT CO., INC., Santa Monica, Calif.



REMARKS

The A3D-2 Skywarriors, which phased out of production in 1961, are now flying in carrier squadrons as the Navy's most potent single striking force. The twin-jet bomber first flew October 28, 1952. Rated in the 600-700 miles-per-hour class, the A3D flies long-range missions above 40,000 feet. Primarily designed to deliver nuclear weapons, it can also carry a huge variety of other armament on twelve bomb bay racks. An in-flight refueling system has been developed for installation at the squadron level to convert the bomber into a high-speed jet tanker. Permanent configurations of the Skywarrior include the A3D-2P, designed exclusively for photographic missions; the A3D-2Q, modified for electronic reconnaissance and countermeasures, and the A3D-T, the Navy's first jet bomber-trainer. These configurations utilize the former bomb bay area to accommodate special equipment and additional personnel in a new pressurized cockpit and cabin. On March 21, 1957, a transcontinental speed record was broken when an A3D-1 completed a round trip from Los Angeles to New York and return in 9 hours 31 minutes 35.4 seconds (1 hour 46 minutes under the old record). Simultaneously, the east-to-west record was bettered. This was 5 hours 12 minutes 39.24 seconds, more than 11 minutes faster than the previous mark. (Both records were later topped.)

SPECIFICATIONS

Span 72 ft. 6 in.; Length 74 ft. 8 in.; Height 22 ft. 9 in.; Normal Gross Weight 70,000 lb.; Engines Two Pratt & Whitney J57s; Crew Three (basic).

PERFORMANCE

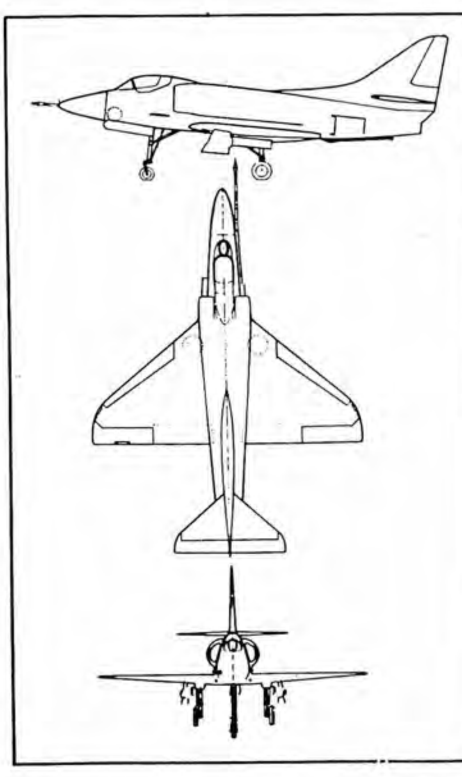
Range more than 2500 n. mi. Other data classified.

DOUGLAS A4D SKYHAWK ATTACK BOMBER

DOUGLAS AIRCRAFT CO., INC., Santa Monica, Calif.

REMARKS

The A4D Skyhawk was designed and built at the Douglas El Segundo Division. The first flight was made June 22, 1954, and fleet deliveries began in mid-1956, following carrier qualifications. The size of the A4D allows it to operate from carriers without folding wings, yet it is capable of carrying out long-range missions with nuclear weapons, missiles, bombs, rockets, guns, and other weapons. Skyhawks can be refueled from tanker aircraft and can also be converted into tankers themselves by carrying external fuel tanks on the wing and the Douglas In-Flight Fueling Store on the centerline rack. Operational with the Navy and Marine Corps are the A4D-1, A4D-2 and A4D-2N, equipped with advanced electronic instrumentation for all weather navigation and weapon delivery. Skyhawks are now equipped to carry the multiple bomb rack, a Douglas innovation which allows six 500-pound bombs to be carried at a single bomb station. A newer version, the A4D-5, with an improved J52 engine, is in production at Douglas. Performance data on the new series of Skyhawks are classified.



SPECIFICATIONS

Span 27 ft. 6 in.; Length 41 ft. 4 in.; Height 15 ft.; Gross Weight 15,000 lb.; Engine Wright J52; Guns Two 20 mm.; Bomb-rocket-missile capability on 5 external racks.

PERFORMANCE

Range Transcontinental; Speed 600-700 mph class.

DOWNER BELLANCA 260A

DOWNER AIRCRAFT COMPANY, Alexandria, Minnesota

REMARKS

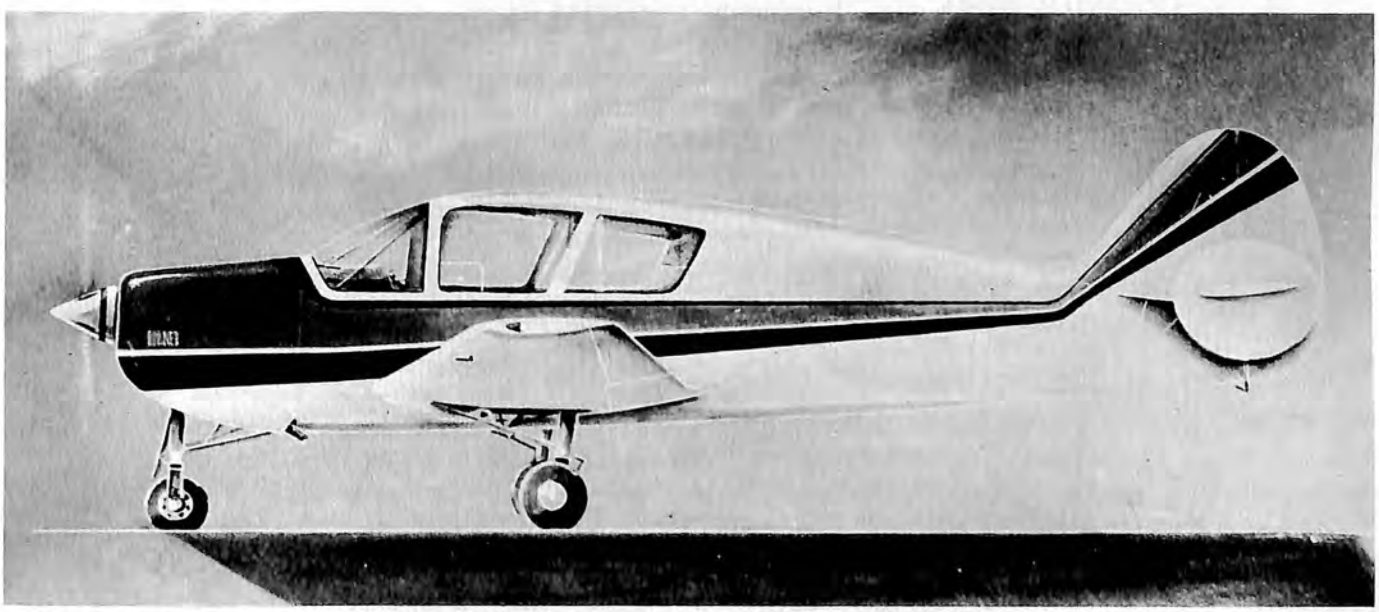
On December 15, 1960, the name of the company was changed to Downer Aircraft Company. New Model 260A, now undergoing final FAA certification tests. Production will begin at approximately twelve per month early in 1962. The Bellanca 260A is the descendant of a long line of Bellanca airplanes dating back to 1918.

SPECIFICATIONS

Span 34 ft. 2 in.; Length 22 ft. 11 in.; Height 6 ft. 4 in.; Empty Weight 1720 lb.; Wing Loading 186 lb. per sq. ft.; Power Loading 11.5 lb. per bhp; Engine Continental IO-470-F, 260 hp normal rated, or 260 hp at 2625 rpm takeoff; Fuel Capacity 60 gal.; Propeller McCauley, Model B2A36C31/90M-8; or Hartzell Model HC-A2XF-1/8433-4; Wing Area 161.5 sq. ft.; Aileron Area 11.77 sq. ft.; Flap Area 16.16 sq. ft.; Tip Fin Area 4.4 sq. ft. total for two; Fin Area 5.67 sq. ft.; Rudder Area 6.28 sq. ft.; Stabilizer Area 17.21 sq. ft.; Elevator Area 12.20 sq. ft.

PERFORMANCE

Maximum Speed 208 mph at 260 (100%) hp at 2625 rpm at Sea Level; Cruise Speed 203 mph at 195 (75%) hp at 2450 rpm at 9200 ft.; Landing Speed 62 mph; Rate of Climb 1760 fpm at Sea Level; Service Ceiling 22,000 ft.; Absolute Ceiling 26,500 ft.; Range with Maximum Payload 880 mi.; Range with Maximum Fuel Load 880 mi.



F-27F PROPJET TRANSPORT

FAIRCHILD STRATOS CORP., Hagerstown, Maryland

REMARKS

Fairchild Stratos has built 88 F-27 airplanes that are flown by 12 airlines and 29 corporations around the world. This aircraft, one of the most efficient and economical twin-propjets in service, is now available in a new transcontinental range version, the F-27F. It is designed for a maximum range of 2,800 miles. Although the range has been increased, the general configuration of the aircraft remains the same. It is pressurized and completely air-conditioned on the ground as well as in flight by a self-contained system. Important features of the F-27 are a highly reliable completely pneumatic retractable landing gear and braking system and fuel-carrying wings that have never experienced algae corrosion. This multi-million dollar headache to military and commercial operators known as the "green slime" problem, has been eliminated from F-27 wet wings by Fairchild Stratos' own unique processes. Other F-27 characteristics: Meets medium and short range requirements of regional airlines, offers 36, 40, or 44 passenger seating, operates from short runways and unimproved fields. A cargo version, the F-27G will carry from 12,000 to 13,000 pounds of cargo.

SPECIFICATIONS

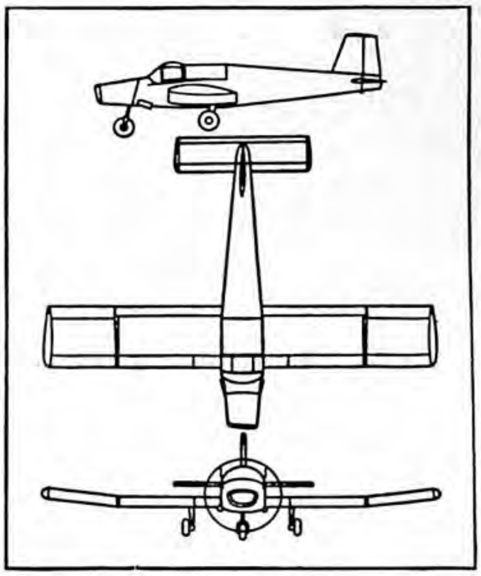
Span 95 ft. 2 in.; Length 77 ft. 6 in.; Empty Weight 21,961 lb.; Operational Weights 39,400 takeoff, 37,500 landing; Engine Rolls-Royce Dart RDa 7/Mark 529-7E, 1990 shp at 15,000 rpm takeoff; Fuel Capacity 1936 gal.; Propeller Rotol, four blade, constant speed; Wing Area 754 sq. ft.; Aileron Area 37.6 sq. ft.; Total Flap Area 136.9 sq. ft.; Vertical Tail including dorsal 190 sq. ft.; Rudder Area (aft of hinge line) 33 sq. ft.; Horizontal Tail Surfaces 172 sq. ft.; Elevator Area (aft of hinge line) 34 sq. ft.

PERFORMANCE

Cruise Speed 300 mph at 14,200 rpm at 20,000 ft.; Rate of Climb 2200 fpm at Sea Level; Service Ceiling 32,700 ft.; Range with Maximum Fuel Load 2800 mi.

FLETCHER FU-24 UTILITY

FLETCHER AVIATION COMPANY, El Monte, California



REMARKS

The Fletcher FU-24 Utility is designed to carry the pilot and four passengers or 1000 pounds of cargo and to accommodate a hopper, spreader, and other equipment required in dusting or fertilizing. The construction of this plane permits simple installation of special equipment to meet individual needs. Also used for hauling machinery and equipment, search and rescue work, transporting work crews and materials, or as a flying fire watcher.

SPECIFICATIONS

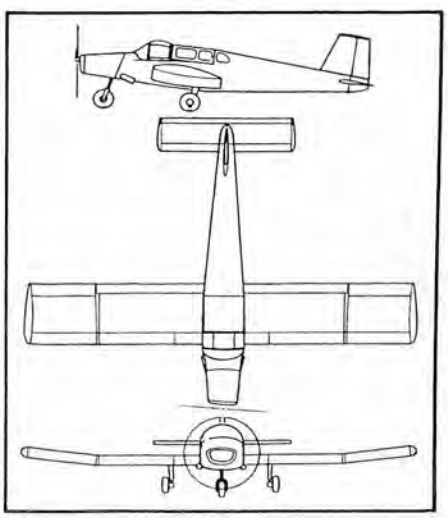
Span 42 ft.; Length 31 ft. 10 in.; Height 9 ft. 4 in.; Empty Weight 2000 lb.; Wing Loading 11.9 lb. per sq. ft.; Power Loading 13.5 lb. per bhp; Engine Continental 10-470-D, 260 hp normal rates; Wing Area 294 sq. ft.

PERFORMANCE

Maximum Speed 143 mph at 260 hp at 2625 rpm at sea level; Cruise Speed 127 mph at 75 percent hp at sea level; Landing Speed 48 mph; Rate of Climb 900 fpm at sea level; Service Ceiling 17,000 ft.; Absolute Ceiling 19,400 ft.; Range with Maximum Payload 371 mi.

FLETCHER FU-24A

FLETCHER AVIATION COMPANY, El Monte, California



REMARKS

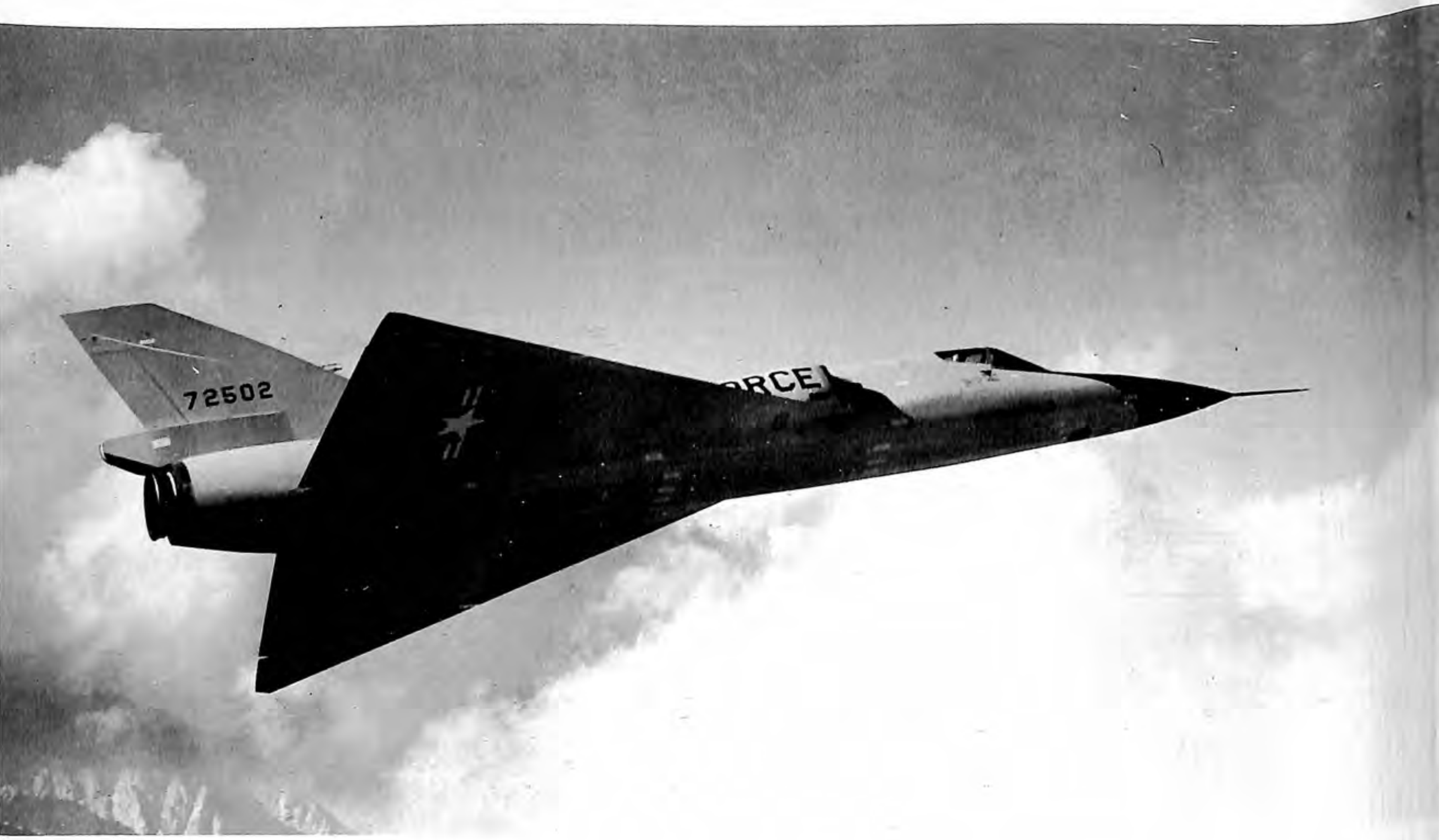
The FU-24A is a rugged six-place version of the FU-24, ideally suited for orientation flights, search and rescue, cargo hauling and agricultural flying.

SPECIFICATIONS

Span 42 ft.; Length 31 ft. 10 in.; Height 9 ft. 4 in.; Empty Weight 2000 lb.; Wing Loading 11.9 lb. per sq. ft.; Power Loading 13.5 lb. per bhp; Engine Continental 10-470-D, 260 hp normal rated, or 240 hp at 2600 rpm takeoff; Fuel Capacity 48 gal.; Propeller Constant Speed Metal; Wing Area 294 sq. ft.; Aileron Area 20 sq. ft.; Flap Area 34 sq. ft.; Fin Area 13.6 sq. ft.; Rudder Area 6.9 sq. ft.; All Moveable Tail 48 sq. ft.

PERFORMANCE

Maximum Speed 143 mph at 260 hp at 2625 rpm at sea level; Cruise Speed 127 mph at 75 percent hp at sea level; Landing Speed 48 mph; Rate of Climb 900 fpm at S. L.; Service Ceiling 17,000 ft.; Absolute Ceiling 19,400 ft.; Range with Maximum Payload 371 mi.

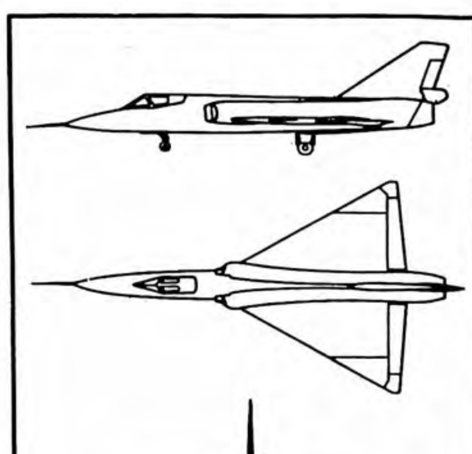


CONVAIR F-106A ADVANCED ALL-WEATHER INTERCEPTOR

GENERAL DYNAMICS/CONVAIR, San Diego 12, California

REMARKS

The single-seat F-106A carries Hughes Falcon GAR-3 and GAR-4 missiles and Douglas Genie MB-1 nuclear warhead. The F-106B is the two-seat version of the F-106A with all-weather capabilities and carrying the same armament. First flight of the F-106A was made December 26, 1956, at Edwards Air Force Base, California. First flight of the F-106B was on April 9, 1958, at the same base. First deliveries of the F-106A to operational Air Force North American Air Defense Command squadrons were made in 1959.

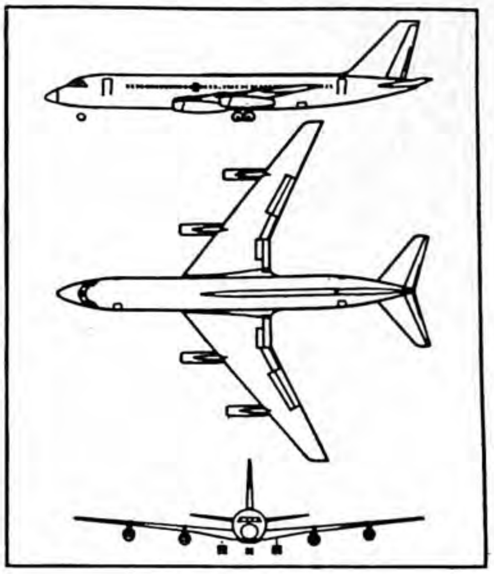


SPECIFICATIONS

Span 38 ft. 1.6 in.; Length 70 ft. 8.78 in.; Height 20 ft. 3.33 in.; Engine One Pratt & Whitney J75-P17 turbojet with afterburner 15,000 lb. thrust class; Wing Area 631.23 sq. ft.; Elevon aft on hinge line 66.60 sq. ft.; Rudder Area aft of hinge line 11.10 sq. ft.; Fin Area 93.90 sq. ft., including rudder.

PERFORMANCE

Maximum Speed 1,525.95 mph; Landing Speed 166.75 mph (All other details are classified); Ceiling above 50,000 ft.



CONVAIR 880 AND 880-M

GENERAL DYNAMICS/CONVAIR, San Diego 12, California

REMARKS

The basic Convair 880 was designed for operation from runways of 5,000 to 8,000 feet and for favorable operating costs on medium range up to transcontinental flights. Its sister airliner, the Convair 880-M, offers increased range, fuel capacity, operating weights and shorter runway requirements. It has wing leading edge slats, power boost rudder, and engines with increased thrust. Both Convair 880s can cruise at 615 miles an hour. Range of the basic 880 with first-class payload and normal fuel reserves is 3,200 statute miles. In a first-class, two-abreast seating arrangement as used by initial operators, the 880 carries 84 passengers. In a five-across coach configuration it will carry 110 persons. The basic 880 received its FAA airworthiness certificate May 1, 1960, and went into commercial service on May 15, 1960. The first flight of the 880-M was October 3, 1960, and FAA certification was obtained on July 25, 1961. The Convair 880 is in service with Delta Air Lines, Northeast Airlines, and Trans World Airlines. Convair 880-Ms are flying the routes of Alaska Airlines, Civil Air Transport of Formosa, Viasa of Venezuela, Swissair and Japan Air Lines.

SPECIFICATIONS

Span 120 ft.; Length 129 ft. 4 in.; Height 36 ft. 4 in.; Empty Weight 84,300 lb.; Wing Loading 92.95 lb. per sq. ft., at maximum 880 takeoff weight of 184,500 lb.; Engines Four General Electric CJ-805-3 turbojets, each with 11,200 lb. thrust; (880-M) Four General Electric CJ-805-3B turbojets, each with 11,650 lb. static thrust; Fuel Capacity 10,776 gal. (with optional center fuel tanks, 12,651 gal.); Wing Area 2,000 sq. ft.; Vertical Tail Area 295 sq. ft.; Rudder Area 82.4 sq. ft.; Horizontal Tail Area 395 sq. ft.; Elevator Area 88.3 sq. ft.

PERFORMANCE

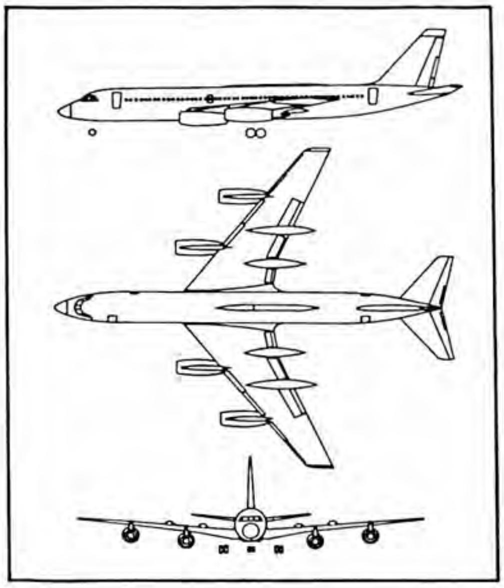
Maximum Speed 615 mph at maximum cruise thrust at 22,500 ft.; Cruise Speed 556 mph at Mach 0.84 at 35,000 ft.; Landing Speed 145 mph, 1.3 stall speed landing weight 121,000 lb.; Rate of Climb 3,565 fpm at Sea Level; Service Ceiling 41,000 ft.; Cabin Altitude 8,000 ft. at 41,000 ft. airplane altitude; Range with Maximum Payload 3,200 statute mi.; Range with Maximum Fuel Load 3,200 mi., with reserve fuel for 200 n. miles plus ¾ hr.

CONVAIR 990

GENERAL DYNAMICS/CONVAIR, San Diego 12, California

REMARKS

The Convair 990 is a medium-range jet airliner with enough cruising speed and fuel capacity to fly nonstop transcontinental routes at near sonic speeds. The transport can fly both medium and long-range routes at premium speeds and, with full reserves, carries enough fuel for maximum-range trips of 4,050 miles. The CJ-805-3B engines, which power the 990, incorporate an additional turbine and fan. This aft-fan compresses air flowing around the basic engine and exhausts it through a double jet nozzle at low velocity for improved engine efficiency. Four "speed capsules" also help make possible the speed of the Convair 990. These capsules resemble inverted canoes extending beyond the trailing edge of the swept wing. They increase the airliner's speed by delaying formation of shock waves of air which tend otherwise to cling to the trailing edge of the wing and create drag. Some of the Convair 990's fuel capacity comes from the fact that these speed capsules also serve as fuel tanks. The passenger seating arrangements differ with the requirements of each customer; but typical is the American Airlines' interior which has 58 four-across, wide-aisle, first-class seats, 37 five-across, coach seats and a four-place lounge forward. The FAA issued a provisional airworthiness certificate for the Convair 990 on November 3, 1961, and final certification was scheduled in December of 1961. Orders for the Convair 990 have been placed by American Airlines, Swissair, Scandinavian Airlines System, and Real/Varig. The Convair 990 Coronado is the intercontinental version of the Convair 990, with increased fuel capacity but equal performance.



SPECIFICATIONS

Span 120 ft.; Length 139 ft. 5 in.; Height 39 ft. 6 in.; Empty Weight 110,750 lb.; Wing Loading 106 lb. per sq. ft., at take-off weight of 239,200 lb.; Engine CJ-805-23B aft fan turbojets, each with 16,050 lb. static thrust; Fuel Capacity 15,188 gal.; Wing Area 2250 sq. ft.; Vertical Tail Area 295 sq. ft.; Rudder Area 82.4 sq. ft.; Horizontal Tail Area 426.5 sq. ft.; Elevator Area 98.0 sq. ft.

PERFORMANCE

Maximum Cruising Speed more than 625 mph at maximum cruise thrust at 21,500 ft.; Landing Speed 145 mph, 1.3 stall speed landing weight 151,000 lb.; Rate of Climb 3,250 fpm at Sea Level; Service Ceiling 41,000 ft., cabin altitude 8,000 ft. at 41,000 ft. airplane altitude; Range with Maximum Payload 4,050 mi.; Range with Maximum Fuel Load 4,050 mi., with reserve fuel for 200 n. miles plus 3/4 hr.

B-58 HUSTLER

GENERAL DYNAMICS/FORT WORTH
(formerly Convair-Fort Worth)
A DIVISION OF GENERAL DYNAMICS CORP., Ft. Worth 1, Texas

REMARKS

Nine new world speed and payload records were set by Air Force B-58 Hustler bombers in the first five months of 1961 as production of the nation's only Mach Two-plus manned bomber weapons system continued at General Dynamics/Fort Worth (formerly Convair-Fort Worth), a Division of General Dynamics Corporation.

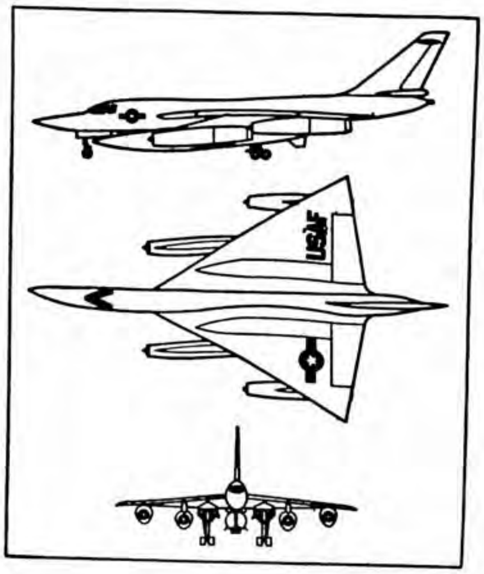
In the same period, Strategic Air Command's second B-58-equipped unit, the 305th Bomb Wing, began operating B-58s at Bunker Hill Air Force Base, near Peru, Indiana. First crews for Bunker were trained at Carswell Air Force Base, Fort Worth, home of the Air Force's first B-58 unit, the 43rd Bomb Wing. The 43rd Bomb Wing carried on its record-setting projects as part of its combat-readiness training.

Another advance in the state of the art was nearing reality in the B-58 program at end of the year. The first crew escape capsule due to become operational on any aircraft was undergoing tests, and capsules were expected shortly to be installed in all three crew stations of all tactical B-58s.

The B-58 was first flown on November 11, 1956. Developed by GD/Fort Worth for the Air Force, the bomber carries its strategic striking power in a missile-like pod beneath the fuselage. The original pod was in a single component. A later version is a two-component pod. The lower portion carries only fuel for the B-58's J-79 engines.

In combat, the lower component would be dropped when its fuel supply was exhausted. The airplane then would fly on to the target to drop the upper component, which carries both fuel and a nuclear weapon. Thus stripped of all excess poundage, the B-58 would have less weight and less drag to make for a speedier return to home base.

The Hustler embodies the Convair-pioneered delta wing for speed and stability both at low and high altitudes.



SPECIFICATIONS

Gross Weight over 160,000 lb.; Span 56 ft. 10 in.; Length 96 ft. 9 in.; Height 30 ft.; Engines Four General Electric J79-5A turbojet pod-mounted; Wing Area 1542 sq. ft.

PERFORMANCE

Maximum Speed over 1300 mph (Mach 2); Service Ceiling above 60,000 ft.; Range Intercontinental, with mid-air refueling; Design Bomb Load Nuclear; Crew Three; Fuel Capacity more than 15,000 gal.; Landing Gear tricycle (dual-wheel nose gear, eight-wheel truck main gear).

TB-58 TRAINER BOMBER

GENERAL DYNAMICS/FORT WORTH
(formerly Convair-Fort Worth)
A DIVISION OF GENERAL DYNAMICS CORP., Ft. Worth 1, Texas

REMARKS

Deliveries of TB-58 supersonic trainer-bombers for the Air Force were completed during 1961 at General Dynamics/Fort Worth, giving Strategic Air Command four of the aircraft for training purposes.

They were immediately placed in service training crews of SAC's two operational B-58 equipped units, the 43rd Bomb Wing at Carswell Air Force Base, Fort Worth, and the 305th Bomb Wing at Bunker Hill Air Force Base, near Peru, Indiana. The B-58s enable the Air Force to train pilots for virtually any operation they may be called upon to perform in combat. This includes not only handling of flight controls, but also training in refueling techniques, as well as procedures for dropping the B-58's externally mounted disposable pod, containing the bomber's payload, on an enemy target.

Externally, the TB-58 is identical to the B-58 except for additional windows. These provide visibility adequate for the TB-58 to be flown either from the first crew station or from the second crew station immediately behind. Pilots may take off, fly and land the plane from either of the first two stations.

The pilot in training uses the forward station. The instructor pilot uses the second station, which is so arranged that the instructor literally may look over the shoulder of the pilot in front. The third station may at the same time carry a qualified B-58 pilot who needs to renew or upgrade his skills. In flight, he may change places with the instructor pilot in the second station.

SPECIFICATIONS

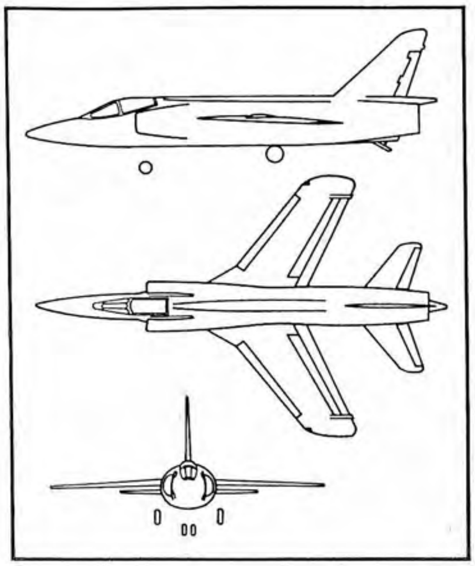
Gross Weight over 160,000 lb.; Span 56 ft. 10 in.; Length 96 ft. 9 in.; Height 30 ft.; Engines Four General Electric J79-5A turbojet pod-mounted; Wing Area 1542 sq. ft.

PERFORMANCE

Maximum Speed over 1300 mph (Mach 2); Service Ceiling above 60,000 ft.; Range Intercontinental, with mid-air refueling; Crew Three; Fuel Capacity more than 15,000 gal.; Landing Gear tricycle (dual-wheeled nose gear, eight-wheel truck main gear).

GRUMMAN F11F-1 TIGER

GRUMMAN AIRCRAFT ENGINEERING CORP., Bethpage, Long Island, New York



REMARKS

Coupled with its extreme speed and altitude capabilities, the Super Tiger, designed primarily as a carrier-based aircraft, has excellent short-field and short-approach performance and can operate out of small unimproved land bases as well as from the most modern airstrips. The aircraft is both fighter-bomber and interceptor. It flew to an altitude of 76,828 feet (over 14½ miles) in April, 1958.

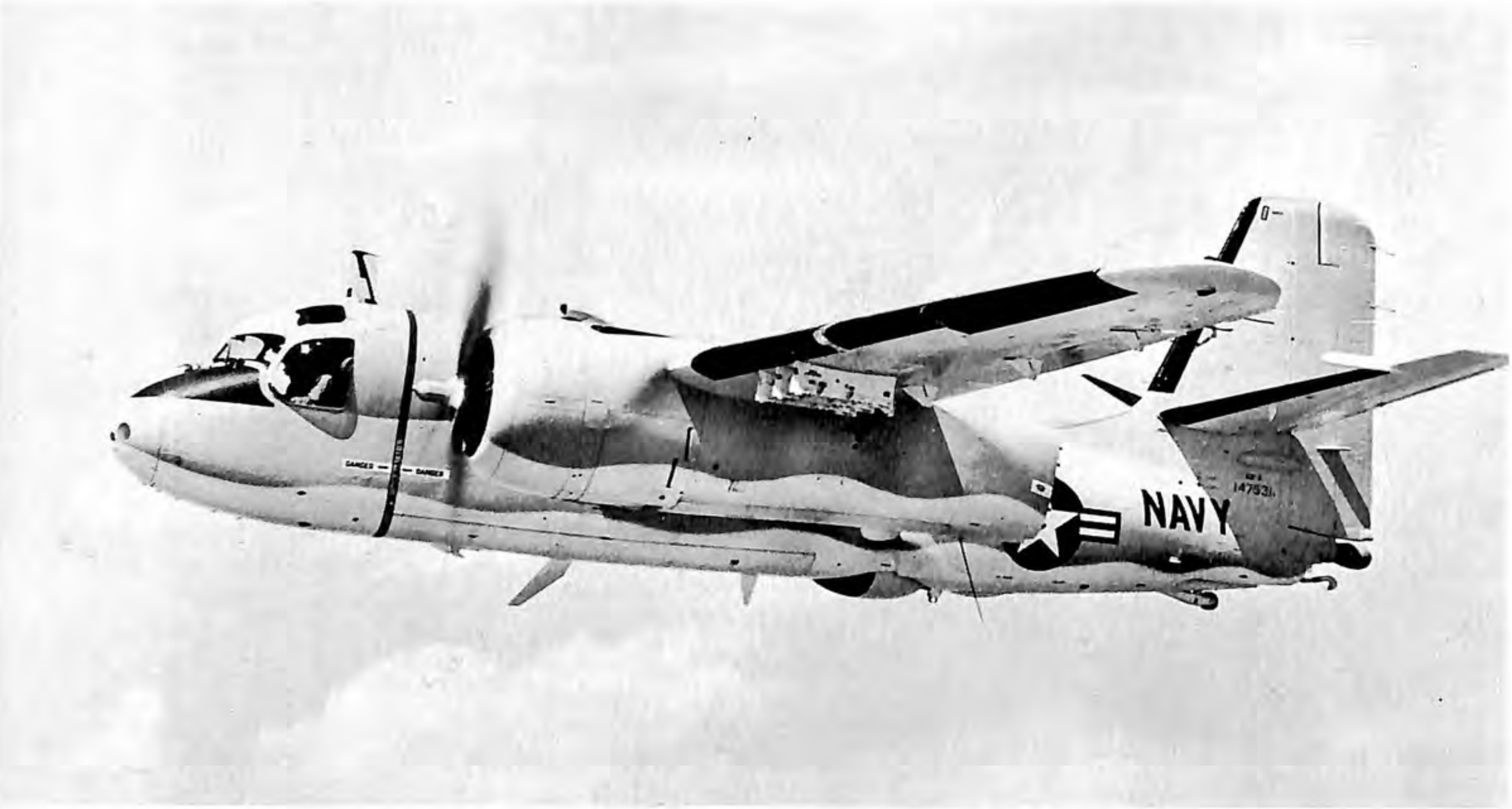
The Super Tiger, a modification of Grumman's F11F-1 Tiger, a jet fighter now in service with the Navy, is one of the smallest high performance aircraft built today. Overall length measures under 50 feet. General Electric's J79 engine gives the airplane a basic thrust of approximately 15,000 pounds (with afterburner) placing the Super Tiger in a Mach-2 category. Like its predecessor, the F11F-1, the Super Tiger features an area-ruled or "coke-bottle" fuselage.

SPECIFICATIONS

Span 31 ft. 7.5 in.; Length 47 ft. 9 in.; Height 14 ft. 5 in.; Engines J79-GE-7, over 15,000 lb. thrust; Wing Area 250 sq. ft.

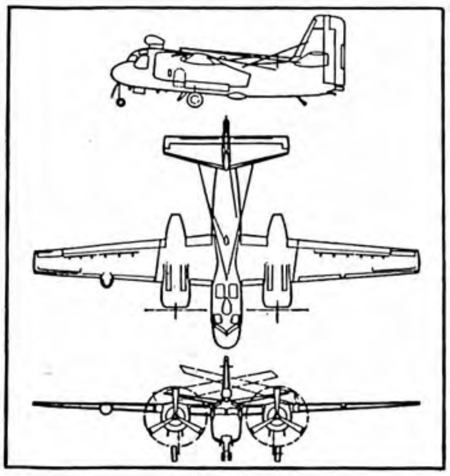
PERFORMANCE

All data are classified.



GRUMMAN S2F-3 TRACKER

GRUMMAN AIRCRAFT ENGINEERING CORP., Bethpage, Long Island, New York



REMARKS

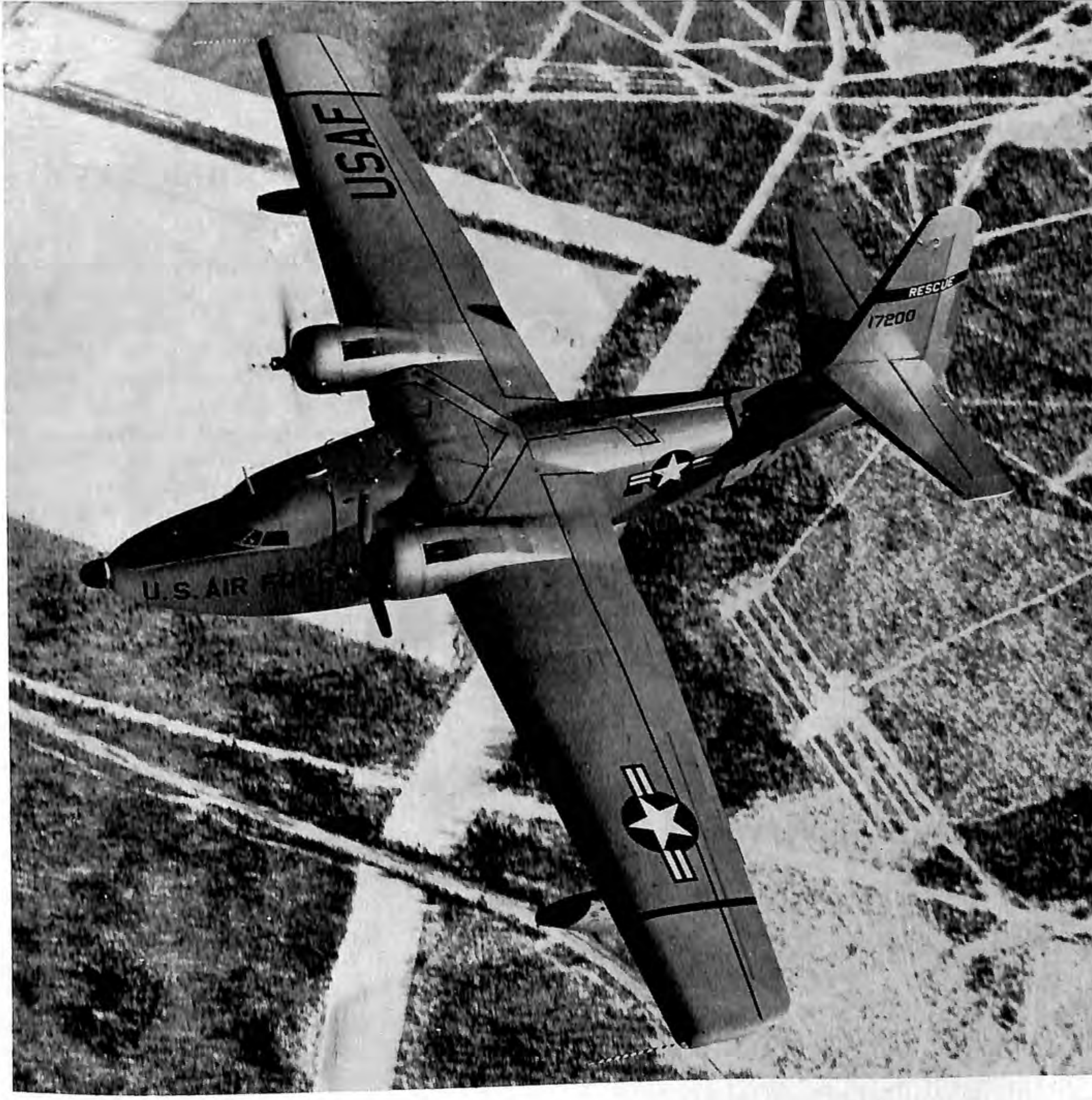
Already delivered to the U. S. Navy, the S2F-3 Tracker is a later version of the S2F-1, still in general use as the main carrier-based, anti-submarine warfare aircraft of U. S. Navy fleet units. The "dash 3" will eventually replace the S2F-1. The new Tracker has basically the same air frame as the S2F-1 but carries greatly improved search and detection equipment. The Tracker performs both the "hunter" and "killer" mission for fleet units.

SPECIFICATIONS

Span 69 ft. 8 in.; Length 42 ft. 3 in.; Height 16 ft. 3 in.; Engines Two Wright R1820-82, 1525 hp takeoff.

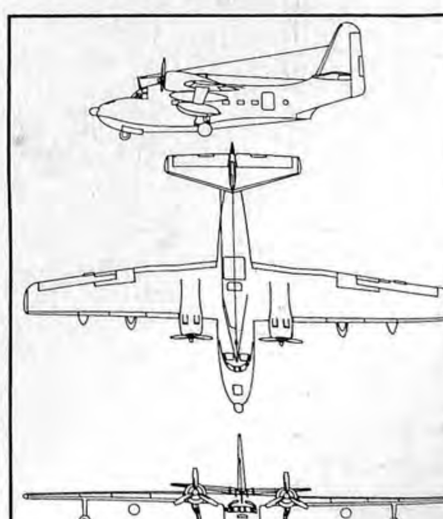
PERFORMANCE

All data are classified.



GRUMMAN SA-16B ALBATROSS

GRUMMAN AIRCRAFT ENGINEERING CORP., Bethpage, Long Island, New York



REMARKS

The Albatross, Grumman's largest amphibian, is used by the Air Force, Navy, and Coast Guard as a general utility aircraft capable of performing as a hospital plane or for air-sea rescue, cargo, transport or photographic duty. On active service with every Air Force Rescue Squadron throughout the world. Crew: 6. The SA-16B, a long-range, faster version (pictured), has a greater wingspan and larger horizontal and vertical surfaces than the SA-1A, and is being integrated into Air Force, Coast Guard and Navy service.

SPECIFICATIONS

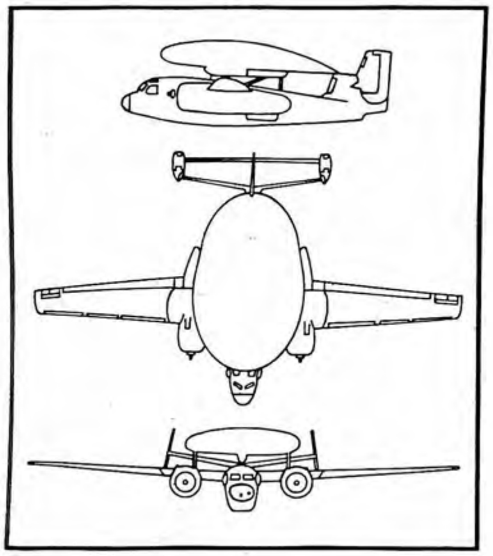
Span 96 ft. 8 in.; Length 61 ft. 4 in.; Height 25 ft. 10 in.; Engines Two Wright R-1820-76, 1425 hp takeoff.

PERFORMANCE

Maximum Speed Military Power-Sea Level 236 mph; Cruise Speed Normal 207 mph.

GRUMMAN WF-2 TRACER EARLY WARNING AIRCRAFT

GRUMMAN AIRCRAFT ENGINEERING CORP., Bethpage, Long Island, New York



REMARKS

The "saucer-topped" WF-2 Tracer, designed to fill one of the Navy's most important roles in the national defense picture by providing early warning to fleet units of impending attacks by enemy air and sea forces, is a modification of Grumman's S2F Tracker and TF-1 Trader, the three airplanes having basically the same airframe structure. The airplane's huge radome, largest yet designed for a carrier-based aircraft, houses long-range detection equipment. As a direct descendent of the TF-1 Trader, major modification—beyond the attachment of the radome—was required in the design of the Tracer's tail assembly. A dual-fin arrangement was decided on to reduce possible radome wake effects on vertical surfaces. In addition, wing fold assembly was changed from more conventional vertical or overhead folding to a "sto-wing" system similar to that used on Grumman's famous World War II Avenger.

SPECIFICATIONS

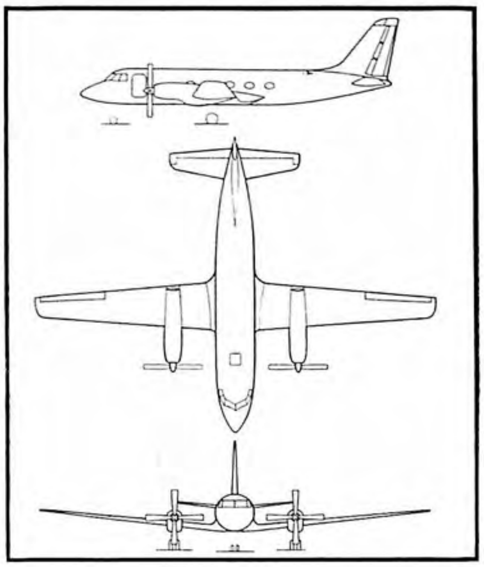
All data are classified.

PERFORMANCE

All data are classified.

GRUMMAN GULFSTREAM EXECUTIVE TRANSPORT

GRUMMAN AIRCRAFT ENGINEERING CORP., Bethpage, Long Island, New York



REMARKS

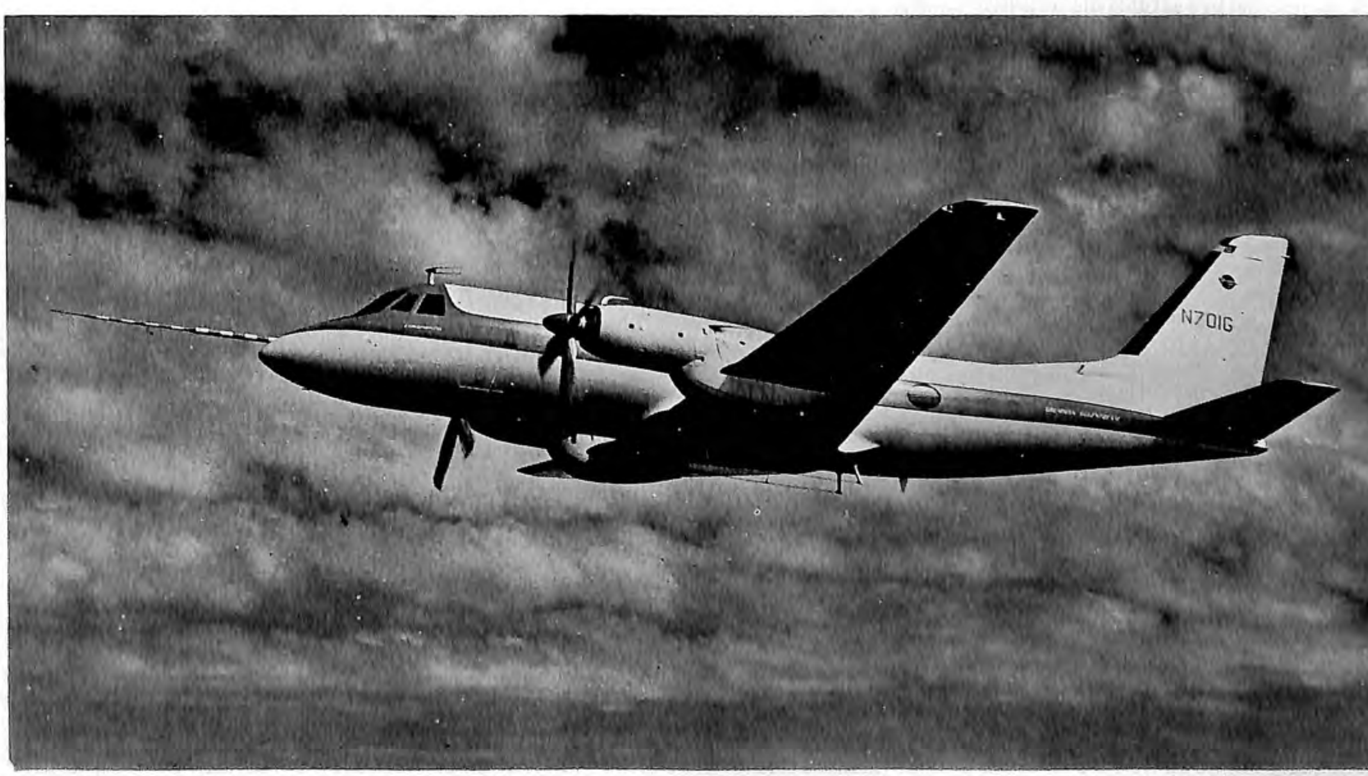
The Gulfstream marks Grumman's return to the commercial aviation market it abandoned at the outset of the Korean conflict. A propjet designed specifically for executive operation, it carries from ten to nineteen passengers (the latter a high-density version), the Gulfstream can operate from runways under 4000 feet long and has a range of 2200 miles, plus a reserve of 200 miles and 45 minutes fuel. Both number one and number two production models have undergone tests to obtain certification under CAR category 4b and SR422A regulation. The first airplane was delivered June 23, 1959.

SPECIFICATIONS

Span 78 ft. 6 in.; Length 64 ft.; Height 22 ft. 9 in.; Engines Two Rolls-Royce Dart RDa 7/2 propjets, 2190 eshp at 15,000 rpm takeoff; Fuel capacity 1540 gal.; Propeller Rotol.

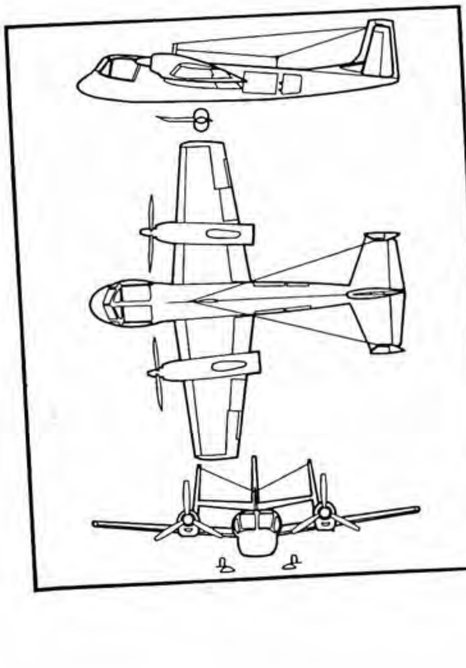
PERFORMANCE

Maximum Speed 350 mph at 14,400 rpm at 30,000 ft.; Cruise Speed 340 mph at 14,000 rpm at 25,000 ft.; Service Ceiling 36,000 ft.; Range with Maximum Payload of 4880 lb. 1310 mi.; Range with Maximum Fuel Load 2200 mi.



GRUMMAN MOHAWK

GRUMMAN AIRCRAFT ENGINEERING CORP., Bethpage, Long Island, New York



REMARKS

Designed to operate from small unimproved fields, the Mohawk will be used by the Army for purposes of tactical observation; its "bug-eye" canopy offering exceptional visibility to its two-man crew. Featuring a 55-knot stall speed and relatively the same short takeoff and landing capabilities as the Army's present light-weight, single-engine airplanes, the Mohawk will be able to virtually "live" with the Army in the field.

SPECIFICATIONS

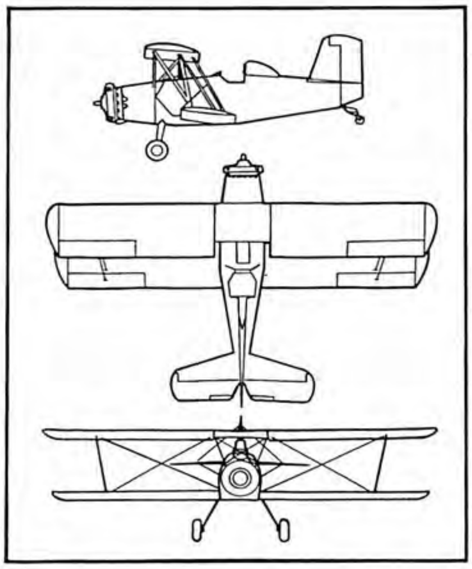
Span 42 ft.; Length 41 ft.; Height 12 ft. 8 in.; Wing Loading 35 lb. per sq. ft.; Power Loading 6 lb. per shp; Engines Two Lycoming T-53-L-3s, 865 eshp normal rated, or 1005 eshp at 1678 (prop) rpm takeoff; Fuel Capacity 292 gal.; Propeller Ham. Std. 53C51; Wing Area 330 sq. ft.; Aileron Area 22.7 (total) sq. ft.; Flap Area 43.6 (total) sq. ft.; Fin Area 12.0 (outb'd), 17.8 (center) sq. ft.; Rudder Area 9.5 ea. (outb'd), 8.0 (center) sq. ft.; Stabilizer Area 66 sq. ft.; Elevator Area 19.0 (total) sq. ft.

PERFORMANCE

Maximum Speed 325 mph at 1484 (total) shp at 1672 (prop) rpm at 13,000 ft.; Cruise Speed 207 mph at 670 (total) shp at 1320 (prop) rpm at 5000 ft.; Landing Speed 76 mph; Rate of Climb 2950 fpm at S. L.; Service Ceiling 33,000 ft.; Absolute Ceiling 33,500 ft.; Range with Maximum Payload 774 mi.; Range with Maximum Fuel Load 1557 mi.

GRUMMAN AG-CAT

GRUMMAN AIRCRAFT ENGINEERING CORP., Bethpage, Long Island, New York



REMARKS

The Ag-Cat was designed as a biplane to provide a maximum wing area, or lift-surface, with minimum wing span, a combination which permits making a continuous 1.5 "G"-turn at dusting speed and at maximum gross weight. Upper and lower wings are interchangeable. Each is torsionally stiffened with a minimum of external wires, a factor which greatly reduces rigging time.

All performance figures shown above, are for a maximum certificated weight of 3700 pounds. Slight differences exist depending on external equipment, i.e., whether equipped as a duster or sprayer.

Both the airspeed indicator and the engine tachometer have been placed on a separate panel forward of the cockpit in the pilot's flying line of vision, recognition having been given the fact that during dusting or spraying operations pilots have little time to look inside the cockpit. Other features of the Ag-Cat include maintenance-free, spring-steel landing gear, instant changeability from duster to sprayer, corrosion-proofed metal surfaces, interchangeability of all four ailerons, and a "sloping" nose which affords excellent visibility in normal flight attitude.

SPECIFICATIONS

Span 35 ft. 8 in.; Length 24 ft. 6 in.; Height 10 ft. 9 in.; Empty Weight 2127 lb., Wing Loading 11.3 lb. per sq. ft.; Power Loading 16.8 lb. per bhp; Engines Continental 220, Radial, 220 hp normal rated, or 220 hp at 2075 rpm takeoff; Fuel Capacity 34 gal.; Propeller McCauley; Wing Area 326 sq. ft.; Aileron Area 31.5 sq. ft.; Fin Area 9.0 sq. ft.; Rudder Area 12.0 sq. ft.; Stabilizer Area 22.8 sq. ft.; Elevator Area 22.2 sq. ft.

PERFORMANCE

Maximum Speed 114 mph at 220 hp at 2075 rpm at Sea Level; Cruise Speed 80 mph at 1800 rpm at 2500 ft.; Landing Speed 61 mph; Rate of Climb 490 fpm at Sea Level; Range with Maximum Payload 205 mi.; Range with Maximum Fuel Load 240 mi.; Design Agricultural Load 1200 lb.

GRUMMAN W2F-1 HAWKEYE

GRUMMAN AIRCRAFT ENGINEERING CORP., Bethpage, Long Island, New York

REMARKS: W2F-1 HAWKEYE

Hawkeye's greatly improved radar, computers, and high speed data relay system provide the U.S. Navy with an unprecedented early-warning-of-attack and intercept-control capability. The coordinated effort of Hawkeye's crew of five and this speedy information collection, evaluation, and relaying equipment is called ATDS (Airborne Tactical Data System). The nerve center of this veritable flying brain, the system provides fleet headquarters with the lead time necessary for offensive action in nullifying high mach number attacking aircraft. Powered by two Allison T-56 A8 turbo-prop engines, Hawkeye will be able to remain airborne for prolonged periods.

SPECIFICATIONS

Span 80 ft. 7 in.; Length 56 ft. 4 in.; Height 16 ft. (to top of radome); Engines Allison T56-A8, 4050 hp normal rated.

APPLICATIONS

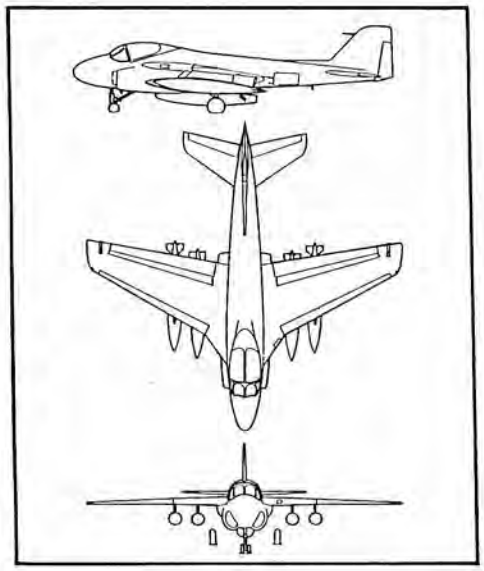
Early warning of attack and intercept control aircraft.

GRUMMAN A2F-1 INTRUDER

GRUMMAN AIRCRAFT ENGINEERING CORP., Bethpage, Long Island, New York

REMARKS: A2F-1 INTRUDER

Versatility of mission was the aim of Grumman designers of the A2F-1 Intruder, the Navy's first low altitude jet-powered attack aircraft. Truly an all-weather aircraft, the Intruder can fly long distances to deliver its nuclear punch or provide close support for tactical ground troops with conventional weapons. The aircraft can carry the broadest spectrum of current or programmed missiles. Key to the two-place, carrier-based aircraft's versatility is the aircraft's "integrated display system." Regardless of obscuring weather or darkness of night, this system enables cockpit occupants to "see" targets or the environment surrounding the aircraft by means of visual displays presented on viewing screens.



SPECIFICATIONS

Wing Span 53 ft.; Length 53 ft. 3 in.; Height 15 ft. 1 in. (to tip of tail); Engines two J-52-P6 Pratt & Whitney, rated at 8,500 lbs. of thrust each.

PERFORMANCE

All data are classified.

DSN-1 DRONE HELICOPTER

GYRODYNE COMPANY OF AMERICA, INC., St. James, Long Island, New York

REMARKS

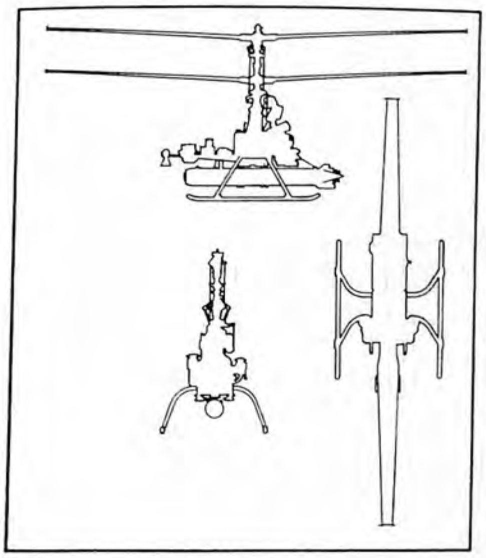
The Gyrodyne DSN-1 Drone Helicopter is a small, two-bladed coaxial helicopter with a rotor diameter of 20 feet and powered by a 72 horsepower Porsche reciprocating air-cooled engine. The production versions are Gyrodyne Drone Helicopters powered by a more powerful Boeing turbine engine and will operate from both modernized and newly built destroyers.

SPECIFICATIONS

Span 5.61 ft.; Length 7.70 ft.; Height 8.25 ft.; Empty Weight 560 lb.; Rotor Diameter 20 ft.; Disc Loading 2.82 lb. per sq. ft.; Power Loading 13 lb. per bhp; Engine One Porsche YO95-8, 72 hp normal rated, or 72 hp at 4500 rpm takeoff; Fuel Capacity 10 gal.

PERFORMANCE

Maximum Speed 78 mph at 72 hp at 4500 rpm at sea level; Cruise Speed 62 mph; Rate of Climb (Maximum) 956 fpm at sea level; Service Ceiling 8300 ft.; Range with Maximum Payload 75 mi.; Range with Maximum Fuel Load 112 mi.



DSN-2 HELICOPTER

GYRODYNE COMPANY OF AMERICA, INC., St. James, Long Island, New York

REMARKS

The DSN-2, in addition to being the second generation Drone test vehicle for the DASH Weapon System, is being slated for possible commercial production as a twin-engine ROTOR-CYCLE.

SPECIFICATIONS

Span 5.61 ft.; Length 7 ft.; Height 8.25 ft.; Empty Weight 813 lb.; Rotor Diameter 20 ft.; Disc Loading 4.60 lb. per sq. ft.; Power Loading 10.03 lb. per bhp; Engines Two Porsche YO95-4, 144 hp normal rated, or 144 hp at 4500 rpm takeoff; Fuel Capacity 20 gal.

PERFORMANCE

Maximum Speed 89 mph at 144 hp at 4500 rpm at sea level; Cruise Speed 72 mph; Rate of Climb (Maximum) 1160 fpm at sea level; Service Ceiling 8600 ft.; Range with Maximum Payload 88 mi.

DSN-3 DRONE HELICOPTER

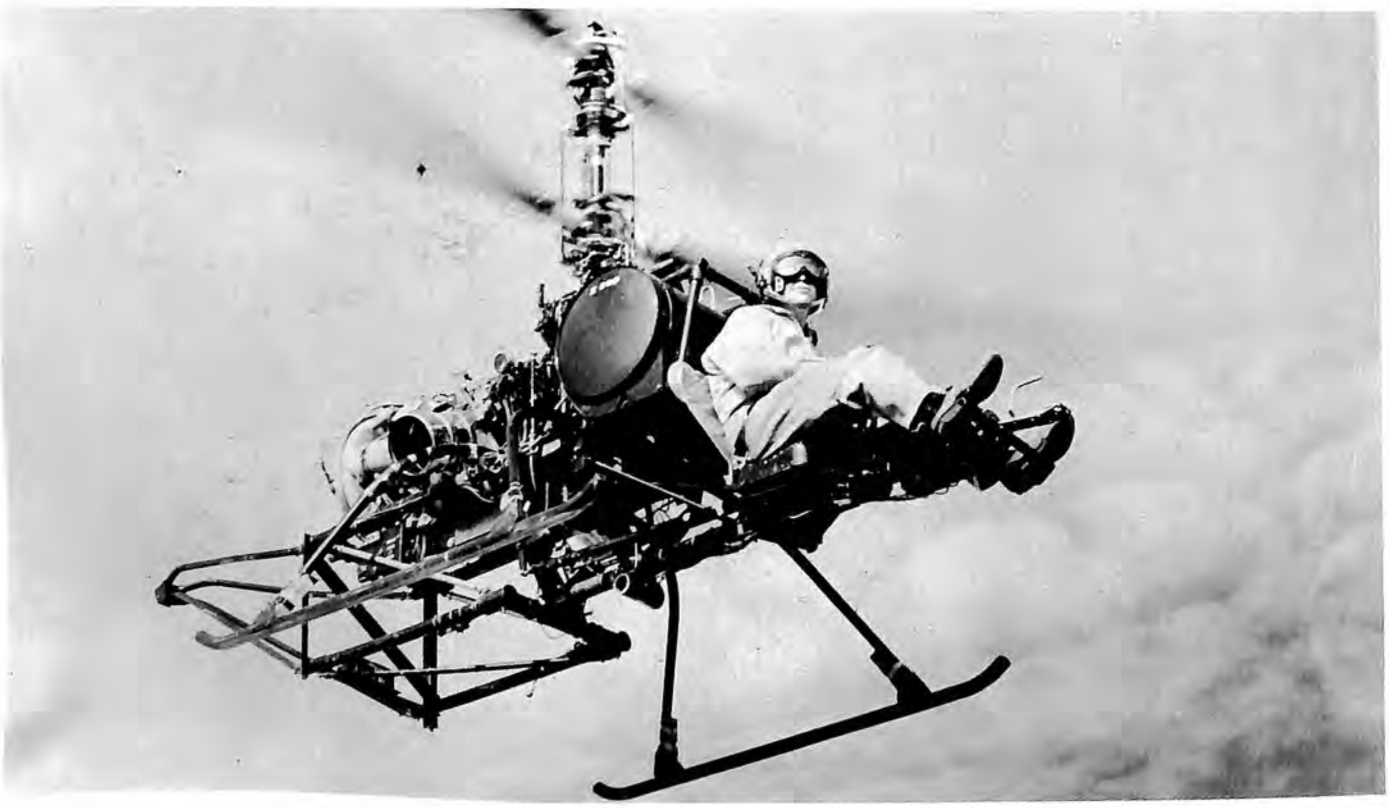
GYRODYNE COMPANY OF AMERICA, INC., St. James, Long Island, New York

SPECIFICATIONS

Engines Boeing T50-BO-4 Turbine, 270 hp normal rated.

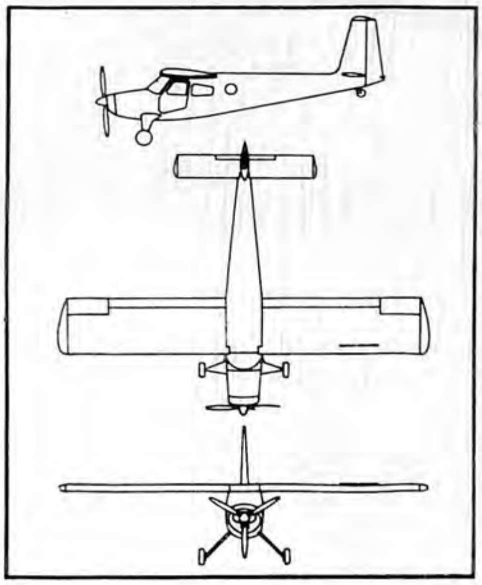
PERFORMANCE

All data are classified.



HELIO H-395 SUPER COURIER

HELIO AIRCRAFT CORP., Norwood, Massachusetts



REMARKS

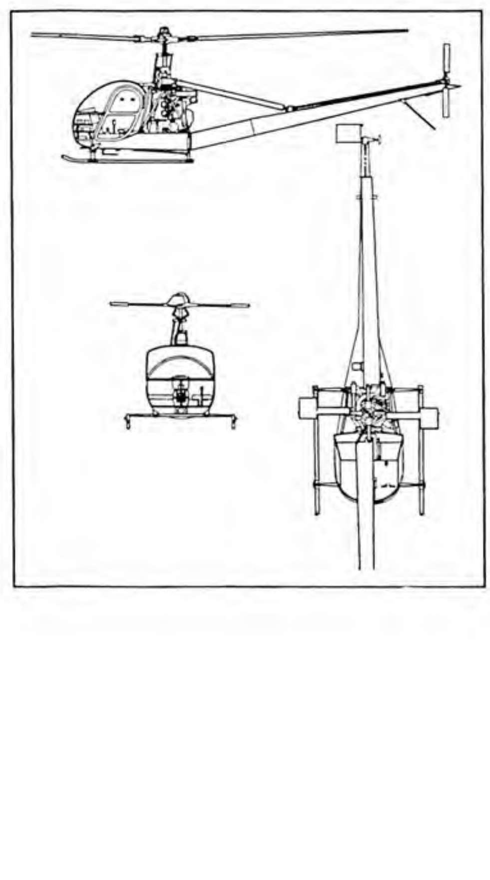
This five-place model H-395 Super Courier is a fast long-range efficient load-carrying STOL-type plane. It combines a high 170 mile-per-hour cruising speed and long-range economy with stall-proof 30 mile-per-hour slow flight and ultra short field utility (i.e., it is capable of taking off and landing over a 50-foot barrier in less than 500 feet with zero wind). It is a high-wing, full cantilever, all metal monoplane with a special heavy-duty landing gear; single piece, all-flying horizontal "stabilizers;" automatic, full-span leading edge slats; slot airflow "interceptors."

SPECIFICATIONS

Length 31 ft.; Height 8 ft. 10 in.; Span 39 ft.; Wing Area 231 sq. ft.; Empty Weight 2012 lb.; Gross Weight (Car Part 3), 3,000 lb.; Max. Industrial Gross Weight (CAR, Part 8), 3920 lb.; Engine 6-cycle 295 hp Lycoming GO-480 swinging a 3-bladed 96 in. diameter Hartzell propeller; Fuel Capacity 60 gal., standard; 120 gal., special. STOL.

PERFORMANCE

Maximum Speed 176 mph at Sea Level; Cruise Speed 170 mph at 8200 ft.; Speed 30 mph; Rate of Climb 1550 fpm; Service Ceiling 21,500 ft.; Maximum Range with standard 60-gal. tanks (10,000 ft. 146 mph) 842 mi.; Takeoff Run 217 ft. in zero wind, 130 ft. with 10 mph wind; Takeoff Distance over 50-ft. barrier 475 ft. in zero wind, 331 ft. in 10 mph wind; Landing Roll (40° flap) 169 ft. in zero wind; Landing Distance over 50-ft. barrier (40° flap) 493 in zero wind.



HILLER H-23D RAVEN

HILLER AIRCRAFT CORP., Palo Alto, California

REMARKS

The H-23D is the U.S. Army's standard Light Observation Helicopter and its primary helicopter trainer. First deliveries of this three-place 250 hp aircraft were made in 1958. In 1961 the H-23D was again selected by the Army in competitive evaluation, and Hiller will build the largest quantity yet awarded, with first deliveries begun in January, 1962. 156 H-23D's at Camp Wolters, Texas, fly up to 10,000 hours every month.

SPECIFICATIONS

Main Rotor Diameter 35.4 ft.; Anti-torque Rotor Diameter 5 ft. 5 in.; Length 27 ft. 8 in.; Height 9 ft. 8 in.; Empty Weight 1816 lb.; Power Loading 10.8 lb. per bhp; Engine One Lycoming VO-435-23B, 250 hp at 3200 rpm takeoff; Fuel Capacity 46 gal.

PERFORMANCE

Maximum Speed 95 mph at Sea Level; Cruise Speed 82 mph at Sea Level; Rate of Climb 1050 fpm at Sea Level; Service Ceiling 13,200 ft.; Absolute Ceiling 14,000 ft.; Range with Maximum Payload 197 mi.

HILLER 12E

HILLER AIRCRAFT CORP., Palo Alto, California

REMARKS

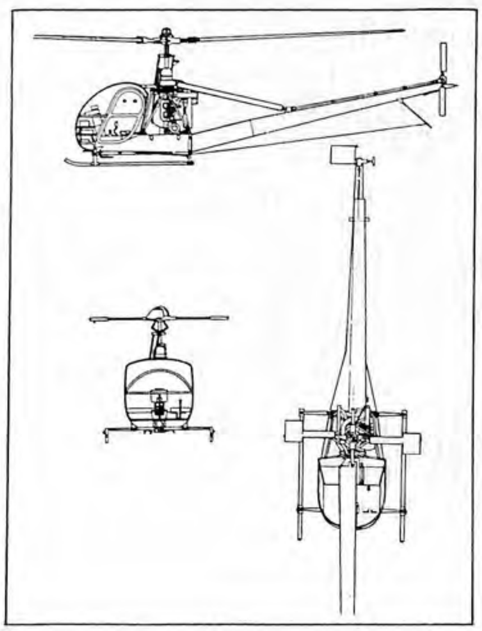
The three-place Hiller 12E, most powerful of light utility helicopters, has opened new markets not previously within the province of small rotor-craft. It was first to construct entire power line systems, the first to complete steel tower construction, the first aircraft to land above 18,000 ft. The 12E is the standard light observation helicopter for the Canadian Army and RCAF (designation CH-112). Powered by a 305 hp Lycoming engine, it is also delivered with dual carburetion providing the equivalent of 18 additional hp for high altitude performance.

SPECIFICATIONS

Main Rotor Diameter 35.4 ft.; Anti-torque Rotor Diameter 5 ft. 5 in.; Length 27 ft. 8 in.; Height 9 ft. 8 in.; Empty Weight 1700 lb.; Power Loading 9.02 lb. per bhp; Engine one Lycoming VO-540-A1A, 305 hp at 3200 rpm takeoff; Dual Carburetion for equivalent 18 hp additional; Fuel Capacity 46 gal.

PERFORMANCE

Maximum Speed 96 mph at Sea Level; Cruise Speed 90 mph at Sea Level; Rate of Climb 1340 fpm; Hover Ceiling 11,400 ft.; Service Ceiling 17,600 ft.; Absolute Ceiling 18,000 ft.; Range with Maximum Payload 225 mi.; Range with Standard Fuel Load 225 mi.



HILLER E4 STATION WAGON; H-23F (ARMY)

HILLER AIRCRAFT CORP., Palo Alto, California

REMARKS

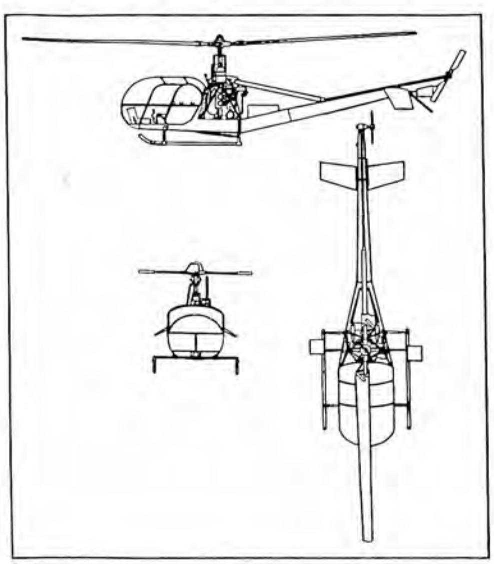
The Hiller E4 is a four-place helicopter using the station wagon approach—personnel carrier or flying pickup truck. The E4 uses the same basic airframe and powerplant as the famous 12E, plus upgraded horsepower gained by dual carburetors and, as kit installation, high compression pistons. Special accessories designed for the aircraft include power-lock cargo hook and power hoist, cabin heater and defroster, soundproofing, and a wide range of accessories for passenger comfort and increased contract utilization.

SPECIFICATIONS

Main Rotor Diameter 35.4 ft.; Anti-torque Rotor Diameter 5 ft. 5 in.; Length 29.8 ft.; Height 9.8 ft.; Empty Weight 1777 lb.; Power Loading 9.02 bhp; Engine One Lycoming VO-540-AIA, 305 hp at 3200 rpm take-off; Fuel Capacity 46 gal.

PERFORMANCE

Standard E4 performance figures: 820 fpm Vertical Rate of Climb, cruising at 90 mph, and with a useful load of 973 lb.



HOWARD 500

HOWARD AERO, INC., San Antonio, Texas

REMARKS

Model Howard 500 twin-engine executive transport offers an excellent power-to-weight ratio and a high useful load affording more range under a wide range of conditions. Advertised price is $594,000.

SPECIFICATIONS

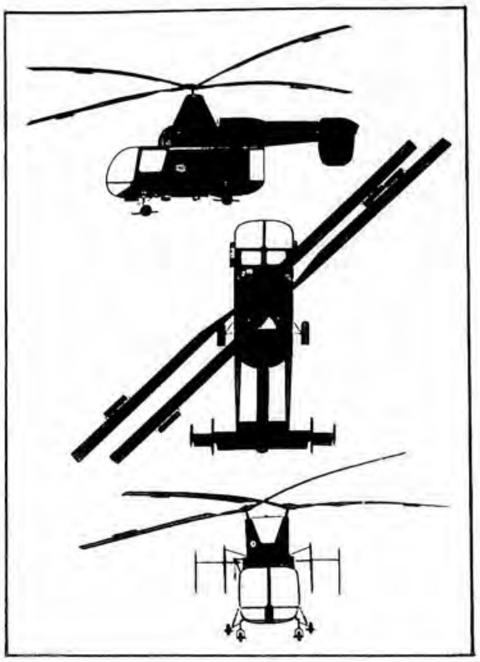
Span 70 ft. 4 in.; Length 57 ft. 10 in.; Height 13 ft. 8 in.; Empty Weight 22,000 lb.; Wing Loading with takeoff flap extended 52.63 lb. per sq. ft.; Cruise configuration at 34,000 lb., gross weight 57.41 lb. per sq. ft.; Power Loading 6.80 lb. per bhp; Single Engine Power Loading 13.60 lb. per bhp; Engines Two Pratt & Whitney R-2800s, CB 16/17; CB-17 hp normal rated, or 2,500 hp (each) at 2,800 rpm takeoff; Fuel Capacity 1556 gal.; Propeller HS-24E60-7037 A-50; Wing Area 592.22 sq. ft.; Aileron Area 17.525 sq. ft.; Flap Area 53.75 sq. ft.; Vertical Stabilizer Area 14.64 sq. ft.; Rudder Area 17.417 sq. ft.; Horizontal Stabilizer Area 93.18 sq. ft.; Elevator Area 35.32 sq. ft.

PERFORMANCE

Maximum Speed over 400 mph at 1,500 hp at 2,600 rpm at 16,000 ft.; Cruise Speed 350 mph at 1,200 hp at 2,200 rpm at 21,000 ft.; Landing Speed 88 mph; Rate of Climb 2,400 (@ METO) fpm at Sea Level; Service Ceiling 35,000 ft.; Absolute Ceiling over 40,000 ft.; Range with Maximum Payload 2,570 mi.; Range with Maximum Fuel Load 2,800 mi.

KAMAN H-43B HUSKIE

KAMAN AIRCRAFT CORP., Bloomfield, Connecticut



REMARKS

A general utility helicopter in use by USAF for local base crash rescue, the H-43B, Kaman Huskie is an outgrowth development of the USAF H-34A, but the Huskie has twice the interior space and twice the payload capacity. The rotor system, as in preceding models, is a synchropter with two counter rotating, intermeshing main rotors which inherently overcome torque and require no tail rotor. Air Force orders to date call for 175 of these rugged, maneuverable aircraft.

SPECIFICATIONS

Rotor Diameter 47 ft.; Length 25 ft.; Height 12 ft. 7 in.; Engine Lycoming T53, 860 hp.

PERFORMANCE

Maximum Speed 103 knots at 1000 ft.; Cruise Speed 95 knots; Maximum Rate of Climb 2000 fpm; Service Ceiling 25,000 ft.; with Maximum Payload 228 nautical mi.

KAMAN HU2K SEASPRITE

KAMAN AIRCRAFT CORP., Bloomfield, Connecticut

REMARKS

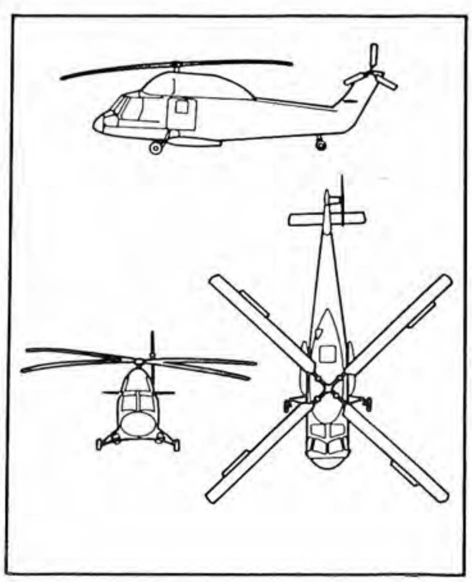
The Navy's new, high-speed utility helicopter Kaman's HU2K, Seasprite, will carry out a wide variety of missions from ships at sea and from shore bases. These will include plane guard duty with aircraft carriers where the helicopters are kept in the air during takeoffs or landings, and the helicopter is immediately ready to go to the rescue of airmen downed at sea. The HU2K will also be used for search, rescue, aerial ambulance activities, personnel transportation and the carrying of supplies from ship-to-ship and ship-to-shore. The Seasprite's advanced electronic stabilization and navigation gear, plus its compact size and ability to carry additional electronic equipment, give it submarine detection and attack capability. The new ship has retractable landing gear and Kaman's "servo-flap" control system.

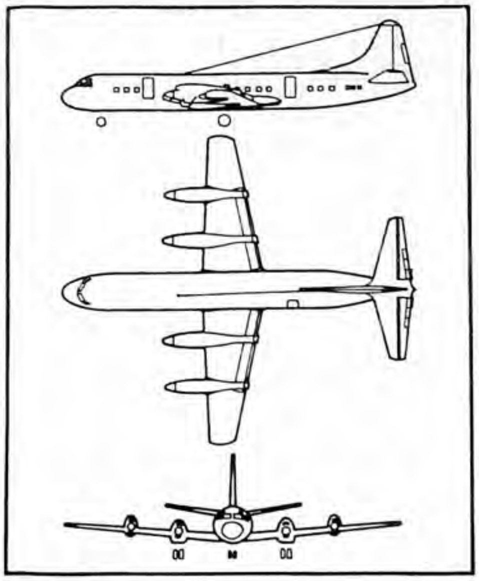
SPECIFICATIONS

Main Rotor Diameter 44 ft.; Length 52 ft. 2 in. (operating); Height 12 ft. 5 in.; Empty Weight 5052 lb.; Engine One General Electric T-58-8, hp military power 1250. Internal Fuel Capacity 276.0 gal.; Stabilizer Area 15.0 sq. ft.

PERFORMANCE

All data are classified.





LOCKHEED ELECTRA

LOCKHEED-CALIFORNIA COMPANY, Burbank, California

REMARKS

The first Electra was airborne in 1957, and by mid-1961 averaged 4300 revenue flights a week, or the equivalent of one landing or takeoff every 70 seconds. Designed primarily for heavily traveled short-to-medium-range routes, the Electra is capable of transcontinental nonstop flight. However, it specializes in economical operation on shorter stages, rapid turnaround time at intermediate stops, altitude flexibility, fast block speeds on short and medium-range flights. It carries from 66 to 98 passengers. It is powered by four Allison 501 propjet engines developing 3750 horsepower each and Aero-products 606, or Hamilton Standard, four-bladed propellers. Its powerplants are half the weight of comparable piston engines and fit into nacelles only half as wide as for reciprocating units. Both cockpit and cabin feature excellent visibility, independent climate controls. Test flight program began well before flight of the first article, with both Lockheed and Allison flying the Electra's powerplants on other test vehicles. Eastern Air Lines put the Electra in service early in 1959. Other airlines ordering the Electra include American Airlines, National Air Lines, Braniff International Airways, Western Air Lines, KLM Royal Dutch Airlines, Cathay Pacific, PSA-Pacific Southwest Airlines, Garuda Indonesian Airways, Ansett/ANA, Qantas Empire Airways, Trans-Australia Airline, Tasman Empire Airways, and Northwest Orient Airlines.

SPECIFICATIONS

Span 99 ft.; Length 104 ft. 8 in.; Height 32 ft. 10.5 in.; Empty Weight 57,300 lb.; Maximum Gross Weight 116,000 lb.; Engines Four Allison 501 D-13 propjet, 3750 hp normal rated; Fuel Capacity 5520 gal.; Wing Area 1300 sq. ft.

PERFORMANCE

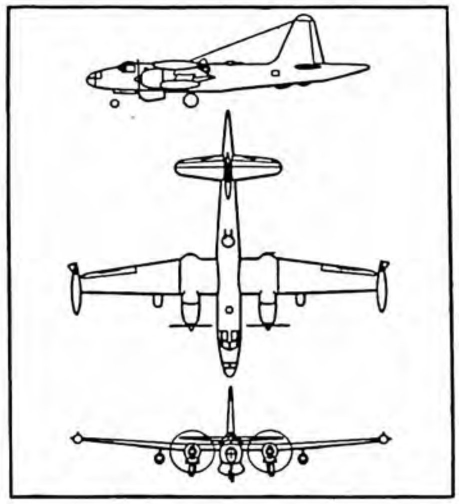
Maximum Speed 450 mph; Cruise Speed 405 mph; Rate of Climb 2400 fpm; Service Ceiling 30,000 ft.; Range with custom interior and maximum payload 2700 mi.; Range with Maximum Fuel Load (1000 extra gal.) 3400 mi. with 2 hr. reserves.

LOCKHEED P2V-7 NEPTUNE

LOCKHEED-CALIFORNIA COMPANY, Burbank, California

REMARKS

The P2V-7 is the latest in the Neptune anti-submarine series. Identifying features are jet pod engines supplementing its turbo-compound powerplants, and an elongated tail housing MAD (magnetic anomaly detector) gear for locating underwater craft. A versatile plane, the Neptune can be converted for patrol, mine laying or torpedo bomber duty. The jet engines, included now on all production planes, can be used whenever desired: for extra power on takeoffs and extra speed at any time during mission. Lockheed modified earlier P2V-5 and P2V-6 airplanes with jet pods. Four ski-equipped Neptunes were flown by Navy in Operation Deep-freeze III at South Pole.

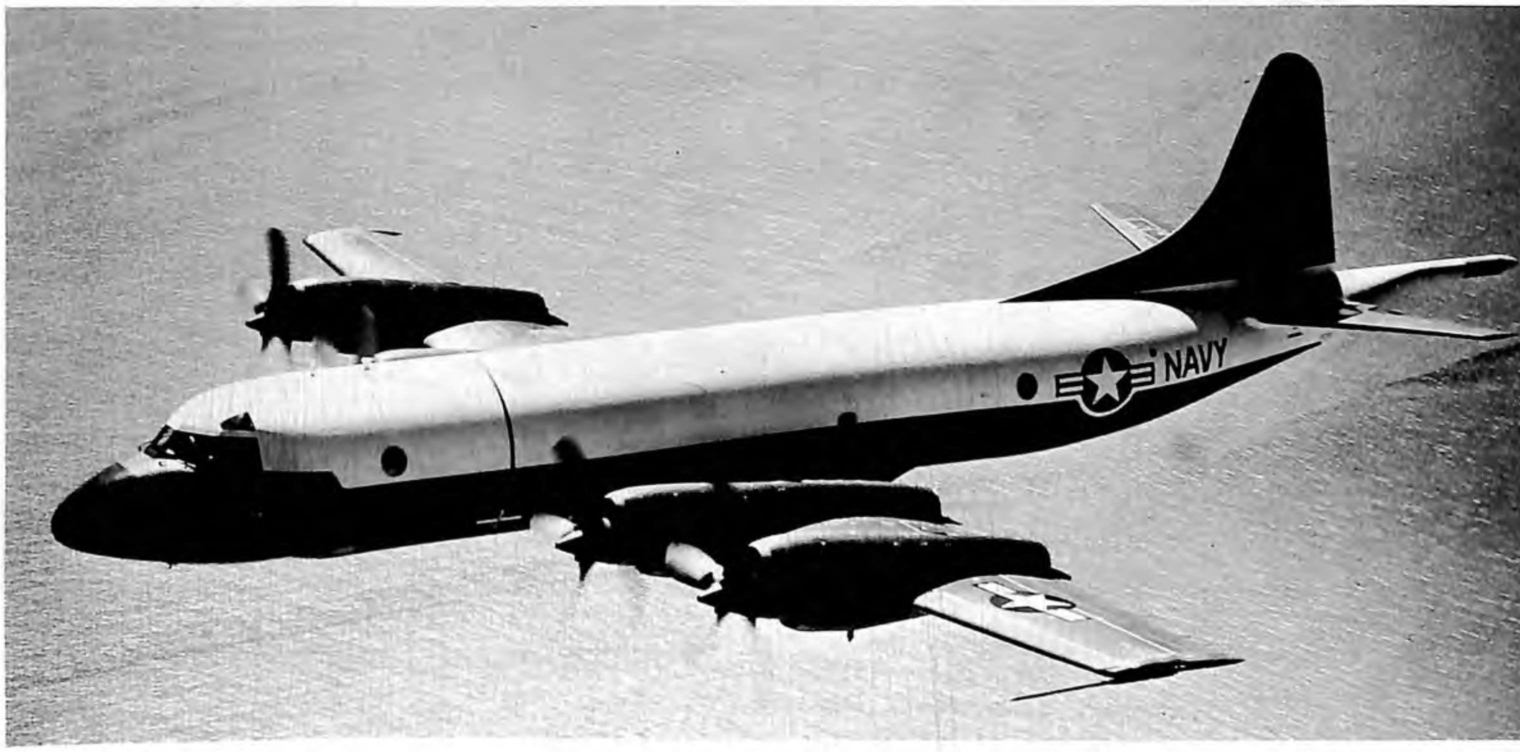


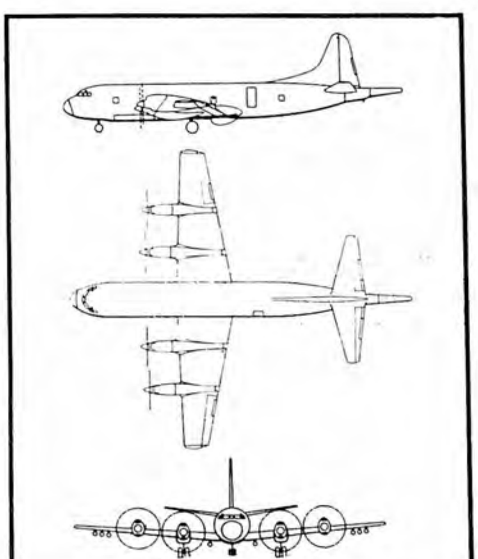
SPECIFICATIONS

Span 101 ft. 4 in. with tip tanks; Length 91 ft. 8 in.; Height 29 ft. 4 in.; Empty Weight 46,088 lb., with jet pod engines 49,548 lb.; Gross Weight 76,278 lb., with jet pods 79,778 lb.; Engines Two Wright R-3350-32W turbo-compound 2800 hp normal rated, and Two Westinghouse J34 engines in pods, 3400 lb. thrust; Propeller Hamilton Standard four-blade; Wing Area 1000 sq. ft.

PERFORMANCE

Maximum Cruise Speed ASW mission with pods at 20,000 ft. at 389 mph; Service Ceiling 22,000 ft. without pods.





LOCKHEED ASW P3V-1 ORION
LOCKHEED-CALIFORNIA COMPANY, Burbank, California

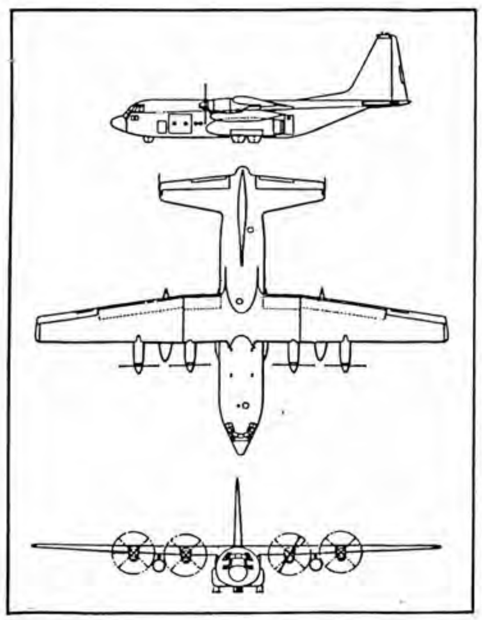
REMARKS
Many production orders for this aircraft assure production well into 1963. The P3V-1 cruises about twice as fast as the P2V-7 Neptune and has 40 percent more range. It can search 280,000 square nautical miles of coastal area in a single flight at a cost of about one cent a square mile. It can carry a crew of ten and two and one half tons of communications, navigation and detection equipment.

SPECIFICATIONS
Span 99 ft. 8 in.; Length 116 ft. 10 in.; Height 33 ft. 8.5 in.; Wing Loading 77.5 lb. per sq. ft. at 101,500 lb.; Power Loading 6.9 lb. per eshp; Engines Four Allison T-56-A-10W, 4500 eshp; Fuel Capacity 9200 gal.; Propeller Hamilton Standard 4-bladed 13½ ft.; Wing Area 1300 sq. ft.

PERFORMANCE
Maximum Speed 465 mph; Cruise Speed 420 mph. Service ceiling more than 30,000 ft.

LOCKHEED C-130B HERCULES

LOCKHEED-GEORGIA COMPANY Marietta, Georgia



REMARKS

The C-130B is another in the series of C-130 Hercules transports which have been produced at the Georgia Division of Lockheed. The first C-130As were delivered to the Tactical Air Command in 1956. This newer model features higher power engines and greater fuselage pressurization, and improved performance and payload-range capabilities. As much as 19 tons of cargo can be airlifted for delivery by parachute or landing. The Lockheed Georgia Division also produces these variants of the C-130B: the SC-130B long-range air search and rescue aircraft for the Coast Guard; the C-130BL ski-equipped transport for the Navy; and the GV-1 inflight refueler and assault transport for the Navy and Marine Corps.

SPECIFICATIONS

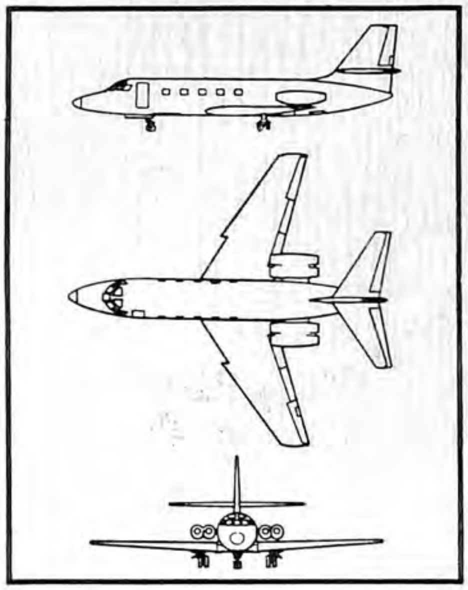
Span 132 ft. 7 in.; Length 97 ft. 9 in.; Height 38 ft. 4 in.; Empty Weight 67,550 lb.; Wing Loading 77.4 lb. per sq. ft.; Power Loading 8.3 lb. per eshp; Engines 4 Allison T56-A-7, 3730 eshp normal rated, or 4050 at 13,820 rpm takeoff; Fuel Capacity 6960 gal.; Propeller Hamilton Standard 4 blades, 13.5 ft. diameter; Wing Area 1745 sq. ft.; Aileron Area 110 sq. ft.; Flap Area 342 sq. ft.; Fin Area 225 sq. ft.; Rudder Area 75 sq. ft.; Stabilizer Area 381 sq. ft.; Elevator Area 155 sq. ft.

PERFORMANCE

Maximum Speed 375 mph at normal power at 25,000 ft.; Cruise Speed 350 mph; Rate of Climb 2250 fpm at Sea Level; Service Ceiling at Maximum Weight over 28,000 ft.; Range with Maximum Payload 2530 mi.; Range with Maximum Fuel Load over 4000 mi.

LOCKHEED C-140 JETSTAR

LOCKHEED-GEORGIA COMPANY, Marietta, Georgia



REMARKS

At year end 1961, multi-mission compact jet C-140 JetStars were in service with the Special Air Mission fleet (MATS) of the U.S. Air Force and others were being prepared for delivery in April, 1962, to the Air Force Communication Service for use in checking navigational aids and air traffic control systems at USAF bases over the world. The aircraft, which, in its corporate version seats eight passengers and a crew of two, received a Type 4B transport certificate from the Federal Aviation Agency in August. The first four-engine compact jet transport in corporate operation, the JetStar was delivered to business firms in the United States and West Germany during the last quarter of the year. The Canadian Department of Transport will put one into operation in January, checking navigational aids and traffic control facilities. The C-140 is powered by four Pratt and Whitney jet engines, which are mounted to the rear fuselage for quietness, comfort, and safety. (Military designation of the engine is J-60, corporate designation JT-12). The C-140 JetStar possesses the navigational and communication equipment of the huge jet airliners, and it is pressurized and air conditioned for flights to 43,000 feet. However, this compact jet plane operated from short runways built to serve the slower, propeller-driven aircraft.

SPECIFICATIONS

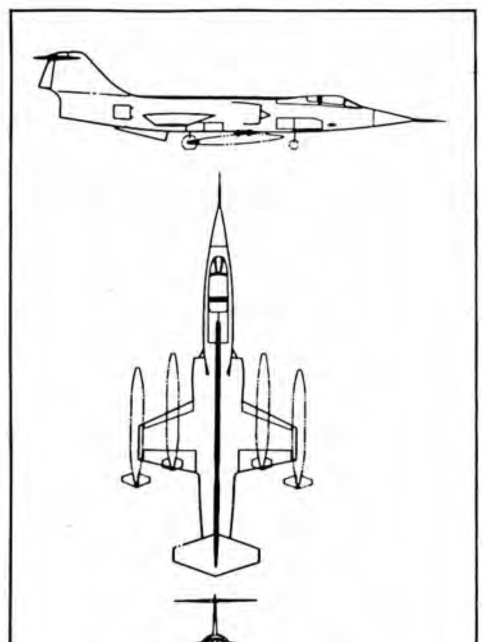
Span 54 ft. 5 in.; Length 60 ft. 5 in.; Height 20 ft. 5 in.; Empty Weight 19,800 lb.; Wing Loading 75.5 lb. per sq. ft.; Power Loading 3.4 lb. per lb. of thrust; Engines Four Pratt & Whitney JT 12A-6; Axial flow turbojet, 3000 lb. at 16,350 rpm takeoff; Fuel Capacity 2580 gal. with two 565 gal. external tanks; Wing Area 542.5 sq. ft.; Aileron Area 24.4 sq. ft.; Flap Area 62.6 sq. ft.; Fin Area 94.0 sq. ft.; Rudder Area 16.2 sq. ft.; Stabilizer Area 117.8 sq. ft.; Elevator Area 31.2 sq. ft.

PERFORMANCE

Speed for warranty cruise thrust at 25,000 ft. is 550 mph; at 40,000 ft. this speed is 510 mph; Landing speed 120 mph; Rate of Climb 4400 (30,000 lb. weight) fpm at sea level; Maximum certificated altitude, 43,000 ft.; Maximum payload 5200 lbs.; Range with eight passengers and maximum fuel load, 2500 statute miles (with 45 minute reserve).

LOCKHEED F-104 SUPER STARFIGHTER

LOCKHEED-CALIFORNIA COMPANY, Burbank, California



REMARKS

Lockheed's 1500-mph, multi-mission F-104 Super Starfighter currently is in production at the company's Burbank and Palmdale, California, factories for Germany, Canada, The Netherlands, Belgium, Italy and Japan. Additional quantities of Super Starfighters are being manufactured in Europe for Germany, The Netherlands, Belgium and Italy. The Lockheed-licensed project will involve production facilities in each country. Super Starfighters also will be produced in Canada for the Royal Canadian Air Force and in Japan for the Japanese Air Self Defense Force. The Lockheed-California Company also is producing Super Starfighters for countries scheduled to receive military aid from the U.S. Mutual Assistance Program. Early-model F-104Cs currently are serving with the United States Air Force's Tactical Air Command. A double-sonic F-104A Starfighter in 1958 set world records for speed, altitude and time-to-climb to seven different heights. In December of 1959, an F-104C Starfighter set a new world altitude mark of 103,395.5 ft. The high-performance fighter in 1959 received the Collier Trophy for its contribution to aviation.

SPECIFICATIONS

Span 21 ft. 11 in.; Length 54 ft. 9 in.; Height 13 ft. 6 in.; Engine General Electric J79, rated at 15,000 lb. of thrust.

PERFORMANCE

Maximum Speed Mach 2 class; Service Ceiling, upper atmosphere.

LOCKHEED 60 BUSH TRANSPORT

LOCKHEED AIRCRAFT INTERNATIONAL, INC., Los Angeles 14, California

REMARKS

Lockheed 60, designed in U.S. by Lockheed and certificated by the FAA, is in production on three continents—by Lockheed-Azcarate S.A. in San Luis Potosi, Mexico; Aviones Lockheed-Kaiser S.A., Cordoba, Argentina; and Aeronautica Macchi, Varese (Milan), Italy. Lockheed Aircraft International holds distribution rights on the Lockheed 60 for the U.S., Canada, and Australasia.

SPECIFICATIONS

Span 39 ft. 4 in.; Length 28 ft. 1 in.; Height 10 ft. 8 in.; Empty Weight 2185 lb.; Wing Loading 16.8 lb. per sq. ft.; Power Loading 13.6 lb. per bhp; Engine One Continental (fuel injection) TSIO-470B turbo-supercharged, 260 hp normal rated, or 260 hp at 2600 rpm takeoff; Fuel Capacity 57 gal.; Propeller 86 in. McCauley; Wing Area 210 sq. ft.; Aileron Area 23.5 sq. ft.; Flap Area 40 sq. ft.; Fin Area 15.6 sq. ft.; Rudder Area 7.2 sq. ft.; Stabilizer Area 36 sq. ft.; Elevator Area 18.4 sq. ft.

PERFORMANCE

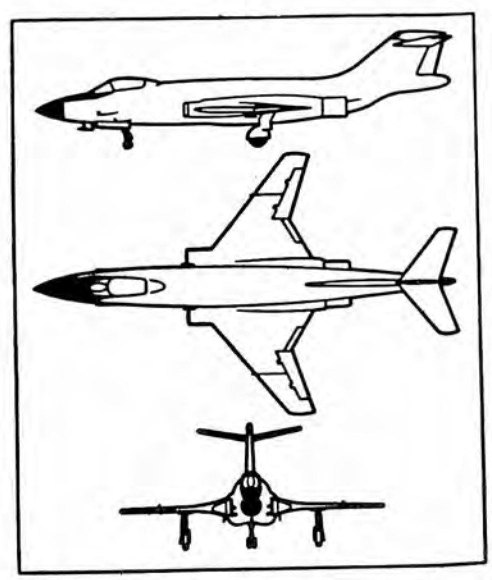
Maximum Speed 169 mph at 260 hp at 2600 rpm at 12,400 ft.; Cruise Speed 143 mph at 169 hp at 2400 rpm at 12,500 ft.; Landing Speed 53 mph; Rate of Climb 940 fpm at Sea Level; Service Ceiling 22,500 ft.; Absolute Ceiling 26,000 ft.; Range with Maximum Fuel Load 550 (with reserve) mi.

McDONNELL F-101B VOODOO

McDONNELL AIRCRAFT CORP., St. Louis 3, Missouri

REMARKS

The McDonnell F-101B, a two-place, twin-engine interceptor, is a potent weapon system in operational squadrons of the Air Defense Command. It combines speed and long-range characteristics. Equipped with MB-1 Genie rockets and Falcon missiles, the Voodoo is effective protection against enemy aircraft which might approach United States territory with hostile intent. Although performance data on the Voodoo interceptor are classified, a sister ship the F-101A, is credited with speeds of more than 1200 miles an hour. In addition to being a long-range interceptor, the F-101B has exceptional "climb" performance and operates at extremely high altitudes. It is capable of delivering advanced nuclear weapons in all kinds of weather at any target—airborne or ground—visible or invisible. The modern weapon system has every basic ingredient for the defense of the Free World—the speed to overtake and the range to intercept; the firepower to destroy all types of targets in any weather, and the margin of safety to return from the mission. The F-101B is now operating in 18 ADC squadrons. The six-year production run of more than 800 Voodoos was completed in December, 1960.



SPECIFICATIONS

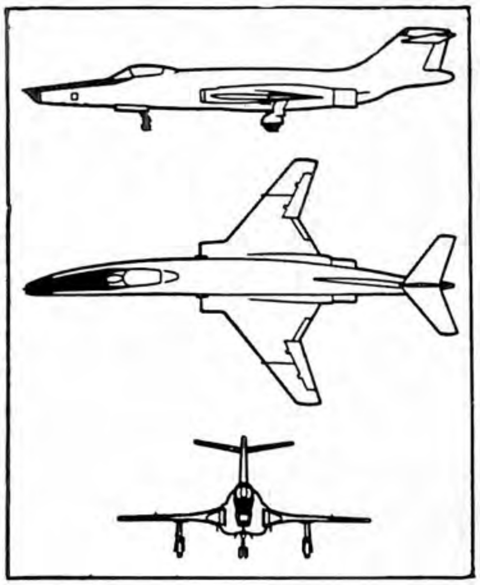
Span 39 ft. 8 in.; Length 67 ft.; Height 18 ft.; Empty Weight 26,277 lb.; Engines Two J57-P-13, 10,000 lb. thrust normal rated, or 15,000 with AB thrust; Fuel Capacity 2249 gal.; Wing Area 368 sq. ft.

PERFORMANCE

Maximum Speed 1200+ mph.

McDONELL RF-101 VOODOO

McDONNELL AIRCRAFT CORP., St. Louis 3, Missouri



REMARKS

The RF-101 Voodoo has a top speed in excess of 1000 miles per hour and makes supersonic photo missions a matter of routine. It has the capability to photograph from 45,000 feet altitude an area 217 miles long and 8 miles wide, plus an area mosaic equivalent to 20,000 square miles. First squadron deliveries of the RF-101 were made to the Tactical Air Command's 363rd Tactical Reconnaissance Wing at Shaw Air Force Base, near Columbia, South Carolina, on May 6, 1957. The RF-101, one of three versions of the Voodoo series designed and built by McDonnell Aircraft, has very long range, which is greatly extended by in-flight refueling capability. This high-speed aircraft is well suited for its role in TAC's Air Strike Force operations. The RF-101 closely resembles its fighter counterpart. Slightly lighter in weight, the RF-101 has the same high-performance characteristics as the fighter version of the Voodoo. A combination viewfinder provides the pilot with a clear view of the terrain below and ahead of the airplane. Utilizing cockpit controls, the pilot can operate the entire camera system while in flight. After the basic instructions are "fed" into the system, the photo procedure becomes completely automatic. Several different types of cameras can be quickly interchanged through large access doors, making it possible to carry out any type of photo-reconnaissance mission on short notice.

SPECIFICATIONS

Span 39 ft. 8 in.; Length 69 ft. 3 in.; Height 18 ft.; Empty Weight 26,136 lb.; Engines Two J57-P-13, 10,000 lb. hp normal rates, or 15,000 with AB hp; Fuel Capacity 2146 gal.; Wing Area 368 sq. ft.

PERFORMANCE

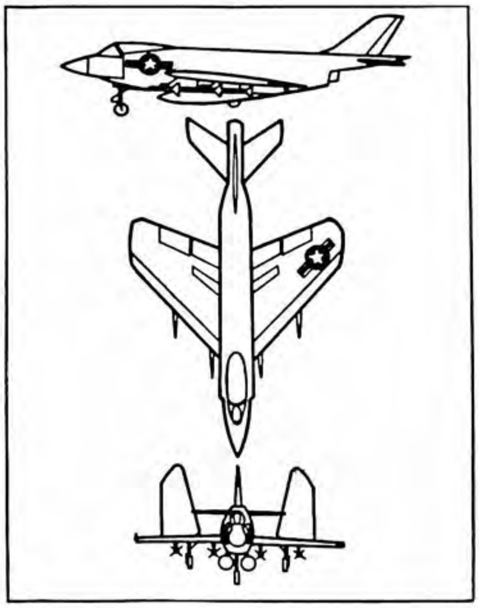
Maximum Speed 1200+ mph.

McDONNELL F3H DEMON

McDONNELL AIRCRAFT CORP., St. Louis 3, Missouri

REMARKS

The McDonnell F3H Demon is a single-place, all-weather, carrier-based jet fighter that is currently in service with the U.S. Navy fleets in all parts of the world. Powered by a Single Allison J71 afterburning engine, the airplane carries all-weather fire control radar and is armed with four 20mm cannon and a variety of wing-mounted air-to-air missiles, including Sparrow IIIs and Sidewinders. In addition, the Demon can carry a heavy load of bombs and/or external fuel tanks. Production of the fleet-configured Demon commenced in 1955 and ended with the delivery of the 519th Demon to the U.S. Navy in November, 1959. It has been succeeded on McDonnell assembly lines by the newer and higher-performance F4H Phantom II.



SPECIFICATIONS

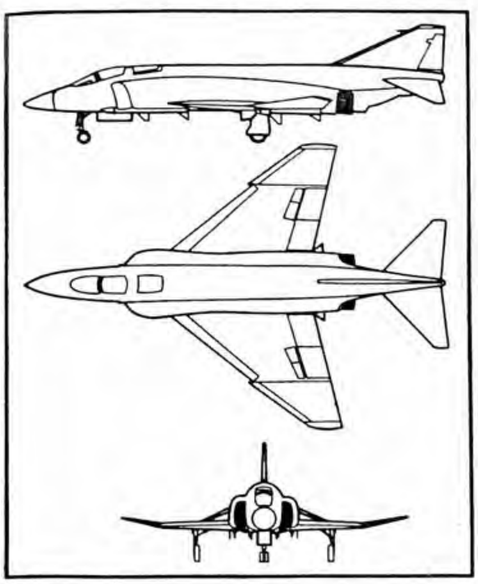
Span 35 ft. 4 in.; Length 58 ft. 11 in.; Height 14 ft. 7 in.; Empty Weight 22,133 lb.; Engine J71-A-2, 14,000 lb. thrust class; Fuel Capacity 1506 gal.; Wing Area 519 sq. ft.

PERFORMANCE

All data are classified.

McDONNELL F4H PHANTOM II

McDONNELL AIRCRAFT CORP., St. Louis 3, Missouri



REMARKS

The McDonnell F4H Phantom II is the Navy's newest and most-advanced carrier-based fighter airpline. Powered by two after-burning G. E. J79's, the F4H is manned by a crew of two, pilot and radar intercept officer, and is extensively equipped with modern electronic detection, tracking and guidance equipment —thus it is completely capable of all-weather operation, day or night. Armament consists of fuselage and wing-mounted Sparrow III and Sidewinder rocket-propelled air-to-air missiles. The airplane has extremely high performance and outstanding range for its type. An additional capability for this versatile fighter is long range special weapons attack. The airplane can carry external fuel tanks as well as a centerline special weapon and is equipped with an all-altitude bombing system.

The Phantom II first flew in May of 1958 and the airplane is now in large-scale production. Squadron deliveries commenced in December, 1960.

During the course of its test program the F4H established three new World's Records: a new altitude record of 98,557 feet was established in December, 1959, and two new speed records were established in September, 1960: 1216.78 mph for the 500-kilometer triangular closed course, and 1390.31 mph for the tight, circular 100-kilometer closed course. New world straightaway speed record of 1606.32 established in November, 1961. New world record for horizontal flight at sustained altitude (66,443 ft.) set in December, 1961. Three-kilometer restricted altitude record of 902.77 mph at 125 ft. altitude set in August, 1961.

SPECIFICATIONS

Span 38 ft. 5 in.; Length 58 ft. 3in.; Height 16 ft. 3 in.; Engines Two General Electric J79-8, or 1600+ hp; Wing Area 530 sq. ft. Wing boundary layer control.

PERFORMANCE

Maximum Speed 1500+ mph; Cruise Speed 600+ mph; Landing Speed 130 mph; Range with Maximum Fuel Load 2000+ mi.

MOONEY MARK 21

MOONEY AIRCRAFT, INC., Kerrville, Texas

REMARKS

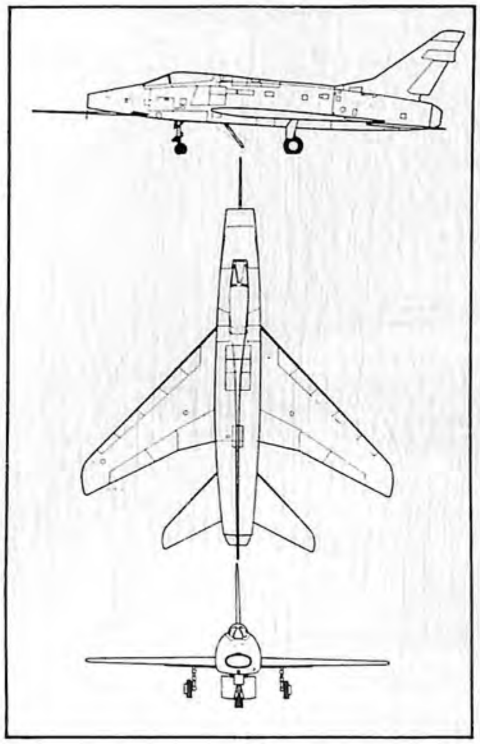
Mooney's MARK 21 features a chrome-molybdenum welded steel island structure engineered to create maximum passenger safety. It has manually retracted gear system and a double down lock system coupled with warning lights to prevent accidental gear retraction on the ground; a full-trim tail which gives maximum stability at slow speeds and minimum drag at high speeds.

SPECIFICATIONS

Span 35 ft.; Length 23 ft. 2 in.; Height 8 ft. 4.5 in.; Wing Loading 15.4 lb. per sq. ft.; Power Loading 14.3 lb. per bhp; Engine One Lycoming O-360, 180 hp at 2700 rpm takeoff; Fuel Capacity 48 plus gal.; Propeller Hartzell 74 in. metal constant speed; Wing Area 167 sq. ft.; Aileron Area 11.2 sq. ft.; Flap Area 17.2 sq. ft.; Fin Area 7.88 sq. ft.; Rudder Area 5.01 sq. ft.; Stabilizer Area 21.5 sq. ft.; Elevator Area 12.0 sq. ft.

PERFORMANCE

Cruise Speed 180 mph at 135 hp at 2400 rpm at 7500 ft.; Landing Speed 57 mph; Rate of Climb 1000 fpm at Sea Level; Service Ceiling 17,100 ft.; Absolute Ceiling 19,600 ft.; Range with Maximum Payload 920 mi.; Range with Maximum Fuel Load 1130 mi.



NORTH AMERICAN F-100D SUPER SABRE

NORTH AMERICAN AVIATION, INC., Los Angeles 45, California

REMARKS

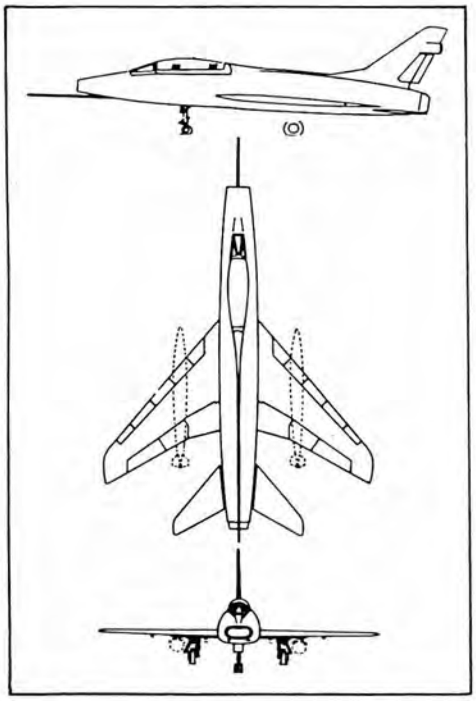
The F-100D is a fighter-bomber designed for maximum climb, maneuverability, altitude and speed. Like F-100A, which was first put into production in mid-1953, it has 45-degree swept-wing, uses tail braking parachute, has "solid" stabilizer and large ventral air brake. -C model differs from -A in that it contains inflight refueling system, has provision for carrying extra fuel drop tanks and bombs. -D model has addition of autopilot. Production of the F-100D was completed in August, 1959.

SPECIFICATIONS

Span 38 ft. 7 in.;Length 46 ft. 5 in.; Height 16 ft.; Empty Weight 21,004 lb.; Wing Loading 52.5 lb. per sq. ft.; Power Loading 3.30 lb. per lb. thrust; Engines J57-21 or J57-21A, 10,000 plus lb. thrust; Fuel Capacity 1189 gal.; Wing Area 400.18 sq. ft.; Fin Area 47.02 sq. ft.; Aileron Area 37.10 sq. ft.; Flap Area 29.8 sq. ft.; Rudder Area 8.54 sq. ft.; Vertical Area 55.56 sq. ft.; Horizontal Stabilizer 98.86 sq. ft.

PERFORMANCE

Maximum Speed in excess 1000 mph; Cruise Speed 600 mph at 40,000 ft.; Landing Speed 155 mph; Rate of Climb 22,000 fpm at Sea Level; Service Ceiling 51,000 ft.; Range with Maximum Fuel Load 1800 mi.



NORTH AMERICAN F-100F SUPER SABRE

NORTH AMERICAN AVIATION, INC., Los Angeles 45, California

REMARKS

The latest operational model of the Super Sabre series is the supersonic two-place F-100F fighter-bomber. At speeds in excess of 1000 miles per hour and capable of delivering a bomb tonnage greater than that carried by a World War II medium bomber, the "F" has the same maximum climb, maneuverability, altitude and speed as the single-seat F-100D. All four models of the Super Sabre are featured with 45 degrees swept-back wings, a solid horizontal stabilizer which is slightly below wing level and leading edge automatic slats. Production of the F-100F was completed in September, 1959.

SPECIFICATIONS

Span 38 ft. 9 in.; Length 52 ft. 6 in.; Height 16 ft. 3 in.; Empty Weight 22,336 lb.; Wing Loading 55.8 lb. per sq. ft.; Power Loading 3.30 lb. per lb. thrust; Engines J57-21 or J57-21A, 10,000 plus lb. thrust; Fuel Capacity 1189 gal.; Wing Area 385.21 sq. ft.; Fin Area 47.02 sq. ft.; Aileron Area 37.10 sq. ft.; Flap Area 29.8 sq. ft.; Rudder Area 8.54 sq. ft.; Vertical Area 57.78 sq. ft.; Horizontal Stabilizer 98.86 sq. ft.

PERFORMANCE

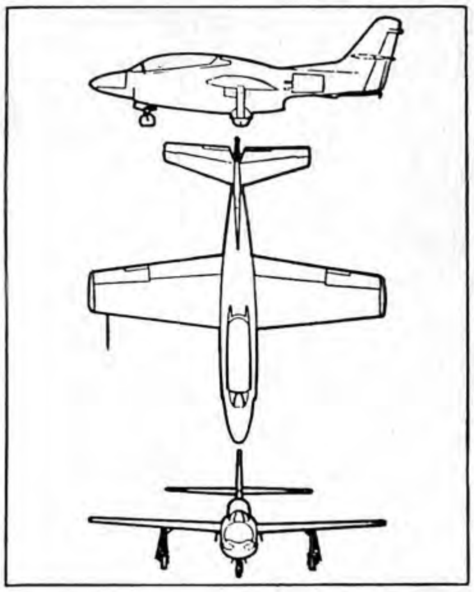
Maximum Speed in excess of 1000 mph; Cruise Speed 600 mph at 40,000 ft.; Landing Speed 155 mph; Rate of Climb 22,000 fpm at Sea Level; Service Ceiling 51,000 ft.; Range with Maximum Fuel Load 1800 mi.

NORTH AMERICAN T2J

NORTH AMERICAN AVIATION, INC., Los Angeles 45, California

REMARKS

The T2J is designed to provide the fleet with a tandem seat land or carrier-based jet trainer with appropriately increased performance and versatility over the primary trainer. It is a straight wing, tricycle landing gear jet trainer. It features stepped tandem seating with a clamshell canopy for better visibility and low altitude ejection provisions. Special attention has been paid to maintenance ease and reliability.



SPECIFICATIONS

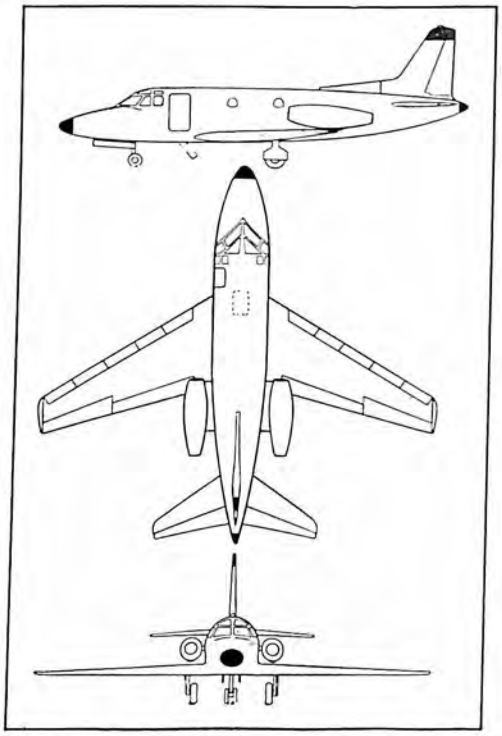
Span 36 ft.; Length 38 ft. 8 in.; Height 14 ft. 9 in.; Empty Weight 6900 lb. (approximately); Wing Loading 35 lb. per sq. ft.; Engine Westinghouse J34-WE-36, 3400 lb. thrust; Fuel Capacity 381 gal. without tip tanks, 581 gal. with tip tanks; Wing Area 255 sq. ft.; Aileron Area 190 sq. ft.; Flap Area 50 sq. ft.; Fin Area 38 sq ft.; Total Rudder Area 10.71 sq. ft.; Stabilizer Area 68 sq. ft.; Elevator Area 17.66 sq. ft

PERFORMANCE

Maximum Speed 429 knots at 25,000 ft.; Cruise Speed 362 knots at 34,700 ft.; Landing Speed 67 knots; Rate of Climb 5000 fpm at Sea Level; Service Ceiling 42,500 ft.; Absolute Ceiling 45,000 ft.; Range with Maximum Payload 840 nautical mi.; Range with Maximum Fuel Load 840 nautical mi.

NORTH AMERICAN T-39 SABRELINER

NORTH AMERICAN AVIATION, INC., Los Angeles 45, California



REMARKS

The Air Force T-39 twin-jet utility aircraft is a high performance trainer currently being built by the Los Angeles Division of North American Aviation, Inc. With a cruising speed of 500 miles per hour at altitudes above 40,000 feet the twin-jet Sabreliner is a multi-purpose aircraft with pilot, navigational, radar training and passenger-cargo carrying capabilities. Basic interior configuration of T-39 provides for four passengers plus pilot and co-pilot.

SPECIFICATIONS

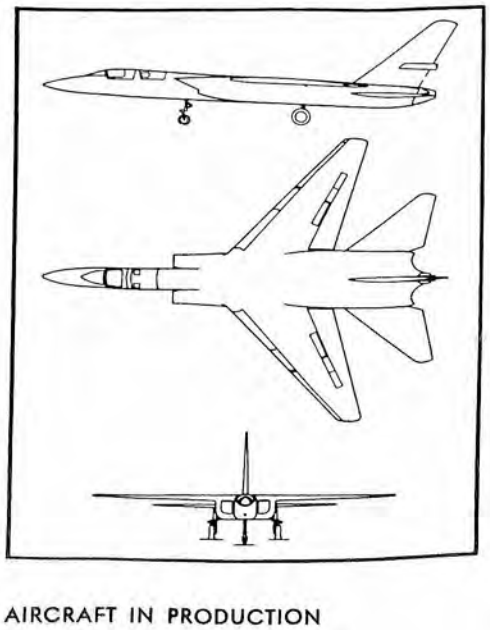
Span 44 ft. 5 in.; Length 43 ft. 9 in.; Height 16 ft.; Empty Weight 9307 lb.; Engines two Pratt and Whitney J60s, 3000 lb. thrust take off rating; Fuel Capacity 1056 gal. (extended range); Wing Area 342.1 sq. ft.; Aileron Area 16.42 sq. ft.; Flap Area 36.6 sq. ft.; Vertical Tail Area 45.6 sq. ft.; Horizontal Tail Area 77 sq. ft.

PERFORMANCE

Maximum Speed 600 mph at 16,000 ft. (optimum alt.); Cruise Speed 500 mph at 43,000 ft.; Landing Speed 100 mph; Service Ceiling 45,000 ft. Range with Maximum Fuel Load at Maximum Gross Takeoff Weight 1800 mi.

NORTH AMERICAN A3J VIGILANTE

NORTH AMERICAN AVIATION, INC., Los Angeles 45, California



REMARKS

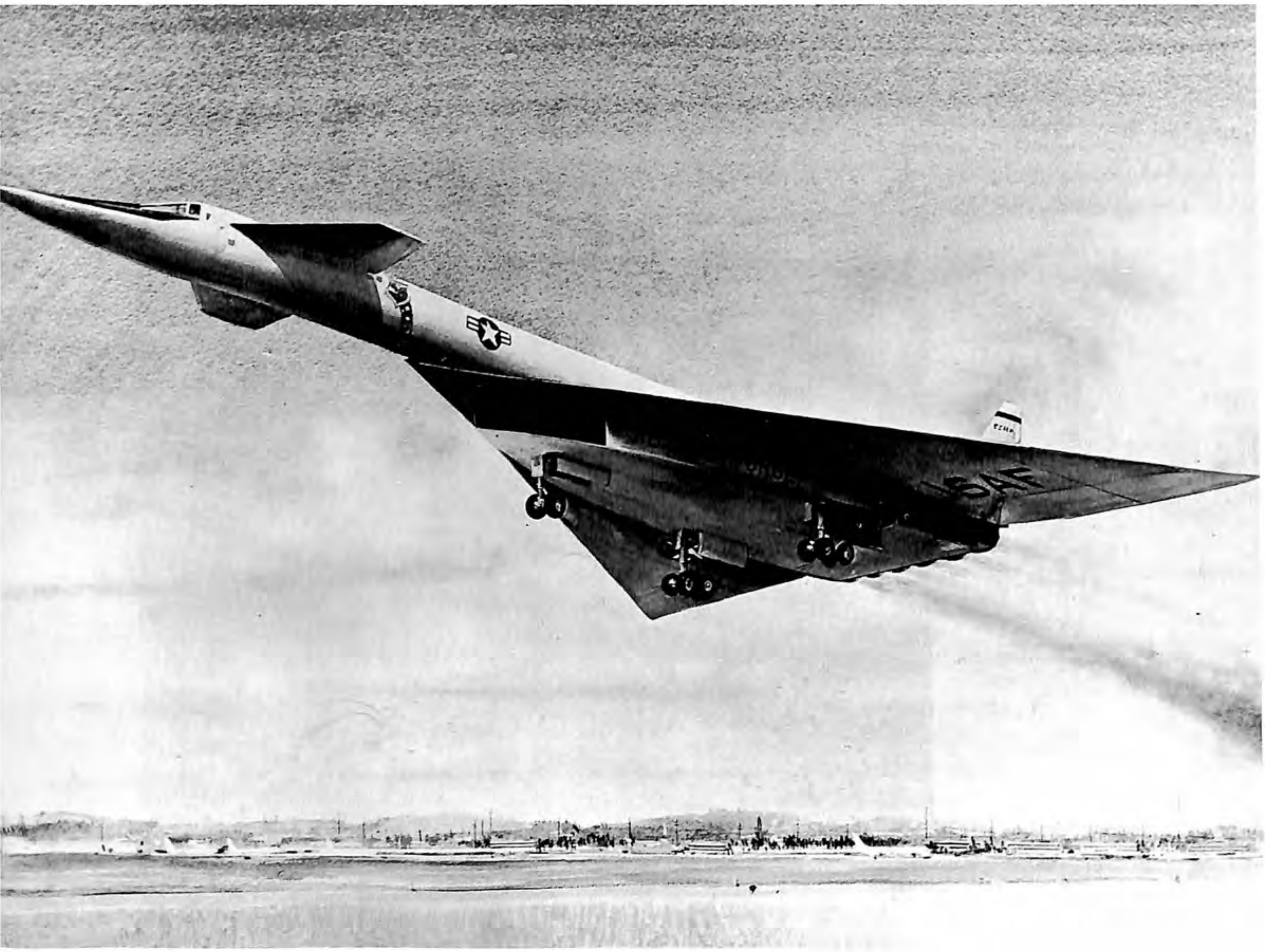
Mission of the A3J is to provide the fleet with an all-weather, carrier-based attack weapons system which can deliver both conventional and nuclear weapons at either high or low altitudes on difficult targets at supersonic speeds. The A3J-1 features a high, thin swept wing and all-movable slab-type tail surfaces with spoiler/deflectors in lieu of conventional ailerons for lateral control. The wing is equipped with droopable leading edges and flaps with boundary layer control, which when used in conjunction with the spoiler/deflectors, improve low-speed flight characteristics. The cockpits are arranged in tandem. The linear bay runs lengthwise in the fuselage and the bomb is ejected rearward. First flight of the Vigilante was August 31, 1958.

SPECIFICATIONS

Approximate Span 50 ft.; Length 70 ft.; Height 20 ft.; Engines Two J79 (General Electric).

PERFORMANCE

Mach 2 range.



NORTH AMERICAN B-70 VALKYRIE

NORTH AMERICAN AVIATION, INC., Los Angeles 45, California

REMARKS

B-70 Valkyrie. This Mach 3 air vehicle, under development for the Strategic Air Command, is classified at this time.

SPECIFICATIONS

Engines Six J93 Turbojets (General Electric).

PERFORMANCE

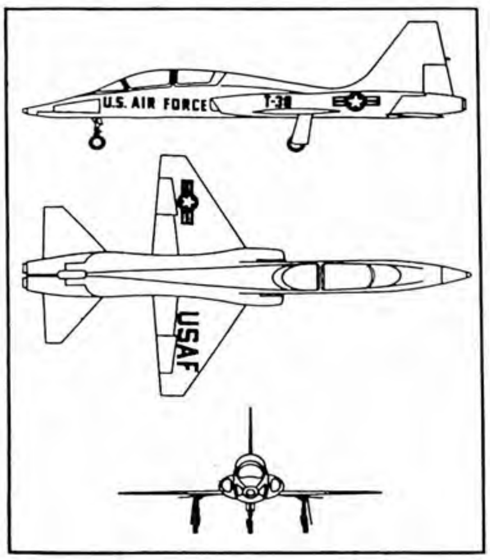
Maximum Cruise Speed 2,000 mph.

NORTHROP T-38A TALON

NORTHROP CORP., Hawthorne, California

REMARKS

The T-38A Talon is a high-altitude, supersonic, low-wing, twin engined, jet-propelled, basic trainer aircraft, designed for a crew of two. The instructor and student sit tandem in a pressurized cockpit enclosed by individual jettisonable canopies. Ejection seats are provided for both crew members. Fuselage lines are characterized by distinct reverse or "coke bottle" curvature at wing junction point in conformance with "area rule" theory. Engine exhausts protrude several inches from aft fuselage providing a "twin tailpipe" effect. Engine air scoops are located just outboard of rear cockpit. Wings are placed in rear section of fuselage just aft of engine scoops. The T-38A utilizes conventional ailerons and rudder and all-movable horizontal tail. It is designed for use by USAF for flight training in the following categories: Supersonic flight, takeoff, and landing techniques, multi-jet engine operations, aerobatics, night flying, instrument instruction and cross-country navigation. The T-38A is now in production at Northrop's Norair Division, Hawthorne, California.

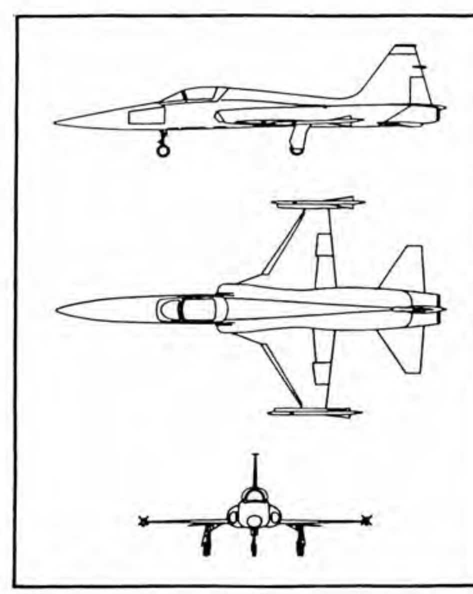


SPECIFICATIONS

Span 25 ft. 3 in.; Length 43 ft.; Height 12 ft. 11 in.; Empty Weight 9000 lb.; Engines Two General Electric J85-5 turbojet.

PERFORMANCE

Maximum Speed Mach 1.27; Maximum Altitude 55,000 ft.; Rate of Climb 30,000 plus per minute at Sea Level.



NORTHROP N-156 LIMITED WAR FIGHTER

NORTHROP CORP., Hawthorne, California

REMARKS

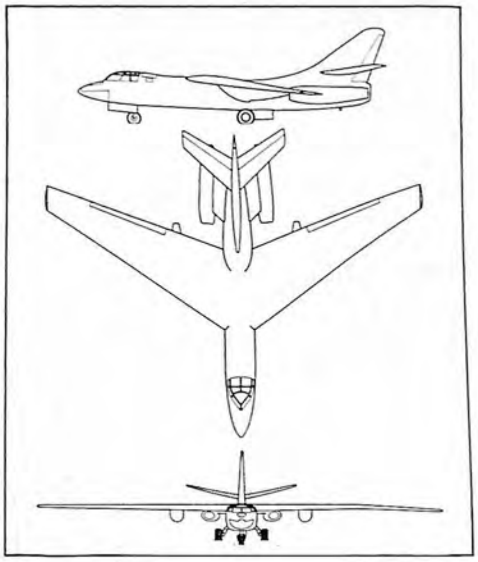
The N-156 is a multipurpose, twin-turbojet fighter, providing high-altitude, supersonic performance in all-weather, capable of operation from short, unprepared fields. The pilot is seated in a pressurized cockpit enclosed by jettisonable canopy with two-stage rocket powered ejection seat. It is the sister ship to the USAF-Northrop T-38A Talon supersonic trainer. The aircraft is versatile in armament and fire control systems. Its mission includes destruction of enemy airpower both in the air and on the ground, close support of troops, and surveillance and reconnaissance. It has a range of 1,680 nautical miles; in excess of 2700 nautical miles with one in-flight refueling. Military payload 5,500 pounds.

SPECIFICATIONS

Span 26 ft. 5 in.; Length 43 ft. 11 in.; Height 13 ft.; Takeoff Weight approximately 12,500 lb.; Engines Two General Electric J85-5 turbojet.

PERFORMANCE

Maximum Speed Mach 1.5; supersonic at any altitude from sea level to 50,000 ft.; Ceiling 55,000 plus; Sea Level Rate of Climb 31,000 fpm with full internal fuel.



LAMINAR FLOWCONTROL NB-66 DEMONSTRATION AIRCRAFT

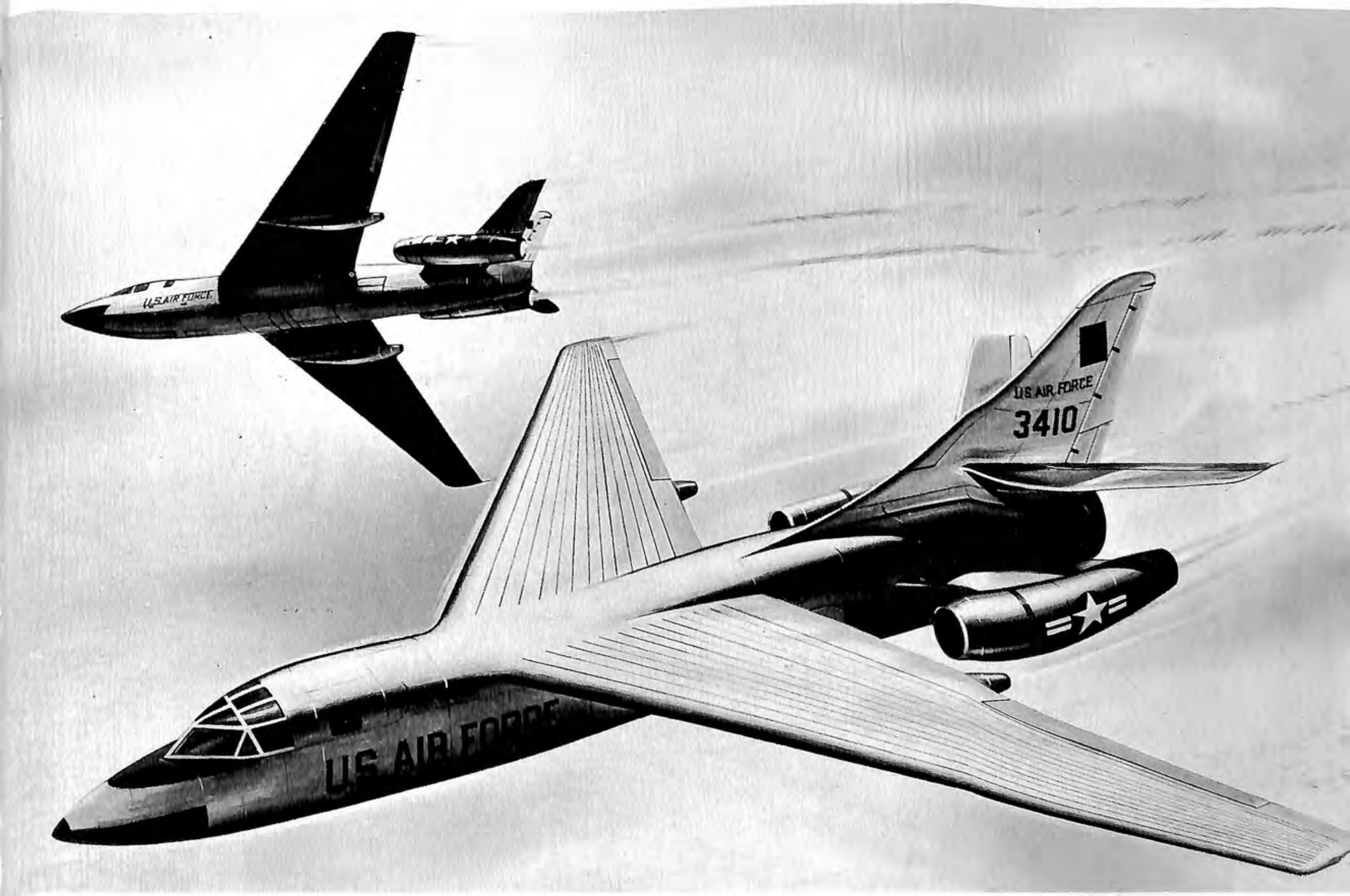
NORTHROP CORP., Hawthorne, California

REMARKS

Two WB-66D aircraft are being redesigned and rebuilt by Northrop under USAF contract to demonstrate the Laminar Flow Control system under operational conditions.

SPECIFICATIONS

Span 93.5 ft.; Length 75.5 ft.; Engines Two 7E-J79-GE-3A; Wing Area 1250 sq. ft.



AERIAL VZ-8P MII JEEP

PIASECKI AIRCRAFT CORP., Philadelphia 42, Pennsylvania

REMARKS

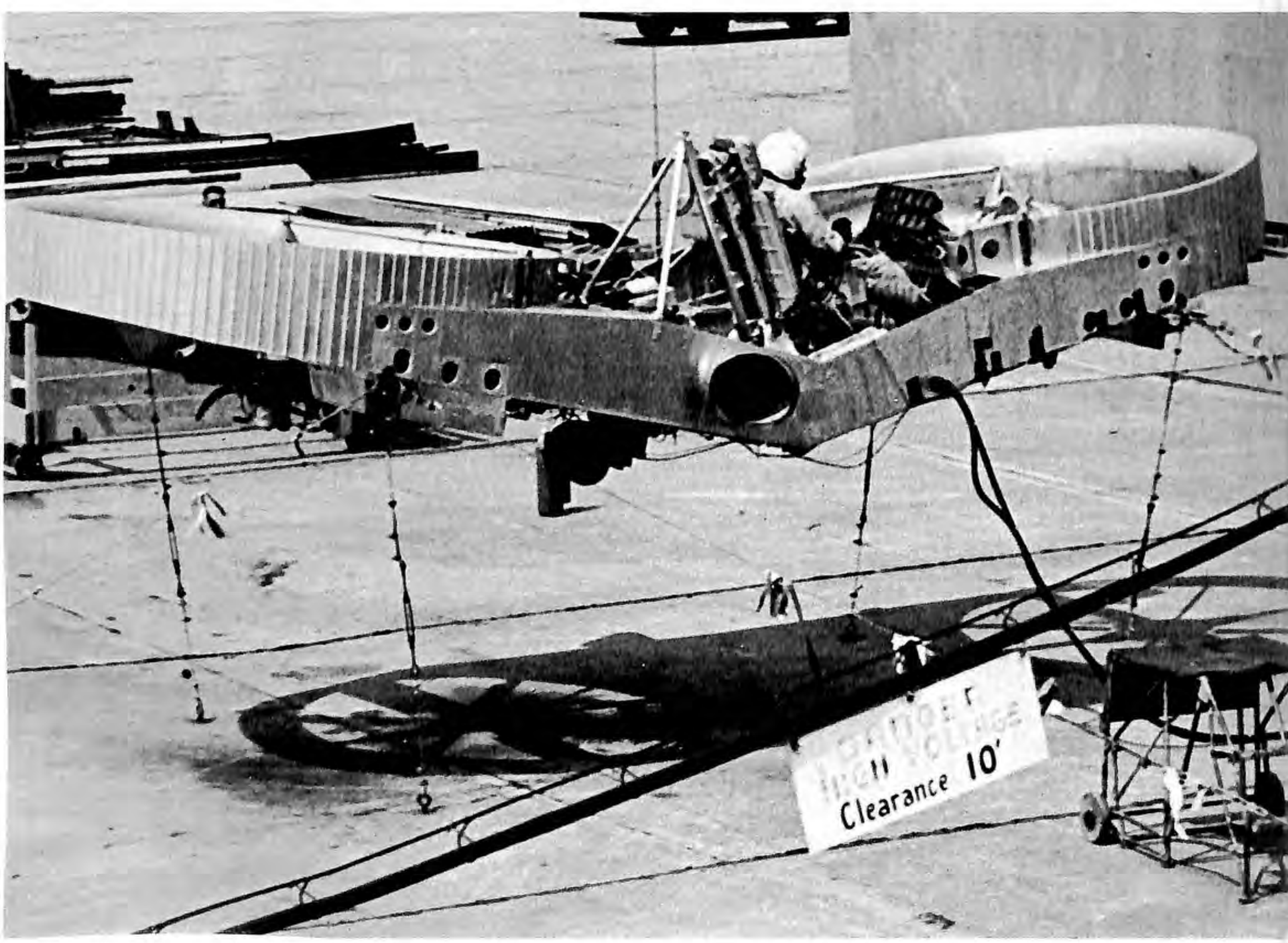
Range with 863 pound payload is 75 miles assuming 100 percent flight at OGW and 210 miles at OGW assuming 10 percent flying time and 90 percent ground maneuver time.

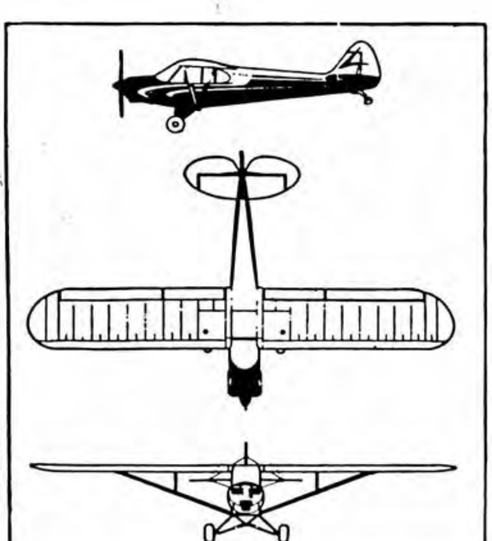
SPECIFICATIONS

Span 9 ft. 11 in.; Length 24 ft. 6 in.; Height 5 ft. 11 in.; Empty Weight 2379 lb.; Rotor Diameter 101 in.; Rotor Loading 32.9 lb. per sq. ft.; Power Loading 4.4 lb. per bhp; Engine Two Artouste IIC, 375 hp normal rated, or 420 hp at 6000 rpm takeoff; Fuel Capacity 64 gal.; Rotor Area 111.4 sq. ft.

PERFORMANCE

Maximum Speed 69 mph at 840 hp at 1650 rpm at Sea Level; Cruise Speed 46 mph at 650 hp at 1650 rpm at Sea Level; Rate of Climb 2000 fpm at Sea Level; Range with Maximum Payload 75 mi.; Range with Maximum Fuel Load 210 mi.





PIPER SUPER CUB PA-18 "150"

PIPER AIRCRAFT CORP., Lock Haven, Pennsylvania

REMARKS

Piper Super Cub is powered by a 150 hp Lycoming engine. The aircraft features excellent STOL characteristics and load-carrying ability, is economical to operate and has long maintenance-free life. Outfitted with skis and floats, and with conventional gear, the Super Cub is in use throughout the world for patrol, inspection, farm and ranch utility, mountain rescue and expeditions, and other special purposes.

SPECIFICATIONS

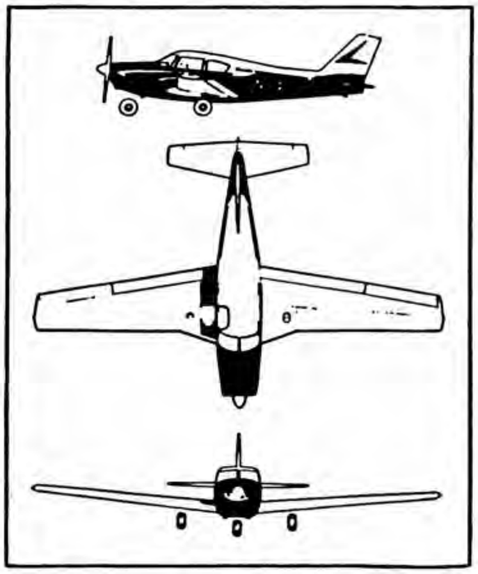
Span 35 ft. 4 in.; Length 22 ft. 6 in.; Height 6 ft. 8 in.; Empty Weight 930 lb.; Gross Weight 1750 lb.; Overload Gross Weight 2070 lb.; Wing Loading 10 lb. per square ft.; Power Loading 11.6 lb. per hp; Engine "150" Lycoming O-320, 150 hp at 2700 rpm takeoff; Fuel Capacity 36 gal.; Propeller Sensenich; Wing Area 178.5 sq. ft.

PERFORMANCE

Maximum Speed 130 mph; Cruise Speed 115 mph at 75 percent power at 7000 ft.; Landing Speed 43 mph with flaps; Rate of Climb 960 fpm at Sea Level; Service Ceiling 19,000 ft.; Absolute Ceiling 21,300 ft.; Range with Maximum Payload 460 mi.

PIPER COMANCHE 180 PA-24 "180"

PIPER AIRCRAFT CORP., Lock Haven, Pennsylvania



REMARKS

The Piper Comanche 180, all-metal, 4-passenger business aircraft with retractable tricycle landing gear, is powered by a new ruggedized Lycoming O-360-A engine for great efficiency and long maintenance-free operation. The Comanche 180 cruises 160 mph, has range up to 1,100 miles with useful load of 1,040 pounds. The Comanche's advance design features include laminar flow wing, single-piece stabilator, swept tail, contributing to aircraft's excellent in-flight stability and efficient performance. The Comanche 180 holds two world non-stop distance records, a 6,921-mile closed circuit record and a 6,967-mile record for distance in a straight line. Roomy cabin, ample luggage space and component systems designed for maintenance ease characterize the Piper Comanche.

SPECIFICATIONS

Span 36 ft.; Length 24 ft. 8 in. (24 ft. 10 in. for "250"); Height 7 ft. 4 in.; Gross Weight 2550 lb. (2900 for "250"); Empty Weight 1510 lb. (180) (1630 lb. for "250"); Wing Loading 14.3 lb. per sq. ft. (15.7 lb. for "250"); Power Loading 14.2 lb. per hp (11.2 for "250"); Engine Lycoming O-360-A for "180" (Lycoming O-540-A1A5 for "250"); 180 hp (250 for "250"), at 2700 rpm (2575 for "250") takeoff; Fuel Capacity 50 or 60 gal. (60 or 90 for "250"); Propeller Constant Speed, controllable; Wing Area 178 sq. ft.

PERFORMANCE

Maximum Speed 167 mph (190 for "250"); Cruise Speed 160 mph (181 for "250") at 75 percent power at 8000 ft.; Landing Speed 61 mph (61 for "250"); Rate of Climb 910 fpm (1350 for "250"); Service Ceiling 18,500 ft. (20,000 for "250"); Absolute Ceiling 21,000 ft. (22,000 for "250"); Range with Maximum Payload 750 mi. (740 for "250"); Range with Maximum Fuel Load 1100 mi (1650 for "250").

PIPER COMANCHE 250 PA-24 "250"

PIPER AIRCRAFT CORP., Lock Haven, Pennsylvania

REMARKS

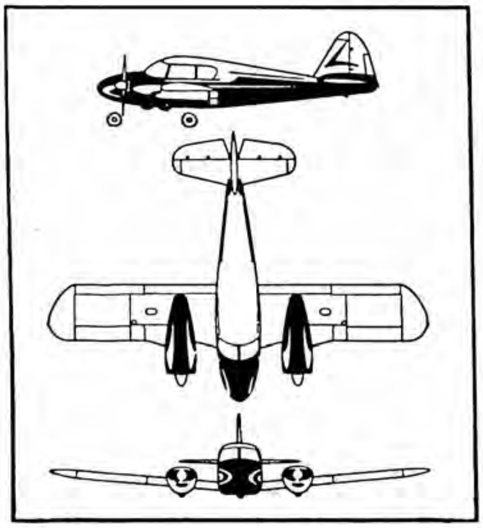
High performance Piper Comanche 250 features significant design improvements including new electrically operated Max-Lift slotted flaps for improved short-field ability and slower landing speed, new ruggedized 250 hp Lycoming O-540 engine for increased efficiency and maintenance-free operation, and optional Bendix fuel injection. With optional 90-gallon fuel capacity, Comanche 250 has range up to 1,650 miles. Cruising speed is 181 mph, and top speed 190 mph. Basic Comanche features include laminar flow wing, single-piece stabilator and swept tail. Husky tricycle landing gear, which retracts in six seconds, combines with Max-Lift flaps to provide excellent rough, short-field capability. Roomy, 4-passenger Comanche cabin is largest of any aircraft in its class and separate, 20-cubic foot baggage compartment has 200-pound capacity.

PIPER APACHE H PA-23 "160"

PIPER AIRCRAFT CORP., Lock Haven, Pennsylvania

REMARKS

The twin-engine Piper Apache H, all-metal executive and utility transport, is designed with short take-off characteristics, slow landing speed, and rugged, wide-tread tricycle gear for rough, short-field operations. Powered by two new-type, 160 hp Lycoming engines, ruggedized for increased wear resistance, the Apache H cruises 171 mph, with range up to 1,260 miles. It is capable of maintaining altitude at full gross weight on one engine. Single-engine capability has been demonstrated by a non-stop, 1,306-mile Apache flight made with one prop removed. Roomy, sound-proofed Apache cabin has 3 large windows on each side for excellent visibility. Standard 4- passenger capacity can be easily increased with addition of fifth rear seat, or rear seats are quickly removeable for 80-cubic foot, unobstructed cargo space. The model can be converted into an ambulance plane with room for stretcher and attendant in the rear seat. The cabin has been built so that a hatch can be cut in the floor for camera installation. Flap and landing gear controls are shaped as an airfoil and wheel respectively for positive identification. Apache H panel groups instruments at left, radios in center, engine instruments at right. Provisions for factory installation of comprehensive electronic navigation and communications equipment, including DME, have been made.

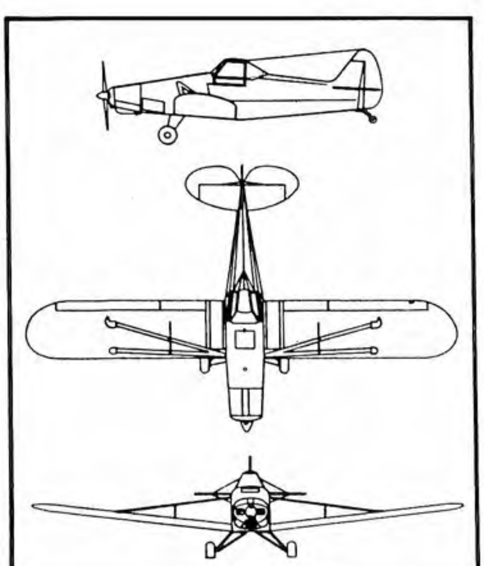


SPECIFICATIONS

Span 37 ft.; Length 27.1 ft.; Height 9.5 ft.; Engines Two Lycoming O-320-B 160 hp at 2700 rpm; Gross Weight 3800 lb.; Empty Weight 2320 lb.; Useful Load 1480 lb.; Wing Loading 18.6 lb. per sq. ft.; Power Loading 11.9 lb. per hp; Wing Area 204 sq. ft.; Baggage 200 lb.; Fuel Capacity 108 gal. with auxiliary tanks.

PERFORMANCE

Cruise Speed 171 mph at 7000 ft.; Range up to 1260 mi.



PIPER PAWNEE PA-25

PIPER AIRCRAFT CORP., Lock Haven, Pennsylvania

REMARKS

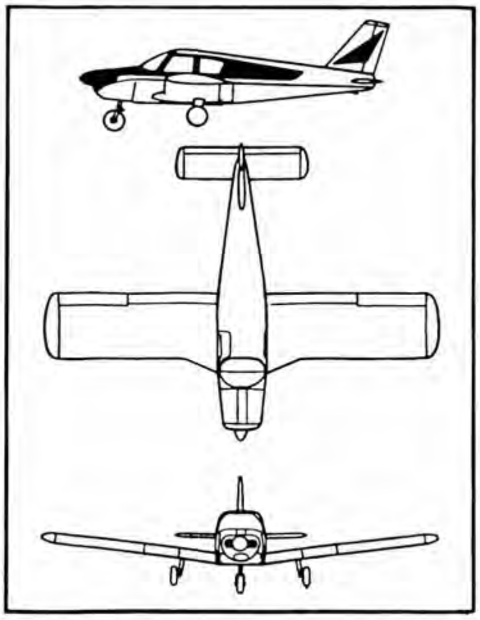
The Piper Pawnee agricultural aircraft is in world wide use in sprayer and duster configurations. Designed at Piper's Vero Beach Development Center, with dispersal efficiency and pilot safety as prime considerations, the Pawnee was introduced in 1959 and has since been in volume production at Piper's Lock Haven, Pa., plant. The Pawnee has a useful load of 1,100 pounds, hopper capacity of 150 gallons or 20 cubic feet. Pilot's cockpit is aft for maximum safety, high as possible for unobstructed vision.

SPECIFICATIONS

Span 36 ft. 3 in.; Length 24 ft.; Height 6.8 ft.; Empty Weight 1200 lb.; Wing Loading 12.6 lb. per sq. ft.; Power Loading 15.3 lb. per hp; Engine Lycoming O-320-A2B, 150 hp at 2700 rpm takeoff; Fuel Capacity 40 gal.; Propeller McCauley-metal; Wing Area 183 sq. ft.

PERFORMANCE

Maximum Speed 113 mph; Cruise Speed 95 mph; Landing Speed 57 mph; Rate of Climb 50.5 fpm; Service Ceiling 11,300 ft.; Absolute Ceiling 13,600; Range with Maximum Payload 440 mi.



PIPER CHEROKEE-PA-28-150; PA-28-160

PIPER AIRCRAFT CORP., Lock Haven, Pennsylvania

REMARKS

New, low wing Piper Cherokee, most advanced all-metal, 4-place aircraft in the low cost field, is powered by Lycoming with 150 or 160 hp engine. Cherokee cruises over 130 miles per hour, with range up to 800 miles. Low wing provides excellent stability, "air cushioned" landings, easier ground handling, extremely good visibility. Cherokee is economical to operate and new, simplified construction requires minimum maintenance. The 4-place Cherokee cabin is largest of any aircraft in its class, and separate 19-cubic foot luggage compartment holds 100 pounds. Cherokee production began in January, 1961. First production models were retained by Piper for evaluation and experimental development, and market deliveries started in May. The Cherokee is in volume production at Piper's Vero Beach Plant.

SPECIFICATIONS

Span 30 ft.; Length 23.3 ft.; Height 7.3 ft.; Empty Weight 1185 lb. (1195 lb. for 160); Wing Loading 13.4 lb. per sq. ft. (13.8 for 160); Power Loading 14.3 lb. per bhp (13.8 for 160); Engine Lycoming O-320-A2B (Lycoming O-320-B2B for 160), 150 hp normal rated (160 hp for 160) at 2700 rpm (both) takeoff; Fuel Capacity 50 (both) gal. with reserve fuel, 36 (both) gal. std.; Propeller Sensenich; Wing Area 160 sq. ft.

PERFORMANCE

Maximum Speed 136 mph (138 for 160); Cruise Speed 130 mph (132 for 160) at 75 per cent Power at 7,000 ft.; Landing Speed 53 mph (56 for 160) with Flaps down; Rate of Climb 660 fpm (700 for 160) at Sea Level; Service Ceiling 14,300 ft. (15,000 for 160); Absolute Ceiling 16,800 ft. (17,500 for 160); Range with Maximum Payload 560 mi. (570 for 160); Range with Maximum Fuel Load 790 mi. (800 for 160).

PIPER COLT PA-22 "108"

PIPER AIRCRAFT CORP., Lock Haven, Pennsylvania

REMARKS

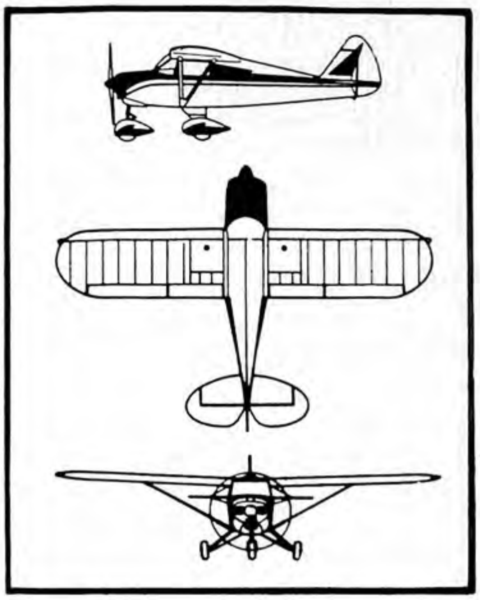
Piper Colt, first "compact of the air," is the lowest-cost two-place business, sport and training plane. Powered by reliable 108 hp Lycoming engine, Colt cruises 115 mph, with fuel consumption at 18-19 miles per gallon. Safe, gentle flight characteristics, tricycle gear, roomy cabin, side-by-side seating, large, 100-pound capacity luggage bin characterize the Colt.

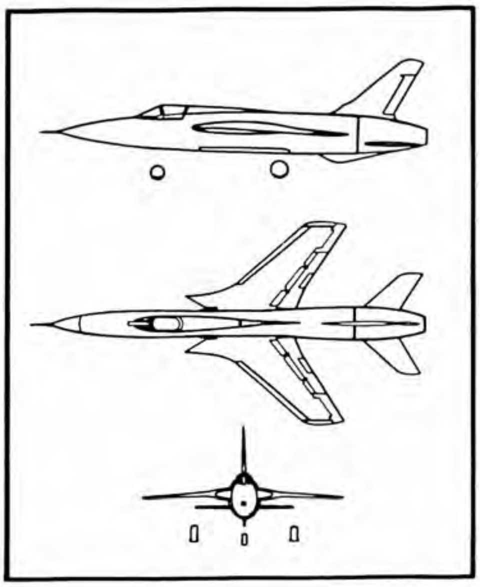
SPECIFICATIONS

Span 30 ft.; Length 20 ft.; Height 6.25 ft.; Gross Weight 1650 lbs.; Wing Loading 11.2 lb. per sq. ft.; Power Loading 15.3 lb. per hp; Engine Lycoming O-235-CIB, 108 hp at 2600 rpm takeoff; Fuel Capacity 18 gal.

PERFORMANCE

Cruise Speed 115 mph at 75 percent power at 7000 ft.; Rate of Climb 610 fpm; Service Ceiling 12,000 ft.; Absolute Ceiling 14,400 ft.





REPUBLIC F-105D THUNDERCHIEF

REPUBLIC AVIATION CORP., Farmingdale, Long Island, New York

REMARKS

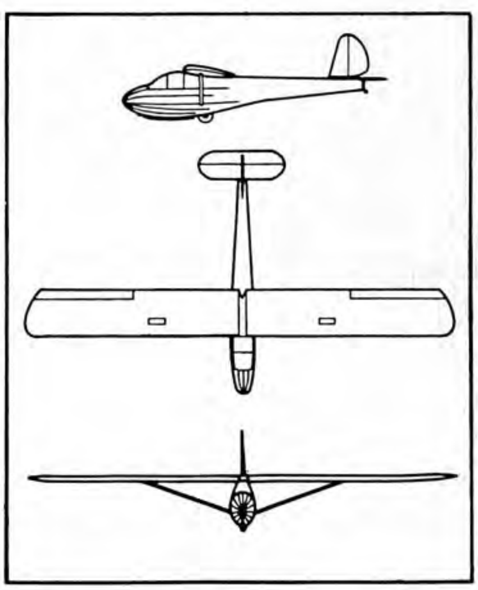
The F-105D is the latest operational model of the Thunderchief series. In full production, it is in service with the Tactical Air Command's 4th Tactical Fighter Wing, the 4520th Combat Crew Training Wing, and overseas with USAFE. It is planned for deployment with the Pacific Air Forces. Similar to its predecessor, the F-105B, in its external configuration, the single seat 'D' has an area rule fuselage and specially designed swept-forward air-intake ducts, as well as the 360 degrees speed brake. Internally, the 'D' is radically different with its advanced electronic equipment providing all-weather, near automatic capabilities. In operation, the Mach 2 'D' enables its pilot to perform a round-trip, low-or-high level bombing mission in any weather, day-or-night, over any terrain, without ever seeing the ground. The electronics-packed 'D' has a completely integrated bombing-navigation-search systems and can carry nuclear or thermonuclear weapons and guided or unguided missiles, including the Sidewinder and Bullpup. It is equipped with an automatic 20 millimeter cannon with a rate of fire of 6,000 rounds per minute.

SPECIFICATIONS

Span 34 ft. 11 in.; Length 64 ft. 3 in.; Height 19 ft. 8 in.; Engine J75, 26,500 lb. thrust with water injection and afterburner.

PERFORMANCE

Speed Mach 2; Altitude Ceiling 50,000 plus.



SCHWEIZER 2-22C SAILPLANE

SCHWEIZER AIRCRAFT CORP., Elmira, New York

REMARKS

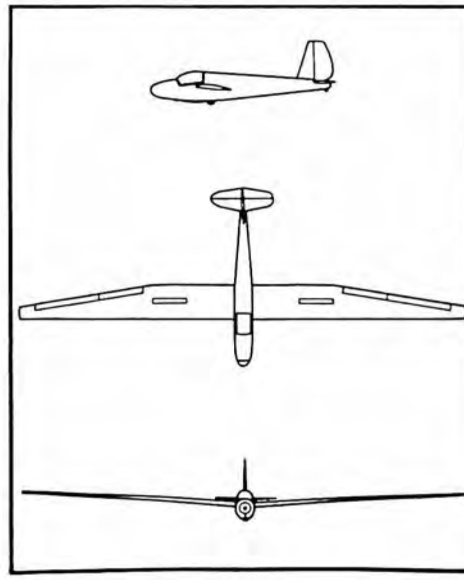
The 2-22C is the latest version of the 2-22 two-place trainer that was developed by Schweizer after World War II. The current "C" Model of this ship incorporates many improvements over the original model. The improvements include incorporation of lighter aileron control system, a fully-enclosed cabin with rear door to improve comfort and performance, re-location of the main wheel to improve control on the ground at slow speeds, positioning of cockpit seating to give more room and improve the instructor's visibility, lengthening of the nose and streamlining the canopy for better performance and appearance. Although not designed primarily for cross country, flights up to 196 miles have been made. Its excellent small field landing characteristics make it ideal for the first cross-country attempts. The new model 2-22C is available in five forms. Dry Kit, Standard Kit, Unit Purchase Plan, Uncovered Sailplane and Completed Sailplane. Schweizer is also producing the 1-26 and 1-23H sailplanes.

SPECIFICATIONS

Span 43 ft.; Length 25 ft. 8.5 in.; Height 9 ft.; Empty Weight 450 lb.; Gross Weight 900 lb.; Wing Loading 4.28 lb. per sq. ft.

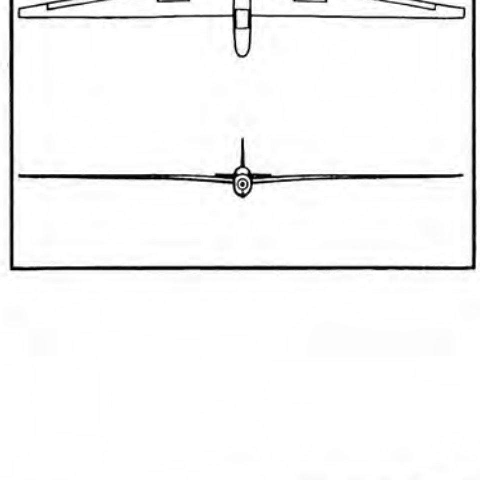
PERFORMANCE

Minimum Sinking Speed (solo (2.8 ft./sec.;) dual) 3 ft./sec.; Placard Speed 90 mph.



SCHWEIZER 1-23H AND 1-23H-15 SAILPLANES

SCHWEIZER AIRCRAFT CORP., Elmira, New York



REMARKS

The 1-23H and 1-23H-15 are the latest FAA approved sailplanes being produced by Schweizer Aircraft. It is the development from the 1-23 series and is featured in two models; the 1-23H-15 which is the 15 meter Standard Class sailplane and the 1-23H which is the extended wing version with a span of 52 ft. 8 in. This ship incorporates the new speed limiting dive brakes which reduce the terminal velocity speed. The conversion from one model to the other is by means of detachable wing tips which can be easily added or removed. The models are available in primed, ready-to-fly form or in the completely finished model. It is a high performance sailplane and designed for contest-flying.

SPECIFICATIONS

1-23H: Span 52 ft. 8 in., Length 20 ft. 10 in., Height 7 ft. 6 in., Empty Weight 480 lb., Weight Loaded 750 lb., Wing Loading 4.56 lb. per sq. ft.; 1-23H-15: Span 49 ft. 2 in., Length 20 ft. 10 in., Height 7 ft. 6 in., Empty Weight 474 lb., Weight Loaded 750 lbs., Wing Loading 4.70 lb. per sq. ft.

PERFORMANCE

1-23H: Minimum Sinking Speed 2.05 ft./sec., Cruise Speed 88.50 mph, Placard Speed 130 mph; 1-23H-15: Minimum Sinking Speed 2.15 ft./sec., Cruise Speed 87.50 mph, Placard Speed 130 mph.

SCHWEIZER 1-26 SAILPLANE

SCHWEIZER AIRCRAFT CORP., Elmira, New York

REMARKS

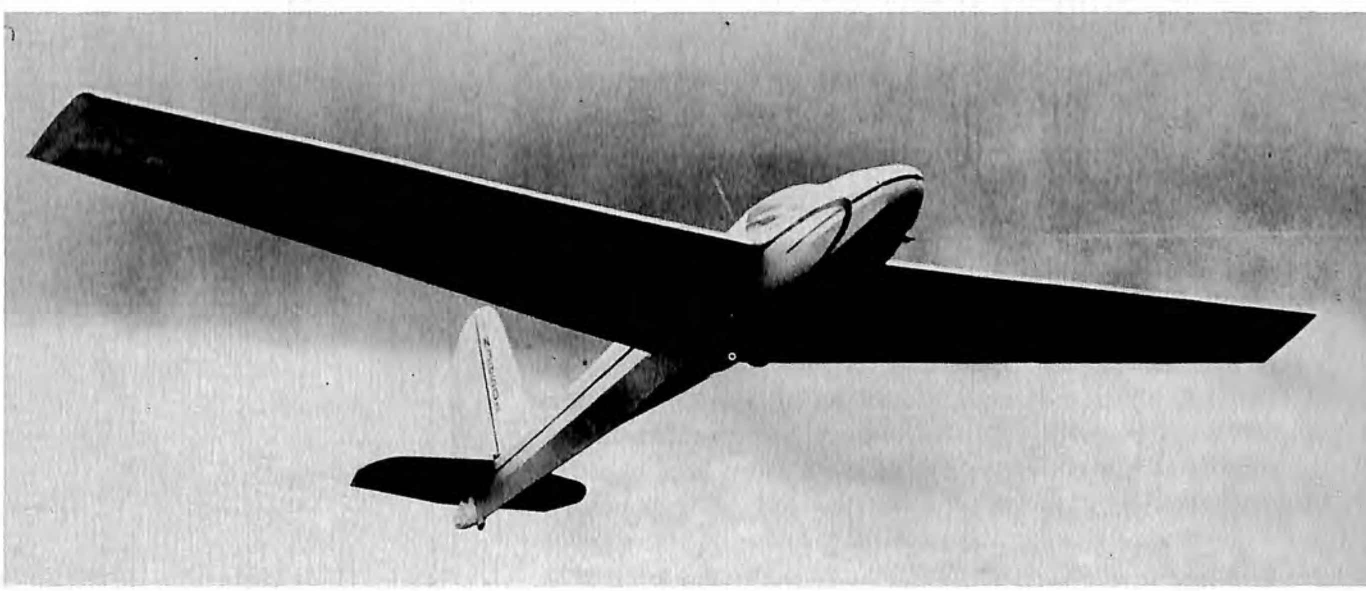
The 1-26, an efficient, single-seat sailplane is the most popular sailplane in America. The 1-26 is the first one-design series of sailplanes, and interest in this concept is growing rapidly among soaring pilots. The 1-26 is available complete, ready-to-fly, or in kit form. Of the more than 160 1-26's built to date by Schweizer Aircraft Corp., about 60% have been purchased in kit form by their pilot-owners. Structure of the 1-26 fuselage is of welded chrome-moly steel tubing; the aluminum wings and empennage are covered by sheet aluminum and fabric, with option of metal covered wings.

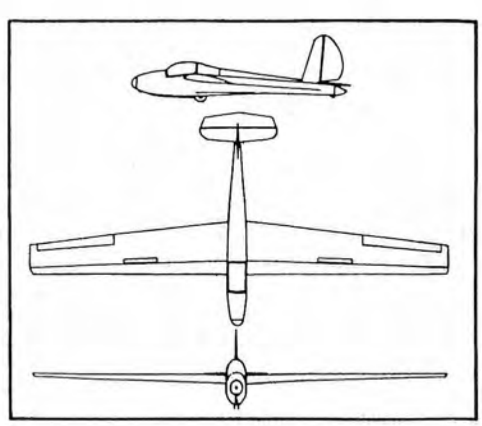
SPECIFICATIONS

1-26: Wing Span 40 ft.; Wing Area 160 sq. ft.; Aspect ratio 10, Length 21 ft. 3 in.; Minimum Load Factor 8.31, Empty Weight 348 lbs., Maximum Gross Weight 575 lbs.; Auto Tow Speed 60 mph; Airplane Tow Speed 95 mph; Placard Speed 104 mph.

PERFORMANCE

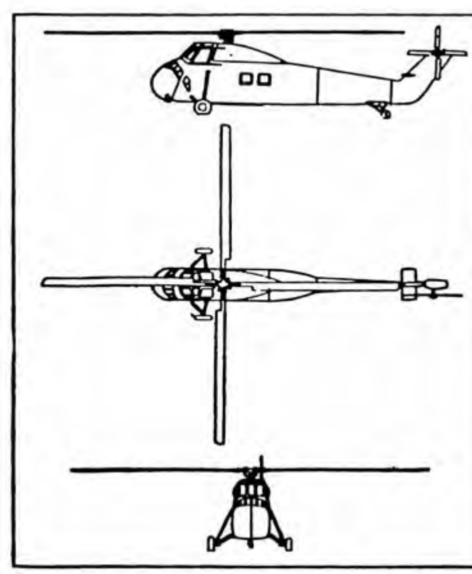
1-26: Minimum Sinking Speed 2.60 ft./sec.; Maximum L/D 23; Cruising Speed 77 mph.





SIKORSKY S-58; *HSS (Navy); H-34 (Army); HUS (Marines & Coast Guard)*

SIKORSKY AIRCRAFT DIVISION, United Aircraft Corp., Stratford, Connecticut



REMARKS

The S-58 is flown by the Navy, Marine Corps, Army, Coast Guard, eight foreign countries and commercial helicopter airlines. It is also used by the Navy for anti-submarine warfare. President Kennedy makes frequent use of the Marine and Army versions of the S-58, embarking and disembarking from the White House lawn. More than 1,400 S-58s have been manufactured. This aircraft has a seating capacity of crew (pilot and co-pilot), 12-18 passengers, eight litters or a net payload of 4000 pounds for a distance of 100 miles. Structural provisions for a 5000-pound automatic touch down release cargo sling and a 600-pound hydraulically-operated utility hoist are standard equipment. Automatic stabilization equipment is being installed on Navy, Marine, Army and Coast Guard versions of the aircraft and has been certified by the CAA for use on Commercial S-58s.

SPECIFICATIONS

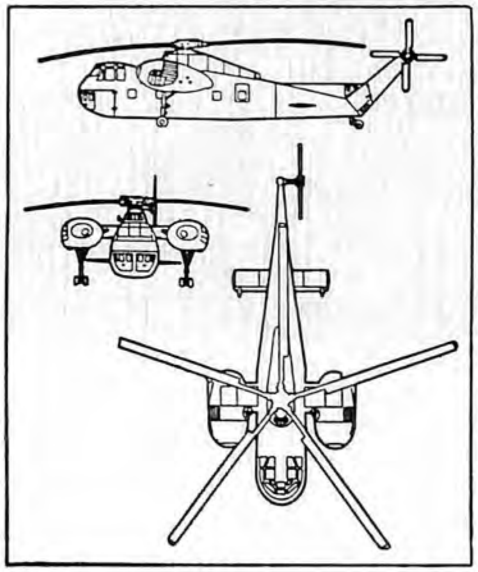
Length 46 ft. 9 in. (Tail Pylon Not Folded); Height 15 ft. 11 in.; Empty Weight 7,630 lb. (With Standard Equipment); Gross Weight 13,000 lb.; Useful Load 5,370 lb.; Engine Wright Cyclone 989C9HE2 1275 hp normal rated at 2500 rpm or 1525 hp at 2800 rpm takeoff; Fuel Capacity 290 gal.; Main Rotor Diameter 56 ft.

PERFORMANCE

Maximum Speed 123 mph at Sea Level; Cruise Speed 98 mph; Best Rate of Climb 1100 fpm at Sea Level.

SIKORSKY S-56; *H-37 (Army); HR2S (Marines)*

SIKORSKY AIRCRAFT DIVISION, United Aircraft Corp., Stratford, Connecticut



REMARKS

The twin-engine S-56 has been delivered to both Army and Marine units and carries 36 fully-equipped troops or equivalent payload in cargo. Loading and unloading may be achieved through clamshell doors in the nose, a cabin floor hatch or cargo door located on the right side of the fuselage. A traversing electric hoist with 2000-pound capacity permits easy cargo shifting in the cabin. Auto-pilot and automatic blade folding equipment are featured as is retractable landing gear. Five-bladed main and four-bladed tail rotors are all metal. More than 150 S-56s have been made.

SPECIFICATIONS

Rotor Diameter 72 ft.; Length 64 ft. 11 in.; Gross Weight 31,000 lb.; Engines Two Pratt & Whitney R2800, derated to 2100 hp.

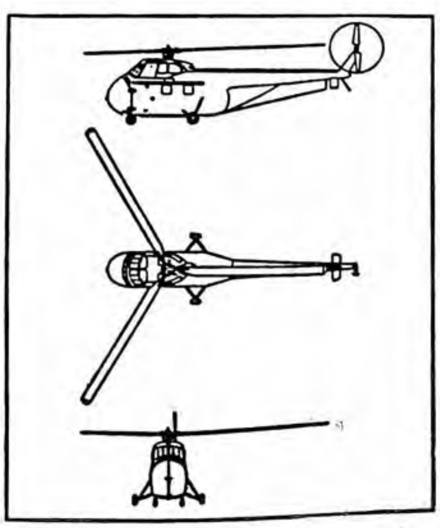
PERFORMANCE

Maximum Speed 130 mph; Cruise Speed 115 mph; Best Rate of Climb at Sea Level 910 fpm.

SIKORSKY S-55;

H-19 (Air Force, Army); HRS (Marines); H04S (Navy, Coast Guard)

SIKORSKY AIRCRAFT DIVISION, United Aircraft Corp., Stratford, Connecticut



REMARKS

The S-55 has a seating capacity of crew (pilot and co-pilot), passengers (commercial-7) (military-10), with alternate cargo capacity of 330 cubic feet. More than 1280 S-55s have been manufactured.

SPECIFICATIONS

Main Rotor Diameter 53 ft.; Tail Rotor Diameter 8 ft. 9 in.; Length 42 ft. 3 in.; Height 13 ft. 4 in.; Empty Weight 4950 lb.; Gross Weight 7200 lb.; Engine Pratt & Whitney S3H2 rated at 600 bhp; Fuel Capacity 185 gal. Alternate 7500 lb. G. W. configuration uses Wright R1300 engine derated to 700 hp.

PERFORMANCE

Maximum Speed 101 mph; Cruise Speed 85 mph; Maximum Rate of Climb at Sea Level 700 fpm; Range 400 st. mi.; Service Ceiling 10,500 ft.

SIKORSKY S-61; *HSS-2 (Navy)*

SIKORSKY AIRCRAFT DIVISION, United Aircraft Corp., Stratford, Connecticut

REMARKS

The HSS-2, the world's largest amphibious helicopter, has a flying boat hull and twin gas turbine engines. It is being produced for the Navy as an anti-submarine warfare weapons system and will be the Navy's first all-weather helicopter. The HSS-2 has undergone the most thorough and extensive development program in the history of the industry, and fleet deliveries are scheduled to commence early in 1962. The HSS-2 was flown publicly for the first time March 24, 1959. Along with the production of the HSS-2 is the commercial S-61L, a 25-28 passenger helicopter which has been ordered by Los Angeles Airways and Chicago Helicopter Airways. First flight of the S-61L took place December 6, 1960. This is the world's first twin-engine helicopter certified for passenger service.

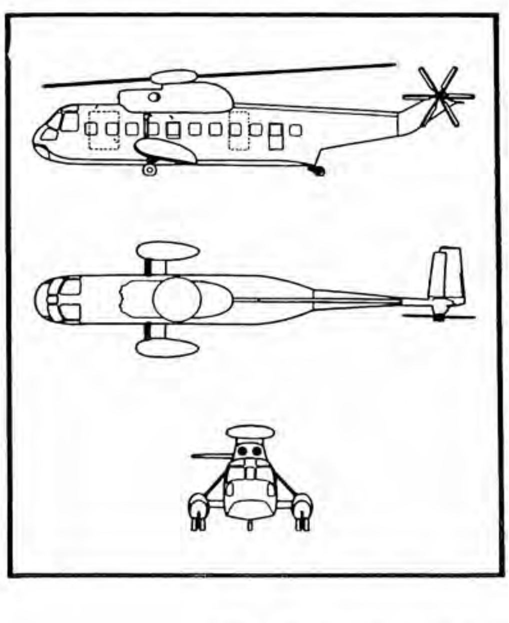
The HSS-2 claims four of the five recognized world speed records. On May 17, 1961, it set a world speed record when it was clocked in 192.9 mph for three kilometers (1.86 miles). December 1, 1961, it claimed three more world records when it flew 182.8 mph for 100 kilometers (62 miles), 179.5 mph for 500 kilometers (311 miles), and 175.3 mph for 1,000 kilometers (623 miles).

SPECIFICATIONS

Rotor Diameter 62 ft.; Overall Length 72 ft. 10.5 in.; Fuselage Length 58 ft. 11 in.; Empty Weight 10,875 lb.; Gross Weight 19,000 lb.; Useful Load 8,125 lb.; Engines Two General Electric CT58-110-1, 1250 shp maximum power, 1050 shp normal rated power; Fuel Capacity 410 gal.

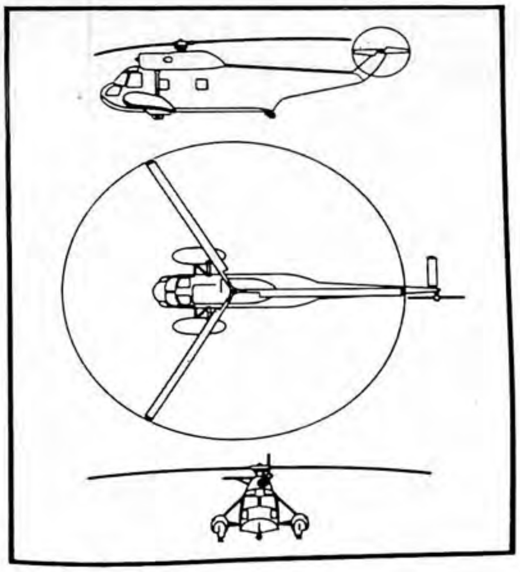
PERFORMANCE

Average Cruising Speed 136 mph at Sea Level; Maximum Speed 147 mph at Sea Level; Best Rate of Climb 1600 fpm at Sea Level; Range with Normal Fuel Load 280 st. mi.



SIKORSKY S-62

SIKORSKY AIRCRAFT DIVISION, United Aircraft Corp., Stratford, Connecticut



REMARKS

The single-turbine S-62 is the first American turbine-powered helicopter to be certified by the Federal Aviation Agency for commercial operations. It also is the first helicopter of any type to be certified under the FAA's new helicopter transport regulations, which are far more stringent than previous requirements. The FAA certificate permits the S-62 to carry a pilot, a co-pilot and 11 passengers. The S-62 is an amphibious helicopter with a flying boat hull, and it can operate from land, water, ice, snow, swamp, mud, or almost any other surface. The first flight took place May 22, 1958, and production is now under way. This helicopter is expected to have wide commercial and military applications. The S-62 flew from the start with proven mechanical components having extended overhaul periods. This was accomplished under the Sikorsky building block concept of blending a new airframe and a modern gas turbine power plant with the mechanical components of the time-tested Sikorsky S-55. The S-55 has mechanical components proved in world-wide operations during more than 1,200,000 flight-hours and the almost 1300 helicopters of this type manufactured during the past eleven years.

SPECIFICATIONS

Length 44 ft. 7 in.; Height 14 ft. 2 in.; Empty Weight 4,789 lb.; Gross Weight 7500 lb.; Useful Load 2,711 lb.; Engine General Electric CT58-100-1, 1050 shp maximum power, 900 shp normal rated power (derated to 670 shp); Fuel Capacity 182 gal.; Main Rotor Diameter 53 ft.

PERFORMANCE

Cruising Speed 98 mph at Sea Level; Maximum Speed 109 mph at Sea Level; Maximum Rate of Climb 1,300 fpm at Sea Level; Range with normal Fuel Load 255 mi.

REMARKS

The first production prototype of L. B. Smith Aircraft's pressurized executive transport, designated Tempo II, completed F.A.A. flight test demonstrations and was certificated on September 21, 1960. Further testing, in accordance with CAR-4b standards, was accomplished during the latter part of 1960 with the result that Tempo II is the only Executive version of the Douglas B-26 in production today to be available for delivery with an F.A.A. approved, 4b type Aircraft Flight Manual.

Because of its inherent good design, safety record, excellent handling characteristics, the famous Douglas B-26 was selected as the basic airframe upon which the Tempo II development program was begun . . . Retaining only the wings, control surfaces and nacelles of the original plane . . . a completely new, fail-safe, pressurized fuselage is manufactured using CAR-4b procedures as a manufacturing guide, that is nine feet, five and one-half inches longer than that of the standard B-26 fuselage, with a constant interior height of six feet, two inches from the cockpit to the rearmost passenger seat . . . thus providing more space for both pilot and passengers than any executive version of the B-26 now in production.

In addition to the longer, higher cabin . . . the original cabin-cutting, carry thru wing spars have been eliminated and replaced by two sets of fuselage spar-ring frames of one and one-quarter inches thick, rolled aluminum alloy plate. This exclusive design permits stand-erect, walk-thru passage from the pilot compartment to the passenger area. The installation causes the wings and engines to be moved outboard, for an increased wing span of twenty inches, contributing to lower cabin noise levels and results in overall, net performance gains due to the increased wing area for added lift and decreased wing loading. The cabin area, forward of the aft ring spar and aft of the pilot compartment, is utilized for a full height lavatory, a complete galley and the radio rack. The standard ten passenger cabin is thereby cleared for installation of executive seating and furniture. Tempo II's entire interior, decorated to suit individual needs and tastes is included as standard equipment. The pressurization system, encompassed by strictly "off-the-shelf" components with the exception of plumbing and ducting, provides a differential of 4.17 psi or a cabin pressure less than 8,000 ft. at a 20,000 foot operating altitude.

SPECIFICATIONS

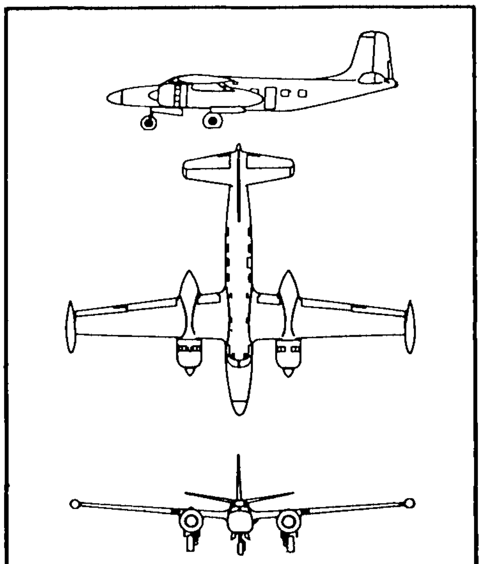
Span 73 ft. 5½ in.; Length 60 ft. 3.5 in.; Height 20 ft.; Empty Weight 26,000 lb.; Wing Loading 61.6 lb. per sq. ft.; Power Loading 7.3 lb. per bhp; Engines Two Water Injected Pratt & Whitney R-2800 CB-17s; 1900 hp normal rated, or 2500 hp at takeoff; Fuel Capacity 1221 gal.; Propeller Hamilton Standard 43E60/6895-12 (reversible); Wing Area 569 sq. ft.; Aileron Area 13.62 sq. ft.; Flap Area 65.9 sq. ft.; Fin Area 48.2 sq. ft.; Rudder Area 23.4 sq. ft.; Stabilizer Area 83.4 sq. ft.; Elevator Area 32.7 sq. ft.

PERFORMANCE

Maximum Speed VNE 365 (TAS); Cruise Speed at 76 percent, 350 (TAS); Landing Speed 111 mph; Rate of Climb 1814 fpm at Sea Level; Service Ceiling 28,000 ft.; Range with Maximum Fuel Load 2075 mi. (cruise).

TEMPO II

L. B. SMITH AIRCRAFT CORP.
P.O. Box 48-456, International Airport
Miami, Fla.



Aerojet's chamber segments for the 100-inch diameter solid rocket motor undergo final machining operations.

ENGINES IN PRODUCTION

AEROJET-GENERAL CORPORATION
AZUSA, CALIFORNIA

• MODEL: 15KS-1000 AIRCRAFT ROCKET ENGINE

Data
Type: Solid-propellant rocket.

Specs
Diameter: 10.30 in. Length: 33.45 in. Empty Weight: 72 lb. Loaded Weight: 144 lb.

Performance
Rating: 1000 lb. thrust, or 400 horsepower, for 15 secs.

Equipment
The engine consists of a steel cylinder closed on the fore end. The igniter is on the fore end, and the exhaust nozzle and pressure release diaphragm are on the aft end. Thrust is transmitted to the aircraft attachment fittings through two mounting lugs welded on the cylinder.

Remarks
The 15KS-1000 aircraft rocket engine was originally developed as a smokeless JATO (jet-assisted takeoff unit) for the Navy, Bureau of Aeronautics. It is one of the two rocket engines certificated by the FAA.

• MODEL: 5KS-4500 AIRCRAFT ROCKET ENGINE

Data
Type: Solid-propellant rocket.

Specs
Diameter: 9.38 in. Length: 54.57 in. Empty Weight: 123 lb. Loaded Weight: 236 lb.

Performance
Rating: 4500 lb. thrust for 5 secs.

Equipment
The engine consists of a steel cylinder closed on the fore end. The igniter is on the fore end, and the canted exhaust nozzle and the pressure release diaphragm are on the aft end. Thrust is transmitted to the aircraft attachment fittings by two mounting lugs welded on the cylinder.

Remarks
5KS-4500 units are used for the assisted takeoff of carrier-based aircraft, or whenever high thrust is required for short duration. These engines are also employed to propel high-velocity deceleration sleds.

• MODEL: AJ10-24 BOOSTER ROCKET ENGINE

Data
Type: Liquid bi-propellant rocket, gas or chemically pressurized.

Specs

Diameter: 15 in. Length: 130 in.

Equipment

Assembly consists of a cylindrical section which contains the oxidizer, fuel and pressurizing tanks. The pressure regulator and rocket motor are attached to the tank section.

Remarks

This powerplant is used to propel the Aerobee high-altitude sounding rocket in investigations of the upper atmosphere.

• MODEL: 15NS-250 AIRCRAFT ROCKET ENGINE

Data

Type: Solid-propellant rocket.

Specs

Diameter: 6 in. Length: 26.6 in. overall. Empty Weight: 21 lb. Loaded Weight: 42 lb.

Performance

Rating: 250 lb. thrust for duration of 15 secs. Nominal at 60°F.

Equipment

The engine consists of a steel cylinder closed on the forward end. The igniter is on the fore end, while the exhaust nozzle and two pressure release diaphragms are on the aft end. Thrust is transmitted to the attachment fittings by two mounting lugs welded on the cylinder.

Remarks

The 15NS-250 "Junior JATO" aircraft rocket engine was developed specifically for use as standby rocket power on light aircraft. This engine received FAA Engine Type Certificate 250 on April 25, 1958. It is one of the only two rocket engines to be so certificated by the FAA.

• MODEL: 2.2KS-11,000 ROCKET ENGINE

Data

Type: Solid-propellant rocket.

Specs

Diameter: 11.38 in. Length: 52.0 in. overall. Empty Weight: 113 lb. Loaded Weight: 256 lb.

Performance

Rating: 11,000 lb. thrust for a duration of 2.2 secs.

Equipment

The engine consists of a steel cylinder closed on the fore end. The igniter and the pressure release diaphragm are on the fore end, while the exhaust nozzle is on the aft end. Thrust is transmitted to the attachment fittings by two mounting bands installed around the cylinder.

Remarks

2.2KS-11,000 units are employed to propel high-velocity test sleds and may be employed as zero launch missile boosters.

• MODEL: 2.2KS-33,000 ROCKET ENGINE

Data

Type: Solid-propellant rocket.

Specs

Diameter: 13.42 in. Length: 109.50 in. overall. Empty Weight: 426 lb. Loaded Weight: 838 lb.

Performance

Rating: 33,000 lb. thrust for a duration of 2.2 secs.

Equipment

The engine consists of a steel cylinder closed on the fore end. The igniter and the pressure release diaphragm are on the fore end and the adjustable nozzle is on the aft end. The nozzle may be canted 1° above the chamber center line to 22° below and 4° to either side of the principal plane of adjustment. Thrust is tachment fittings by two mounting bands installed ing bands installed around the cylinder.

Remarks

2.2KS-33,000 units may be employed as zero launch missile boosters or to propel high-velocity test sleds.

• MODEL: 40NS-4500 ROCKET ENGINE

Data

Type: Solid-propellant rocket.

Specs

Diameter: 16.03 in. Length: 152.5 in. overall. Empty Weight: 1382 lb. Loaded Weight: 2380 lb.

Performance

Rating: 4500 lb. thrust for a duration of 40 secs.

Equipment

The engine consists of a steel cylinder closed on the fore end. The igniter and the pressure release diaphragm are on the fore end while the exhaust nozzle is on the aft end. Thrust is transmitted to the aircraft attachment fittings by mounting bands installed around the cylinder.

Remarks

40NS-4500 units may be employed for assist takeoff of large aircraft.

• MODEL: AJ10-33 BOOSTER ROCKET ENGINE

Remarks

This triple thrust chamber, liquid-propellant, rocket sled powerplant is the most powerful such unit ever developed. It was designed and built for use at the Hurricane Supersonic Research Site at Hurricane Mesa, Utah, to test airplane cockpit ejection systems for supersonic aircraft. This engine develops the equivalent of one-half million horsepower during the run, driving the sled at a maximum velocity of 1600 ft. sec. with an acceleration of 8-10 g's. The use of multiple thrust chambers makes possible the high velocities noted above as well as better control of the thrust level and consequent wide applications in the rocket-sled field.

• MODEL: AJ10-37 BOOSTER ROCKET ENGINE

Remarks

This engine is used as the powerplant for the second stage of the Vanguard, satellite-launching vehicle. Performance data are classified on this bi-propellant liquid rocket engine. The second stage engine drives the satellite and its third stage from the 40-mile first stage burnout altitude to the second stage burnout altitude of 130 miles. The vehicle then coasts to its orbital altitude where a small amount of residual propellant is burned to tip the vehicle over to a horizontal position. The third stage engine then fires to complete the satellite launching mission.

AiRESEARCH MANUFACTURING DIVISION
THE GARRETT CORPORATION
PHOENIX, ARIZONA

• MODEL: GTC 85 Series

Type: Gas Turbine Compressor, open cycle without regenerator.

Specs

Length: 35.5 in. Width: 25.7 in. Weight: 217 pounds, complete with accessories. Compressor: centrifugal. Turbine: single stage, radial inward flow inlet, axial flow discharge.

Performance

(Typical of one unit, units of both higher and lower perf. available): Total air mass flow, 120 lbs./min. Pressure ratio: 3.34:1 rating (cont. air hp): 162 ahp fuel consumption 1.18 lbs./ahp/hr. oil consumption: 0.25 lbs./ahp/hr.

Remarks
Reliable, compact, independent source of pneumatic power for starting turbojet and turboprop engines and for furnishing compressed air for turbine driven vapor or air cycle refrigeration machines, cabin heating ground checkout, ice and snow removal and other low pressure pneumatic functions. Unit can be aircraft mounted or installed in either a trailer or self-propelled vehicle.

ALLISON DIVISION
GENERAL MOTORS CORPORATION
INDIANAPOLIS, INDIANA

• **MODEL: T56-A-7**

Data
Type: Axial-flow propjet.
Specs
Length: 145 in. Width: 28 in. Fuel Grade: JP-4. Dry Weight: 1850 lb. Compressor Stages: 14. Turbine Stages: 4.
Performance
Fuel Consumption: 0.541. Oil Consumption: 2.8.
Equipment
Starter: Govt. furn. equip.
Remarks
Designed for installation in Lockheed C-130B Hercules; ESHP 4050 at 13,820 rpm, sea level conditions.

• **MODEL: T56-A-8**

Data
Type: Axial-flow propjet.
Specs
Length: 145 in. Width: 28 in. Fuel Grade: JP-5. Dry Weight: 1850 lb. Compressor Stages: 14. Turbine Stages: 4.
Performance
Maximum Thrust: 740. Normal Rated Thrust: 718. Fuel Consumption: 0.544. Oil Consumption: 2.8.
Equipment
Starter: Govt. furn. equip.
Remarks
ESHP 4050 at 13,820 rpm, sea level conditions.

• **MODEL: T56-A-9**

Data
Type: Axial-flow propjet.
Specs
Length: 145 in. Width: 28 in. Fuel Grade: JP-4. Dry Weight: 1679 lb. Compressor Stages: 14. Turbine Stages: 4.
Performance
Maximum Thrust: 726. Normal Rated Thrust: 702. Fuel Consumption: 0.55. Oil Consumption: 3.6.
Equipment
Starter: Govt. furn. equip.
Remarks
Current production installation in Lockheed C-130A Hercules; ESHP 3750 at 13,820 rpm, sea level conditions.

• **MODEL: T56-A-10W**

Data
Type: Axial-flow propjet.
Specs
Length: 145 in. Width: 28 in. Fuel Grade: JP-4/JP-5. Dry Weight: 1850 lb. Compressor Stages: 14. Turbine Stages: 4.
Performance
Maximum Thrust: 750. Normal Rated Thrust: 718. Fuel Consumption: 0.541. Oil Consumption: 2.8.
Equipment
Starter: Govt. furn. equip.
Remarks
Designed for P3V-1 Lockheed Electra; ESHP 4500 with water-alcohol injection.

• **MODEL: T63-A-1**

Data
Type: Free turbine propjet.
Specs
Length: 38.5. Width: 15.8. Fuel Grade: JP-4 (Alternate 115/145). Dry Weight: 147 lb. Compressor Stages: 7 axial; 1 centrifugal. Turbine Stages: Single-stage gas producer; Two-stage power turbine.
Performance
Fuel Consumption: 0.71.
Remarks
Rated at 250 SHP.

• **MODEL: T63-A-3**

Data
Type: Free turbine turbo-shaft.
Specs
Length: 34.6. Width: 15.8. Fuel Grade: JP-4 (Alternate 115/145). Dry Weight: 110 lb. Compressor Stages 7 axial; 1 centrifugal. Turbine Stages: Single-stage gas producer; Two-stage power turbine.
Performance
Fuel Consumption: 0.71.
Remarks
Rated at 250 SHP.

• **MODEL: 501-D13 PROPJET ENGINE**

Data
Type: Axial-flow propjet.
Specs
Length: 145 in. Width: 27 in. Weight: 1750 lb. Compressor Stages: 14. Turbine Stages: 4.
Equipment
Starter: Airframe-furnished.
Remarks
Current production installation in Lockheed Electra commercial transport; ESHP 3750 at 13,820 rpm, sea level conditions.

• **MODEL: T56-A-1A**

Data
Type: Axial-flow propjet.
Specs
Length: 145 in. Width: 27 in. Total Weight: 1645 lb. Compressor Stages: 14. Turbine Stages: 4.
Equipment
Starter: Govt. furn. equip.
Remarks
Current production installation is in Lockheed C-130A Hercules; ESHP 3750 at 13,820 rpm, sea level conditions.

THE BOEING COMPANY
INDUSTRIAL PRODUCTS DIVISION

• **MODEL: 502-10VB**

Data
Type: Simple Cycle Two-Shaft Free Power Turboshaft.
Specs
Length: 41.5 in.; Width: 24 in.; Fuel Grade: all fuels except leaded gasoline; Dry Weight: 330 lb. Compressor Stages: 1 Single-Stage Centrifugal; Turbine Stages: Single-Stage Gas Producer; Single-Stage Power Turbine.
Performance
325 hp at 3000 rpm; Fuel Consumption: 0.97.

Equipment
Starter: 24 volt 30 ampere Starter-Generator.

- **MODEL: T50-BO-4 (502-10V)**

Data
Type: Simple Cycle Two-Shaft Free Power Turboshaft.
Specs
Length: 40 in.; Width: 24 in.; Fuel Grade: All fuels except leaded gasoline; Dry Weight: 334 lb.; Compressor Stages: One Single-Stage Centrifugal; Turbine Stages: Single-Stage Gas Producer; Single-Stage Power Turbine.
Performance
270 hp. at 6000 rpm; Fuel Consumption: 1.02.
Equipment
Starter: 24 volt 30 ampere Starter-Generator. Oil Cooler: integral eductor type.
Remarks
Powerplant for Gyrodyne DSN-3 Drone Helicopter.

- **MODEL: 502-12B**

Data
Type: Gas Turbine-Driven Compressor.
Specs
Length: 46 in.; Width: 24 in.; Fuel Grade: All fuels except leaded gasoline; Dry Weight: 410 lb. (includes air compressor); Compressor Stages; One Single-Stage Centrifugal; Turbine Stages: Single-Stage Gas Producer; Single-Stage Power Turbine.
Performance
205 air hp; Fuel Consumption: 1.02.
Equipment
Starter: 24 volt 30 ampere Starter-Generator.
Remarks
Boeing Turbo-Starter ground support unit used by domestic and foreign airlines.

- **MODEL: T60-BO-2 (520-2)**

Data
Type: Simple Cycle Two-Shaft Free Power Turboshaft.
Specs
Length: 58 in.; Width: 25 in.; Fuel Grade: All fuels except leaded gasoline; Dry Weight: 315 lb.; Compressor Stages: One Single-Stage Centrifugal; Turbine Stages: Single-Stage Gas Producer; Single-Stage Power Turbine.
Performance
430 hp at 6000 rpm; Fuel Consumption: 0.72.
Equipment
Starter: 24 volt 100 ampere Starter-Generator.

- **MODEL: 520-6**

Data
Type: Simple Cycle Two-Shaft Free Power Turboshaft.
Specs
Length: 55 in.; Width: 25 in.; Fuel Grade: All fuels except leaded gasoline; Dry Weight: 250 lb.; Compressor Stages: One Single-Stage Centrifugal; Turbine Stages; Single-Stage Gas Producer; Single-Stage Power Turbine.
Performance
550 hp at 6000 rpm; Fuel Consumption: 0.65.
Equipment
Starter: 24 volt 100 ampere Starter-Generator.

- **MODEL: 502-14**

Data
Type: Simple Cycle Two-Shaft Free Power Turboshaft.
Specs
Length: 34 in.; Width: 23 in.; Fuel Grade: All fuels except leaded gasoline; Dry Weight: 233 lb.; Compressor Stages: One Single-Stage Centrifugal; Turbine Stages: Single-Stage Gas Producer; Single-Stage Power Turbine.

Boeing T60-BO-2 turbo shaft engine.

Performance
330 hp at 6000 rpm; Fuel Consumption: 0.85.
Equipment
Starter: 24 volt 30 ampere Starter-Generator; Oil Cooler: integral eductor type.

- **MODEL: 502-18**

Data
Type: Simple Cycle Two-Shaft Free Power Turboshaft.
Specs
Length: 34 in.; Width: 23 in.; Fuel Grade: All fuels except leaded gasoline; Dry Weight: 215 lb.; Compressor Stages: One Single-Stage Axial and One Single-Stage Centrifugal; Turbine Stages: Single-Stage Gas Producer; Single-Stage Power Turbine.
Performance
375 hp at 6000 rpm; Fuel Consumption: 0.78.
Equipment
Starter: 24 volt 30 ampere Starter-Generator.

CONTINENTAL AVIATION & ENGINEERING CORPORATION

DETROIT, MICHIGAN

- **MODEL: 352-5A (J69-T-25)**

Data
Type: Turbojet.
Specs
Diameter: 22.3 in. Length: 50 in. Fuel Grade: JP-4. Dry Weight: 364 lb. Compressor Stages: 1. Turbine Stages: 1.
Performance
Maximum Thrust: 1025. Normal Rated Thrust: 880. Fuel Consumption: 1.12 (S.F.C.). Oil Consumption: 0.5 lb./hr.
Equipment
Starter: Electric.
Remarks
Current production installation: Cessna T-37B USAF Jet Trainer.

- **MODEL: 356-7A (J69-T-29)**

Data
Type: Turbojet.
Specs
Diameter: 22.3 in. Length: 46 in. Dry Weight: 335 lb. Compressor Stages: 2. Turbine Stages: 1.
Performance
Maximum Thrust: 1700. Normal Rated Thrust: 1375. Fuel Consumption: 1.085 (S.F.C.). Oil Consumption: 1.0 lb./hr.

Equipment
Starter: Electric.

Remarks
Current production installation: Ryan Q-2C "Firebee."

- **MODEL: 217-5A (T72-T-2)**

Data
Type: Turboshaft.

Specs
Diameter: 19.4 in. Length: 42.5 in. Compressor Ratio: 6:1; Fuel Grade: JP-4; Dry Weight: 210 lb.: Compressor Stages: 2; Turbine Stages: 3.

Performance
Maximum hp: 500 lb. Normal Rated hp: 405 lb., Fuel Consumption: 0.67 SFC: Oil Consumption: .4 pts/hr; 6000 rpm output shaft, free turbine design.

- **MODEL: 217-6A**

Data
Type: Turboprop.

Specs
Diameter: 19.4 in. Length: 42.5 in. Compressor Ratio: 6:1; Fuel Grade: JP-4; Dry Weight: 230 lb.; Compressor Stages: 2; Turbine Stages: 3.

Performance
Maximum hp: 500 lb. Normal Rated hp: 405 lb. Fuel Consumption: 0.67 SFC; Oil Consumption: 0.4 pts/hr; 2100 rpm prop drive free turbine design.

- **MODEL: CJ69-1400**

Data
Type: Turbojet.

Specs
Diameter: 22.3 in. Length: 44.8 in. Compressor Ratio: 5:1; Fuel Grade: JP-4; Dry Weight: 370 lb.; Compressor Stages: 2.

Performance
Maximum thrust: 1400 lb. Normal Rated Thrust: 1200 lb.; Fuel Consumption: 1.04 SFC; Oil Consumption: .5 pts/hr.

- **MODEL: 141**

Data
Type: Gas Turbine Air Compressor.

Specs
Length: 44.6 in. Width: 15.94 in. Total Weight: 197 lb. Compressor Stages: 1. Turbine Stages: 2.

Performance
Rated Air hp; St'd day 191, 130°F 182. Air Delivery: St'd day 2.2 lb./sec. Delivery Pressure: St'd day, PSIA 52.5. RPM: 35,000.

Equipment
Starter: Electric.

Remarks
Current production installation: Used in TC-106 (USAF type MA-1A) trailer mounted turbine air compressor. Also suitable as powerplant for pressure-jet helicopters.

- **MODEL: 142-1**

Data
Type: Combination Shaft Power-Air Bleed Turbine Engine (APU).

Specs
Height: 22.4 in. Length: 36.0 in. Width: 20.0 in. Dry Weight: 265 lb. Compressor Stages: 1. Turbine Stages: 2.

Performance
Maximum & Normal Rating (St'd Day), 295 hp or 175 lbs/min Bleed Air; 6000 rpm output Power Shaft; Fuel Consumption: 452 lbs/hr.; Oil Consumption: 0.5 lbs/hr.

CONTINENTAL MOTORS CORPORATION
MUSKEGON, MICHIGAN

- **MODEL: O-470-J**

Data
Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 273.

Specs
Length: 36.03 in. Width: 33.32 in. Displacement: 470 cu. in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 7.0:1 Fuel Grade: 80/87 octane. Dry Weight: 378 lb.

Performance
Rating: 225 hp at 2550 rpm at sea level.

Equipment
Carburetor: Marvel. Magneto: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy, 12 volt, 35 amp.

- **MODEL: O-470-M**

Data
Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 273.

Specs
Length: 43.31 in. Width: 33.58 in. Displacement: 470 cu. in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 8.0:1. Fuel Grade: 91/90 octane. Dry Weight: 410 lb.

Performance
Rating: 240 hp at 2600 rpm at sea level.

Equipment
Carburetor: Bendix. Magneto: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy, 24 volt, 25 amp.

- **MODEL: O-300-D**

Data
Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 253.

Specs
Length: 36.38 in. Width: 31.50 in. Displacement: 300 cu. in. Bore: 4.0625 in. Stroke: 3.875 in. Compression Ratio: 7.0:1. Fuel Grade: 80/87 octane. Dry Weight: 268 lb.

Performance
Rating: 145 hp at 2700 rpm at sea level.

Equipment
Carburetor: Marvel. Magneto: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy, 12 volt, 20 amp.

- **MODEL: O-470-R**

Data
Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 273.

Specs
Length: 36.03 in. Width: 33.58 in. Displacement: 470 cu. in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 7.0:1. Fuel Grade: 80/87 octane. Dry Weight: 401 lb.

Performance
Rating: 230 hp at 2600 rpm at sea level.

Equipment
Carburetor: Marvel. Magneto: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy, 12 volt, 35 amp.

- **MODEL: A65-8F**

Data
Type: 4 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 205.

Specs
Length: 27.00 in. Width: 31.50 in. Fuel Grade: 80/87 octane. Bore: 3.875 in. Stroke: 3.625 in. Displacement: 171 cu. in. Compression Ratio: 6.3:1. Dry Weight: 171 lb.

Performance
Rating: 65 hp at 2300 rpm at sea level.
Equipment
Carburetor: Marvel. Ignition: Scintilla.
Remarks
This engine is supplied without starter or generator provisions.

• MODEL: C85-12F
Data
Type: 4 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 233.
Specs
Length: 28.50 in. Width: 31.50 in. Fuel Grade: 80/87 octane. Bore: 4.062 in. Stroke: 3.625 in. Displacement: 188 cu. in. Compression Ratio: 6.3:1. Dry Weight: 181 lb.
Performance
Rating: 85 hp at 2575 rpm at sea level.
Equipment
Carburetor: Stromberg. Ignition: Scintilla. Starter: Deco-Remy, Generator: Delco-Remy, 12 volt, 20 amp.

• MODEL: C90-12F
Data
Type: 4 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 252.
Specs
Length: 28.50 in. Width: 31.50 in. Fuel Grade: 80/87 octane. Bore: 4.062 in. Stroke: 3.875 in. Displacement: 200 cu. in. Compression Ratio: 7:1. Dry Weight: 188 lb.
Performance
Rating: 90 hp at 2475 rpm at sea level.
Equipment
Carburetor: Marvel. Ignition: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy, 12 volt, 20 amp.

• MODEL: E-185-9
Data
Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 246.
Specs
Length: 48.40 in. Width: 33.39 in. Fuel Grade: 80/87 octane. Bore: 5 in. Stroke: 4 in. Displacement: 470 cu. in. Compression Ratio: 7:1. Dry Weight: 352 lb.
Performance
Rating: 205 hp at 2600 rpm at sea level.
Equipment
Carburetor: Bendix. Ignition: Scintilla. Starter: Provisions for direct cranking starter. Generator: Delco-Remy, 12 volt, 35 amp. This engine also available with full AN accessory section.

• MODEL: E-225-4
Data
Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 267.
Specs
Length: 48.4 in. Width: 33.39 in. Fuel Grade: 80/87 octane. Bore: 5 in. Stroke: 4 in. Displacement: 470 cu. in. Compression Ratio: 7:1. Dry Weight: 355 lb.
Performance
Rating: 225 hp at 2650 rpm at sea level.
Equipment
Carburetor: Bendix. Ignition: Scintilla. Starter: Eclipse. Generator: Delco-Remy, 12 volt, 35 amp. This engine also available with full AN accessory section.

• MODEL: O-470-2
Data
Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 281.
Specs
Length: 37.73 in. Width: 33.62 in. Displacement: 470 cu. in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 7.0:1. Fuel Grade: 100/130 octane. Dry Weight: 484 lb.
Performance
Rating: 265 bhp at 2600 rpm at sea level.
Equipment
Carburetor: Bendix. Magneto: Scintilla. Starter: Eclipse. Generator: Eclipse, 30 volt, 50 amp.
Remarks
The engine has a belt driven supercharger.

• MODEL: O-470-15
Data
Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 269.
Specs
Length: 45.20 in. Width: 33.41 in. Displacement: 470 in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 7.0:1. Fuel Grade: 80/87 octane. Dry Weight: 405 lb.
Performance
Rating: 213 bhp at 2600 rpm at sea level.
Equipment
Carburetor: Stromberg. Magneto: Scintilla. Starter: Bendix. Generator: Bendix, 24 volt, 50 amp.

• MODEL: IO-470-C
Data
Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 273.
Specs
Length: 37.56 in. Width: 33.58 in. Displacement: 470 cu. in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 8.0:1. Fuel Grade: 91/96 octane. Dry Weight: 432 lb.
Performance
Rating: 250 bhp at 2600 rpm at sea level.
Equipment
Carburetor: CMC Injector. Magneto: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy, 12 volt, 50 amp.

• MODEL: IO-470-S
Data
Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 3E2.
Specs
Length: 43.53 in. Width: 33.58 in. Displacement: 470 cu. in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 8.6:1. Fuel Grade: 100/130 octane. Dry Weight: 429 lb.
Performance
Rating: 260 bhp at 2625 rpm at sea level.
Equipment
Fuel Injector: Continental Motors. Magnetos: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy, 25 amp, 24 volt.

• MODEL: IO-470-K
Data
Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 3E1.
Specs
Length: 37.93 in. Width: 33.58 in. Displacement: 470 cu. in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 7.0:1. Fuel Grade: 80/87 octane. Dry Weight: 402 lb.
Performance
Rating: 225 bhp at 2600 rpm at sea level.
Equipment
Fuel Injector: Continental Motors. Magneto: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy, 35 amp, 12 volt.

• MODEL: FSO-526-A (HELICOPTER)
Data
Type: 6 cylinder, fan-cooled, horizontally opposed, FAA Type Certificate. 292.

Specs
Length: 47.69 in. Width: 33.64 in. Displacement: 526 cu. in. Bore: 51.25 in. Stroke: 4.25 in. Compression Ratio: 7.0:1. Fuel Grade: 91/96 octane. Dry Weight: 568 lb.

Performance
Rating: 270 bhp at 3200 rpm at sea level to 7,900 ft. critical altitude.

Equipment
Carburetor: Bendix. Magneto: Scintilla.

Remarks
This engine has a gear driven single stage supercharger.

- **MODEL: GO-300-E**

Data
Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 298.

Specs
Length: 39.12 in. Width: 31.50 in. Displacement: 300 cu. in. Bore: 4.0625 in. Stroke: 4.25 in. Compression Ratio: 7.3:1. Propeller Shaft Ratio: 7.5:1. Fuel Grade: 80/87 octane. Dry Weight: 314 lb.

Performance
Rating: 175 bhp at 3200 rpm at sea level.

Equipment
Carburetor: Marvel. Magneto: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy, 12 volt, 25 amp.

Remarks
This engine has a geared propeller shaft and provision for a hydraulic propeller.

- **MODEL: O-200-A**

Data
Type: 4 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 252.

Specs
Length: 28.53 in. Width: 31.56 in. Displacement: 200 cu. in. Bore: 4.062 in. Stroke: 3.875 in. Compression Ratio: 7.0:1. Fuel Grade: 80/87 octane. Dry Weight: 190 lb.

Performance
Rating: 100 bhp at 2750 rpm at sea level.

Equipment
Carburetor: Marvel. Magneto: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy, 12 volt, 20 amp.

- **MODEL: GIO-470-A**

Data
Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate (Pending).

Specs
Length: 44.89 in. Width: 33.56 in. Displacement: 471 in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 8.6:1. Propeller Shaft Ratio: .750:1. Fuel Grade: 100/130 octane. Dry Weight: 461 lb.

Performance
Rating: 310 bhp at 3400 rpm at sea level.

Equipment
Fuel Injector: Continental Motors. Magnetos: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy 24 volt, 73 amp.

Remarks
This engine has a geared propeller shaft and generator drive.

- **MODEL: TSIO-470-B**

Data
Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 3E3.

Specs
Length: 42.82 in. Width: 33.56 in. Displacement: 471 in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 7.5:1. Fuel Grade: 100/130 octane. Dry Weight: 468 lb.

Performance
Rating: 260 bhp at 2600 rpm at sea level to 16,000 ft. critical altitude.

Performance
Fuel Injector: Continental Motors. Turbo-Supercharger: AiResearch. Magneto: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy, 12 volt, 50 amp.

Remarks
Length includes Turbo-Supercharger system.

FRANKLIN ENGINE CO., INC.
SUBSIDIARY, AERO INDUSTRIES, INC.
SYRACUSE, NEW YORK

- **MODEL: FRANKLIN 6A4-165-B3**

Data
Type: 6 cylinder, air-cooled, horizontally opposed. FAA Type Certificate: 238.

Specs
Length: 37⅜ in. Fuel Grade: 80 octane. Bore: 4.5 in. Stroke: 3.5 in. Displacement: 335 cu. in. Compression Ratio: 7:1. Dry Weight 280 lb.

Performance
Takeoff Power: 165 hp at 2800 rpm. Cruise: 124 hp at 2200 rpm. Fuel Consumption: .5 lb. per hp hr. Oil Consumption: .002 lb. per hp hr.

Equipment
Carburetor: Marvel-Schebler MA4-5. Ignition: Dual Scintilla S6RN-21, Starter: Delco-Remy. Generator: Delco-Remy. Fuel Pump: AC.

- **MODEL: FRANKLIN 6V4-200-C32, C33**

Data
Type: 6 cylinder, air-cooled, horizontally opposed. FAA Type Certificate: 244.

Specs
Length: 34¾ in. Fuel Grade: 91 octane. Bore: 4.5 in. Stroke: 3.5 in. Displacement: 335 cu. in. Compression Ratio: 7.1. Dry Weight: 280 lb.

Performance
Takeoff Power: 200 hp. Fuel Consumption: .52 lb. per hp hr. Oil Consumption: .002 lb. per hp hr.

Equipment
Carburetor: Marvel-Schebler MA4-5. Ignition: Dual ScintillaS6RN-23. Starter: Delco-Remy. Generator: Delco-Remy. Fuel Pump: Weldon.

Remarks
This model was designed for helicopter installations.

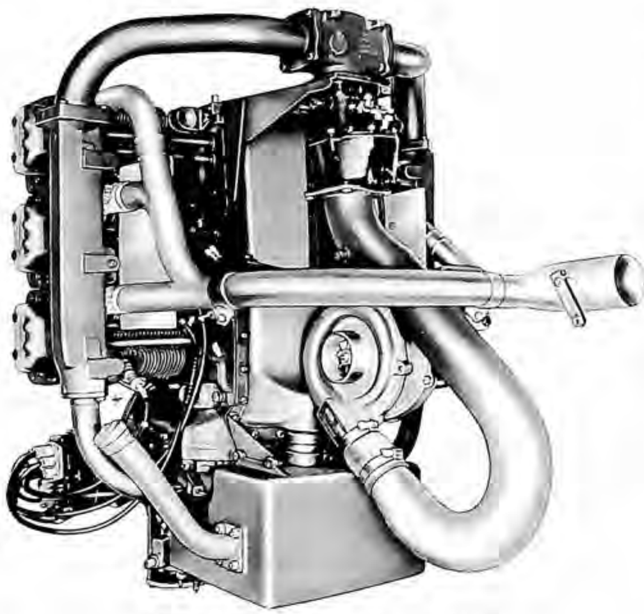
- **MODEL: FRANKLIN 6V-335-A, B**

Data
Type: 6 cylinder, air-cooled, horizontally opposed; 210 hp. FAA Type Certificate: 244.

Specs
Length: 34¾ in. Fuel Grade: 91 octane. Bore: 4.5 in. Stroke: 3.5 in. Displacement: 335 cu. in. Compression Ratio: 8.5:1. Dry Weight: 280 lb.

Performance
Takeoff Power: 210 hp. Fuel Consumption: .52 lb. per hp hr. Oil Consumption: .002 lb. per hp hr.

Equipment
Carburetor: Marvel-Schebler MA4-5. Ignition: Dual Scintilla S6RN-23. Starter: Delco-Remy. Generator: Delco-Remy. Fuel Pump: Weldon. Designed for helicopter installation.



FRANKLIN Model 6VS-335

• **MODEL: FRANKLIN 6A4-150-B3**

Data

Type: 6 cylinder, air-cooled, horizontally opposed. FAA Type Certificate: 238.

Specs

Length: 37⅜ in. Fuel Grade: 80 octane. Bore: 4.5 in. Stroke: 3.5 in. Displacement: 335 cu. in. Compression Ratio: 7:1. Dry Weight: 280 lb.

Performance

Takeoff Power: 150 hp at 2600 rpm. Cruise: 113 hp at 2350 rpm. Fuel Consumption: .5 lb. per hp hr. Oil Consumption: .002 lb. per hp hr.

Equipment

Carburetor: Marvel-Schebler MA-3SPA. Ignition: Dual Eisemann LA-6 or Scintilla S6RN21. Starter: Delco-Remy. Generator: Delco-Remy. Fuel Pump: AC.

• **MODEL: 6VS-335**

Data

Type; 6 cylinder, air-cooled, horizontally opposed, turbosupercharged. FAA Type Certificate: 1E2.

Specs

Height: 38$\frac{9}{64}$ in. Depth: 39¾ in. Width: 31$\frac{9}{16}$ in. Displacement: 335 cu. in. Bore: 4½ in. Stroke: 3½ in. Compression Ratio: 7:1. Fuel Grade: 100/130. Dry Weight: 284 lb. Total Weight: 360 lb., including starter, carburetor, ignition, fuel pump, turbo and complete exhaust system.

Performance

Takeoff Power: 240 hp to 13,000 ft.; 225 hp continuous to 15,000 ft. Fuel Consumption: Normal rating .55 lb. per hp hr., at 70% power, .50 lb. per hp hr., Oil Consumption: Normal rating .020 lb. per hp hr., at 70% power. .015 lb. per hp hr. max.

Equipment

Carburetor: Marvel MA-6. Magnetos: Two Scintilla S6RN23s. Starter: Delco-Remy 24 volt. Generator: (Optional) Pierson 28 volt. Turbosupercharger; Fuel pump, complete exhaust system. Designed for helicopter installation.

• **MODEL: FRANKLIN 6A-335-A**

Data

Type: 6 cylinder, air-cooled, horizontally opposed; 210 hp.

Specs

Length: 36⅜ in. Width: 31$\frac{19}{32}$ in. Displacement: 335 cu. in. Bore: 4½ in. Stroke: 3½ in. Compression Ratio: 8.5:1. Fuel Grade: 91 octane. Dry Weight: 284 lb.

Equipment

Carburetor: Marvel-Schebler MA4-5. Magnetos: Scintilla SCRN-23. Starter: Delco-Remy 24 volt. Generator: Pierson 24 volt, 25 amp.

• **MODEL: Franklin 4A4-100-B3**

Data

Type: 4-cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 239.

Specs

Length: 28 in.; Fuel Grade: 80 octane; Bore: 4.5 in.; Stroke: 3.5 in.; Displacement: 225 cu. in.; Compression Ratio: 7:1; Dry Weight: 198 lb.

Performance

Takeoff Power: 100 hp at 2550 rpm; Cruise: 80 hp at 2400 rpm; Fuel Consumption: 0.52 lb. per hp hr.

Equipment

Carburetor: Marvel-Schebler MA-35PA; Ignition: Dual Scintilla S4RN-21; Starter: Delco-Remy; Generator: Delco-Remy; Fuel Pump: AC.

GENERAL ELECTRIC COMPANY
FLIGHT PROPULSION DIVISION
CINCINNATI 15, OHIO

• **MODEL: J79**

Data

Type: Military Turbojet.

Specs

Diameter: 38.0 in.; Length: 207.5 in.; Compression Ratio: 12.8:1; Fuel Grade: JP-4 and 5; Total Weight: 3,200 lb. approximate, less afterburner; Compressor Stages: 17; Turbine Stages: Three.

Performance

Maximum Thrust: 17,000 lb.; Normal Rated Thrust: 9,700 SLS; Fuel Consumption: 2.0 at Maximum Thrust; Oil Consumption: 1 lb. per hr.; Single Rotor Variable Stator Design.

Remarks

Current production installation includes: Lockheed F-104 Starfighter, Convair B-58 Hustler, North American A3J Vigilante, McDonnell F4H Phantom II.

• **MODEL: J93**

Data

Type: Turbojet.

Equipment

Compressor: Variable Stator; Afterburner and Nozzle Section: Converging-Diverging Exhaust Nozzle; Controls: Controlled Environment Pod employed for accessories, mounted beneath compressor section; accessory pod is completely removable as a single unit for ease of maintenance; Single Shaft; Light Weight Construction, incorporating honey-comb structures.

Remarks

Installed in North American Aviation B-70 Valkyrie Long-Range Bomber. Applicable to future Mach 3 commercial transports.

• **MODEL: CJ-805-3B**

Data

Type: Turbojet.

Specs

Diameter: 31.6 in.; Length: 188.94 in. (with Reverser/Suppressor); Fuel Grade: Commercial JP; Total Weight: 3200 lb.; Compressor Stages: 17; Turbine Stages: three.

Performance
Maximum Thrust: 11,650; Normal Rated Thrust: 9190 lb.; Fuel Consumption: .728; Oil Consumption: 1 lb. per hr.

Remarks
Installed in Convair 880M.

- **MODEL: CJ-805-23**

Data
Type: Turbofan.

Specs
Diameter: 31.6 in. for basic engine, 53.0 with Aft-Fan Unit: Length: 138.6 in. with Thrust Reverser; Fuel Grade: Commercial JP; Total Weight: 4270 lb. with Thrust Reverser; Compressor Stages: 17; Turbine Stages: three plus one Fan Stage.

Performance
Maximum Thrust: 16,100 lb.; Normal Rated Thrust: 13,600 lb.; Fuel Consumption: .528; Oil Consumption: 2 lb. per hr.

Remarks
Installed in Convair 990 Coronado.

- **MODEL: CJ-805-23C**

Data
Type: Turbofan.

Specs
Diameter: 31.6 in. Basic Engine, 53.0 with Aft-Fan Unit; Length: 166.3 in.; Fuel Grade: Commercial JP; Total Weight: 4,465 lb.; Compressor Stages: 17; Turbine Stages: three plus one Fan Stage.

Performance
Maximum Thrust: 16,100 lb.; Normal Rated Thrust: 13,600 lb.; Fuel Consumption: .528; Oil Consumption: 2 lb. per hr.

Remarks
Installed in Sud Caravelle 10A.

- **MODEL: 240 Turboshaft Engine**

Data
Type: Marine or Industrial Gas Turbine.

Specs
Diameter: 65 in.; Length: 290 in.; Height: 95 in.; Compression Ratio: 12:1; Fuel Grade; JP or Diesel #2; Total Weight: Approximately 6,600 lb.; Compressor Stages: 17; Turbine Stages: three plus one-stage power turbine.

Performance
Maximum Power: 20,000 shp; Normal Rated Thrust: 14,000 shp; Fuel Consumption: .478 at Maximum lb./hr./shp; Oil Consumption: 3 lb. per hr. at Maximum.

Remarks
Installed in MARAD Hydrofoil.

- **MODEL: X353-5A**

Data
Type: Lift Fan VTOL Propulsion System.

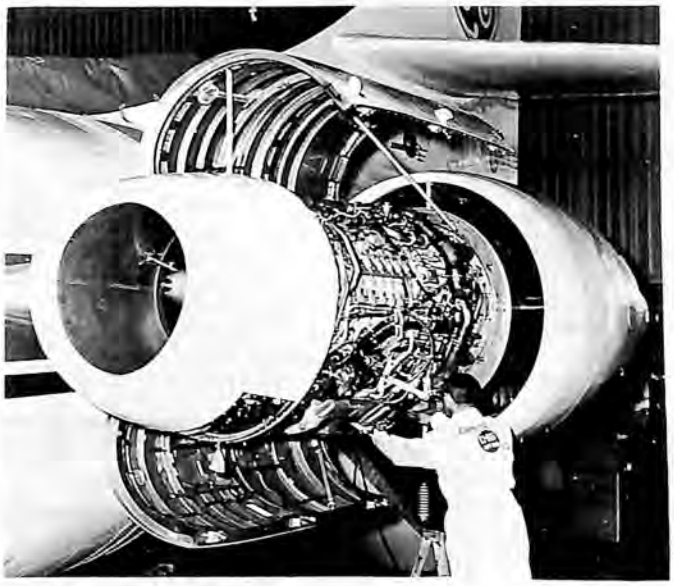
Specs
Diameter of gas generator: 17.75 in.; Fan installed diameter: 76 in.; Gas generator length: 80 in.; Total system weight: 1145 lb.; Thrust-to-weight ratio, lift and cruise combined: 6.5:1; Lift only: 9.4:1.

Performance
Lift thrust: 7430 lb.; Horizontal thrust: 2580 lb.; Fuel Consumption: .34 for lift, .98 for horizontal.

Remarks
Gas generator is G-E J85 turbojet. Earlier version of this system, the X353-5, will power the Army's lift fan flight research airplane.

SMALL AIRCRAFT ENGINE DEPARTMENT
LYNN, MASSACHUSETTS

- **MODEL: T58-8B**



GE's CJ-805-23C aft-turbofan engine.

Specs
Diameter: 16 in. Length: 55 in. Fuel Grade: JP-4/JP-5 (contaminated fuel). Dry Weight: 295 lb. Compressor Stages: 10. Turbine Stages: 2 plus 1 free power turbine.

Performance
Maximum thrust: 1250 shp. Normal rated thrust: 1050 shp. Fuel consumption: 0.61 military. The T58-8B has a horsepower to weight ratio of 4.2 to 1 and fuel economy from 0.6 to 0.7 sfc in the normal operating range of the engine.

Applications
Sikorsky HSS-2; Boeing-Vertol HRB-1; Kaman HU2K; Kaman K-16 (experimental VTOL); Fairchild M-224-1 (experimental VTOL).

- **MODEL: CT58-100**

Data
Type: Turboshaft.

Specs
Diameter: 16 in. Length: 55 in. Fuel Grade: JP-4/JP-5 (Contaminated Fuel). Dry Weight: 280 lb. Compressor Stages: 10. Turbine Stages: 2 plus 1 free power turbine.

Performance
Maximum HP: 150 Takeoff Power. Normal Rated HP: 900 lb. Fuel Consumption: 0.64.

Applications
Sikorsky S-61—ordered by L. A. Airways and Chicago Airways; Sikorsky—S-62 in operation by Petroleum Helicopters and L. A. Airways; Vertol· 107, Model II—ordered by New York Airways.

- **MODEL: CT58-110-1**

Data
Type: Turboshaft.

Specs
Diameter: 16 in. Length: 55 in. Fuel grade: JP-4/JP-5 (contaminated fuel). Dry Weight: 299 lb. Compressor Stages: 10. Turbine Stages: 2 plus 1 free power turbine.

Performance
Maximum thrust: 1250 shp. Normal rated thrust: 1050 shp. Fuel consumption: 0.61 sfc. The CT58-110-1 has a horsepower to weight ratio of 4.2 to 1 and fuel economy from 0.6 to 0.7 sfc in the normal operating range of the engine.

Applications

Boeing-Vertol 107 (twin CT58's)—ordered by New York Airways, Fuji Air Transport, Osaka Airways, Fuji Airlines, Kanki Airlines, Japanese Government, Canadian Air Force and Swedish Navy. Sikorsky S-61 (twin CT58's)—ordered by Los Angeles Airways and Chicago Helicopter Airways. Sikorsky S-62 (single CT58)—in operation by Los Angeles Airways, San Francisco-Oakland Helicopter Airlines, Petroleum Helicopters, Okanagan Airways, Indian Government, Canadian Government, Fuji Airlines, World Wide Airways and United Aircraft—ordered by Nitto Airlines.

- **MODEL: CF700-2B**

Data

Type: Turbofan.

Specs

Diameter: 34 in. Length: 65 in. Fuel Grade: JP-4/JP-5. Dry Weight: 640 lb. Compressor Stages: 8. Turbine Stages: 2.

Performance

Maximum Thrust: 4200 lb. Fuel Consumption: 0.69 lb./hr./lb. The CF700-2B offers a 6.6-to-1 thrust-to-weight ratio and high mass-flow per unit of frontal area.

Applications

With the promise of new standards in range and economy, the aft-turbofan engine will be the logical choice for many of the executive and military craft now in design stages.

- **MODEL: CJ610-1**

Data

Type: Turbojet.

Specs

Diameter: 17.7 in. Length: 40 in. Fuel Grade: JP-4/JP-5. Dry Weight: 355 lb. Compressor Stages: 8. Turbine Stages: 2.

Performance

Maximum thrust: 2850. Fuel Consumption: 0.99 lb./hr./lb.

Remarks

The CJ610 is essentially the same engine as the dry J85. The CJ610/CF700 constitute the ideal powerplant combination for the budding executive aircraft market. For example, the CJ610-1 will power the Aero Commander Jet 1121 and the Piaggio-Douglas PD-808. Both are six-to-eight place twin-jet executive aircraft. The CJ610 is also well suited for such military applications as light attack, trainers, and surveillance aircraft.

- **MODEL: CJ610-2B**

Data

Type: Turbojet.

Specs

Diameter: 17.7 in.; Length: 40 in.; Fuel Grade: JP-4/JP-5; Dry Weight: 355 lb.; Compressor Stages: 8; Turbine Stages: 2.

Performance

Maximum Thrust: 2400 lb.; Fuel Consumption: 0.91.

Remarks

Twin CJ610-2B's have been chosen to power Swiss American Aircraft Corp. SAAC-23 Executive Jet.

- **MODEL: T64-2**

Data

Type: Turboshaft.

Specs

Diameter: 30 in. Length: 91 in. Fuel Grade: JP-4/JP-5. Dry Weight: 864 lb. Compressor Stages: 14. Turbine Stages: 2.

Performance

Maximum thrust: 2810. Normal rated thrust: 2235. Fuel Consumption: 0.506 (military). The T64-2 has a power-to-weight ratio of 3.3 to 1.

Remarks

All configurations of the T64 engine can operate continuously at attitude from 100 degrees nose up to 45 degrees nose down. The turboprop and turboshaft configurations are derived by the simple addition of gearing to a basic engine building block.

- **MODEL: T64-4**

Data

Type: Turboshaft.

Specs

Diameter: 36 in. Length: 113 in. Fuel Grade: JP-4/JP-5. Dry Weight: 1136 lb. Compressor Stages: 14. Turbine Stages: 2.

Performance

Maximum Thrust: 2850. Normal rated thrust: 2315. Fuel Consumption: 0.500 (military). The T64-4 has a power-to-weight ratio or 2.5 to 1.

- **MODEL: T64-8**

Data

Type: Turboprop.

Specs

Diameter: 46 in. Length: 113 in. Width: 29 in. Fuel Grade: JP-4/JP-5. Dry Weight: 1136 lb. Compressor Stages: 14. Turbine Stages: 2.

Performance

Maximum thrust: 2850. Normal rated thrust: 2090. Fuel Consumption: 0.490 lb./hp-hr. The T64-8 has a power-to-weight ratio of 2.5 to 1.

Remarks

The T64 "family" of engines, because of their low fuel consumption and attractive power-to-weight ratio are especially suited for application in high performance helicopters, VTOL, STOL, and fixed wing utility aircraft, military and commercial.

- **MODEL: T64-6**

Data

Type: Turboshaft.

Specs

Diameter: 30 in. Length: 83 in. Fuel Grade: JP-4/JP-5. Dry Weight: 713 lb. Compressor Stages: 14. Turbine Stages: 2.

Performance

Maximum trust: 2850. Normal rated thrust: 2270. Fuel Consumption: 0.405 lb/hp-hr. The T64-6 has a power-to-weight ratio of 4 to 1.

Remarks

The T64-6 has recently been announced as the powerplant for the four-engine tri-service VTOL transport to be built by the aerospace team of Ling-Temco-Vought, Ryan Aeronautical Company and Hiller Aircraft Corporation.

- **MODEL: 720-722**

Data

Type: Turboshaft.

Specs

Diameter: 16 in. Length: 55 in. Fuel Grade: 720-JP-4/JP-5 diesel (contaminated fuel) 722-Natural gas. Dry Weight: 320 lb. Compressor Stages: 10. Turbine Stages: 2 plus 1 free power turbine.

Performance

Maximum HP: 1000 lb. Fuel Consumption: 12,400 btu/hp/hr.

Applications

Pacific Telephone and Telegraph Co.-Power for 750 KW stand-by generator unit; Halliburton-Pump drive for oil well fracturing unit; Trunkline-Compressor drive for natural gas pipeline pumping station; Grumman-Maneuvering or "docking" engine for Maritime Administration (MARAD) 80 ton hydrofoil boat; Dynamic Development-Main propulsion for Bureau of Ships 24-foot experimental hydrofoil boat; Jered-Main propulsion for Marine Corps experimental amphibious landing vehicle.

• **MODEL J85-5**

Data

Type: Turbojet.

Specs

Diameter: 20.2 in. Length: 108.8 in. Fuel Grade: JP-4. Dry Weight: 550 lb. Compressor Stages: 8. Turbine Stages: 2.

Performance

Maximum thrust: 3850. Normal rated thrust: 2050. Fuel Consumption: 2.20 reheat (military) 1.01 sfc dry. Maximum Reheat Thrust, SLS, Standard Day: 3850 lb. Military Thrust, SLS, Standard Day: 2500 lb. Power-to-weight ratio of 7.2 to 1 and high mass-flow per unit frontal area.

Applications

Northrop T-38 "Talon" supersonic trainer. Northrop N156 "Freedom Fighter." Radioplane Q4B supersonic target drone. VTOL X-14A for NASA experimental program. VTOL lift-fan flight research vehicle for US Army.

• **MODEL: J85-7**

Data

Type: Turbojet.

Specs

Diameter: 17.7 in. Length: 39.3 in. Fuel Grade: JP-4. Dry Weight: 327.5 lb. Compressor Stages: 8. Turbine Stages: 2.

Performance

Maximum thrust: 2450. Normal rated thrust: 2000. Fuel Consumption: 0.975 sfc. The J85-7 offers a 7.5 to 1 thrust-to-weight ratio and high mass-flow per unit frontal area.

Applications

McDonnell GAM-72 "Quail" decoy missile for Strategic Air Command.

LYCOMING DIVISION
AVCO CORPORATION
STRATFORD, CONNECTICUT

• **MODEL: T53-L-1A (LTC1B-1)**

Data

Type: Shaft turbine engine. FAA Type Certificate: 1-E6.

Specs

Diameter: 23.0 in. Length: 47.61 in. Width: 23.0 in. Pressure Ratio: 6:1. Fuel Grade: Mil-F-5624 Grade JP-4. Dry Weight: 480 lb. Compressor Stages: 5 axial plus 1 cent. Turbine Stages: 1 compressor, 1 free power.

Performance

Maximum SHP: 860 military. Normal Rated SHP: 770. Fuel Consumption: 0.735 ESFC at military power.

Remarks

Development was sponsored by Army and Air Force on this single stage free-type power turbine, combination axial-centrifugal compressor driven by a single stage turbine, and external annular vaporizing combustor engine. Current production installation: Bell H40/HU-1; Kaman H43B. Also installed in prototype vehicles: Ryan Model 92; Doak Model 16; Vertol Model 76; Bu Ships "Halobates" Boat, Army "Flying Duck." Vertol Model 107; Vanguard Omniplane, Curtiss-Wright X-100.

• **MODEL: T53-L-3**

Data

Type: Turboprop.

Specs

Diameter: 23.0 in. Length: 58.40 in. Width: 23.0 in. Pressure Ratio: 6:1. Fuel Grade: JP-4. Dry Weight: 524 lb. Compressor Stages: 5 axial plus 1 cent. Turbine Stages: 1 compressor plus 1 free power.

Performance

Maximum SHP: 960. Normal Rated SHP: 825. Fuel Consumption: .655 ESFC at takeoff. Oil Consumption: .14 gal. per hr.

Remarks

Developed under sponsorship of Army and Air Force on this single stage free-type power turbine, axial-centrifugal compressor driven by single stage turbine, and external annular vaporizing combustor engine. Now in production for use in Grumman AO-1 Mohawk high-performance observation plane for Army.

• **MODEL: T53-L-5**

Data

Type: Shaft turbine engine.

Specs

Diameter: 23.0 in. Length: 47.6 in. Width: 23.0 in. Pressure Ratio: 6:1. Fuel Grade: JP-4. Dry Weight: 487 lb. Compressor Stages: 5 axial plus 1 centrifugal. Turbine Stages: 1 compressor plus 1 free power.

Performance

Maximum SHP: 960 takeoff. Normal Rated SHP: 825. Fuel Consumption: 0.665 ESFC at takeoff.

Remarks

Development funded by Army. This engine is a shaft turbine version of the T53-L-3 turboprop embodying Lycoming's "Universal Engine" concept. Only difference between these two engines is in reduction gear and fuel control. For use in growth versions of vehicles presently using T53-L-1. Scheduled for Bell HU-1B.

• **MODEL: T55-L-5**

Data

Type: Shaft turbine engine.

Specs

Diameter: 24.25 in. Length: 45.21 in. Width: 24.76 in. Pressure Ratio: 6:1. Fuel Grade: JP-4. Dry Weight: 570 lb. Compressor Stages: 7 axial plus 1 centrifugal. Turbine Stages: 1 compressor plus 2 free power.

Performance

Maximum SHP: 2200 military. Normal Rated SHP: 1850. Fuel Consumption: 0.600 ESFC at military power. Oil Consumption: .25 gal. per hr.

Remarks

High speed version of T55-L-3. Output shaft speed equal to power turbine speed. In production for use in Vertol YHC-1B "Chinook" cargo helicopter for Army. Embodies Lycoming's "Universal Engine" concept.

• **MODEL: T53-L-7**

Data

Type: Turboprop.

Specs

Length: 58.40 in.; Width: 23.00 in.; Fuel Grade: JP-4; Dry Weight: 540 lb.; Compressor Stage: 5 Axial plus 1 cent.; Turbine Stages: 1 compressor plus 1 free power.

Performance

Maximum SHP: 1100 at 1700 rpm. Normal rated SHP: 900 at 1700 rpm; Fuel Consumption: ESFC at military .649.

Remarks

The T53-L-7 is the higher rated version of the T53-L-3 to be used in advance models of the Grumman AO-1 Mohawk.

• **MODEL: T53-L-9**

Data

Type: Turboshaft.

Specs

Length: 47.61 in.; Width: 23.00 in.; Fuel Grade JP-4; Dry Weight: 485 lb.; Compressor Stages: 5 Axial plus 1 Cent.; Turbine Stages: 1 Compressor plus 1 free power.

Performance

Maximum SHP: 1100 at 6610 rpm. Normal Rated SHP: 900 at 6610 rpm. Fuel Consumption: SFC at 0.661 military power.

Remarks

The T53-L-9 is a universal helicopter engine for use in the advance model of the Bell HU-1D Iroquois, utility and cargo transport helicopters and VTOL/STOL aircraft.

• **MODEL: LTC4G-3**

Data

Type: Turboprop.

Specs

Length: 62.2 in.; Width: 24 in.; Fuel Grade: JP-4; Dry Weight: 795 lb.; Compressor Stages: 7 Axial plus 1 Cent.; Turbine Stages: 1 Compressor plus 2 free power.

Performance

Maximum SHP: 2445 at 1270 PRPM; Normal Rated SHP: 2100 at 1,225 rpm; Fuel Consumption: .61 SFC at 2445 SHP.

Remarks

The LTC4G-3 is a new high performance version of the earlier T55-L-1 utilizing a new split power gear system developed by Lycoming. In addition to turboprop applications the LTC4G-3 has been developed with possible VTOL operations in mind.

LYCOMING DIVISION
AVCO CORPORATION
WILLIAMSPORT, PENNSYLVANIA

• **MODEL: O-235-C1B**

Data

Type: 4 cylinder, air-cooled, horizontally opposed, 115 hp. FAA Type Certificate: 223.

Specs

Length: 29.81 in. Width: 32.00; Height 22.40; Fuel Grade: 80 octane. Bore: 4.375 in. Stroke: 3.875 in. Displacement: 233.3 cu. in. Compression Ratio: 6.75:1. Dry Weight: 240 lb. Weight per hp: 2.08 lb.

Performance

Takeoff Power: 115 hp 2800 rpm. Cruise: 80 hp at 2350 rpm. Fuel Consumption: .52 lb. per hp hr. Oil Consumption: .012 lb. per hp hr.

Equipment

Carburetor: Marvel-Schebler MA-3A. Ignition: Dual Scintilla S4LN-204 and S4LN-200. Starter: Delco-Remy. Generator: Delco-Remy.

• **MODEL: O-290-D2C**

Data

Type: 4 cylinder, air-cooled, horizontally opposed, direct drive, 140 hp. FAA Type Certificate: 229.

Specs

Length: 29.81 in. Width: 32.24 in. Height: 22.68 in. Bore: 4.875. Stroke: 3.875. Compression Ratio: 7.00:1. Displacement: 289.0 cu. in. Weight: 263 lb. Fuel Grade: 80/87.

Performance

Takeoff Power: 140 hp at 2800. Rated Power: 135 hp at 2600 rpm. Fuel Consumption: 6.5 gal. per hr. at 2250 rpm, economy cruise.

Equipment

Carburetor: Marvel-Schebler MA-3SPA. Magnetos: Scintilla S4LN-204 and S4LN-200. Generator: Delco-Remy, 12 volt. Starter: Delco-Remy.

• **MODEL: O-320-A2C**

Data

Type: 4 cylinder, air-cooled, horizontally opposed, direct drive, 150 hp. FAA Type Certificate: 274.

Specs

Length: 29.81 in. Height: 22.99 in. Width: 32.24 in. Bore: 5.125. Stroke: 3.875. Displacement: 319.8 cu in. Compression Ratio: 7.00:1. Weight: 271 lb. Fuel Grade: 80/87.

Performance

Takeoff and Rated Power: 150 hp at 2700 rpm. Fuel Consumption: 8.2 gal. per hr. at 2350 rpm, economy cruise.

Equipment

Carburetor: Marvel-Schebler MA-4SPA. Magnetos: Scintilla S4LN-200 and S4LN-204. Generator: Delco-Remy, 12 or 24 volt. Starter: Delco-Remy.

• **MODEL: O-320-B2C**

Data

Type: 4 cylinder, air-cooled, horizontally opposed, direct drive, 160 hp. FAA Type Certificate: 274.

Specs

Length: 29.81 in. Width: 32.24 in. Height: 22.99 in. Bore: 5.125. Stroke: 3.875. Displacement: 319.8 cu. in. Compression Ratio: 8.50:1. Weight: 277 lb. Fuel Grade: 91/96.

Performance

Takeoff and Rated Power: 160 hp at 2700 rpm. Fuel Consumption: 8.2 gal. per hr. at 2350 rpm, economy cruise.

Equipment

Carburetor: Marvel-Schebler MA-4SPA. Magnetos: Scintilla S4LN-204 and S4LN-200. Generator: Delco-Remy, 12 or 24 volt. Starter: Delco-Remy, 12 or 24 volt.

• **MODEL: O-320-B3C**

Data

Type: 4 cylinder, air-cooled, horizontally opposed, direct drive, 160 hp. FAA Type Certificate: 274.

Specs

Length: 29.81 in.; Width: 32.24 in.; Height: 22.99 in.; Displacement: 320 cu. in.; Bore: 5.125 in.; Stroke: 3.875 in.; Compression Ratio: 8.50:1; Fuel Grade: 91/96; Dry Weight: 277 lb.

Performance

Takeoff and Rated Power: 160 hp at 2700 rpm at Sea Level. Cruising: 120 hp at 2450 at 7000 ft. Fuel Consumption: 10.0 gal. per hr. at 75 percent rated power, 8.8 gal. per hr. at 65 percent rated power. Oil Consumption: .012 lb. bhp per hr. at rated power.

Equipment

Carburetor: Marvel-Schebler MA-4SPA. Magnetos: Scintilla S4LN-200 and S4LN-204. Starter: Delco-Remy. Generator: Delco-Remy.

• **MODEL: O-340-A1B**

Data

Type: 4 cylinder, air-cooled, horizontally opposed, direct drive, 170 hp. FAA Type Certificate: 277.

Specs

Length: 29.81 in. Width: 32.55 in. Height: 24.55 in. Bore: 5.125. Stroke: 4.125. Compression Ratio: 8.50:1. Displacement: 340.4 cu. in. Weight: (with starter and generator) 277 lb. Fuel Grade: 91/96.

Performance

Takeoff and Rated Power: 170 hp at 2700 rpm. Fuel Consumption: 8.5 gal. per hr. at 2350 rpm and 65 percent rated power.

Equipment

Carburetor; Marvel-Schebler MA4-5. Magnetos: Scintilla S4LN-204 and S4LN-200. Generator: Delco-Remy, 12 volt. Starter: Delco-Remy.

- **MODEL: O-360-A1C**

Data

Type: 4 cylinder, air-cooled, horizontally opposed, 180 hp. FAA Type Certificate: 286.

Specs

Length: 30.67 in.; Width: 33.37 in.; Height: 19.68 in.; Displacement: 361 cu. in.; Bore: 5.125 in.; Stroke: 4.375 in.; Compression Ratio: 8.50:1; Fuel Grade: 91/96; Dry Weight: 289 lb.

Performance

Takeoff and Normal Rated Power; 180 hp at 2700 rpm at Sea Level. Cruising: 135 hp at 2450 rpm to 7,500 ft. Fuel Consumption: 10.5 gal. per hr. at 75 percent rated power, 9.0 gal. per hr. at 65 percent rated power. Oil Consumption: .012 lb. bhp per hr. at rated power.

Equipment

Carburetor: Bendix PSH-5BD. Magnetos: Scintilla S4LN-200 and S4LN-204. Starter: Delco-Remy. Generator: Delco-Remy.

- **MODEL: O-360-A1D**

Data

Type: 4 cylinder, air-cooled, horizontally opposed, 180 hp. FAA Type Certificate: 286.

Specs

Length: 29.81 in. Width: 33.37 in. Height: 24.59 in. Displacement: 361 cu. in. Bore: 5.125 in. Stroke: 4.375. Compression Ratio: 8.50:1. Fuel Grade: 91/96. Dry Weight: 284 lb.

Equipment

Carburetor: Marvel-Schebler MA4-5 Magnetos: Scintilla S4LN-200, S4LN-204. Starter: Delco-Remy. Generator: Delco-Remy.

- **MODEL: O-360-C2D**

Data

Type: 4 cylinder, air-cooled, horizontally opposed, direct drive helicopter, 180 hp. FAA Type Certificate: 286.

Specs

Height: 19.68 in. Length: 30.67 in. Width: 33.37 in. Displacement: 361 cu. in. Bore: 5.125 in. Stroke: 4.375 in. Compression Ratio: 8.50:1. Fuel Grade: 91/96. Dry Weight: 288 lb.

Performance

Takeoff and Rated Power: 180 hp at 2700 rpm, alternate rating 180 hp at 2900 rpm at 28.0 in. HG manifold pressure.

- **MODEL: IO-360-B1A**

Data

Type: 4 cylinder, air-cooled, horizontally opposed, direct drive, fuel injection, 180 hp. FAA T.C. 1E-10.

Specs

Length: 32.81 in. Width: 33.37 in.; Height: 22.47 in. Displacement: 361 cu. in. Bore: 5.125 in. Stroke: 4.375 in. Compression Ratio: 8.50:1. Fuel Grade: 91/96. Dry Weight: 295 lb.

Performance

Takeoff and Normal Rated Power: 180 hp at 2700 rpm at Sea Level. Cruising: 135 hp at 2450 rpm. Fuel Consumption: 11.0 gal. per hr. at 75 percent rated power, 8.5 gal. per hr. at 65 percent rated power. Oil Consumption: .012 lb. bhp per hr. at rated power.

Equipment

Fuel Injector: Simmonds Type 530. Magnetos: Scintilla S6LN-200 and S6LN-204. Starter: Delco-Remy. Generator: Delco-Remy.

- **MODEL: VO-360-A1B**

Data

Type: 4 cylinder, horizontally opposed, vertical, air-cooled helicopter, 180 hp. FAA Type Certificate: 1-E1.

Specs

Height: 22.23 in. Length: 30.00 in. Width: 33.37 in. Displacement: 361 cu. in. Bore: 5.125 in. Stroke: 4.375 in. Compression Ratio: 8.50:1. Fuel Grade: 91/96. Dry Weight: 297 lb.

Performance

Takeoff and Rated Power: 180 hp at 2900. Fuel Consumption: 13.5 gal. per hr. at 80 percent rated power.

Equipment

Carburetor: Marvel-Schebler MA4-5. Magnetos: Two Scintilla S4LN-200, S4LN-204.

Remarks

Current production installation: Brantly B-2 helicopter (Army HO-3).

- **MODEL: IMO-360-B1B**

Data

Type: 4 cylinder, horizontally opposed, air-cooled, fuel injection, drone, 225 hp at 3400 rpm.

Specs

Height: 17.49 in. Length: 33.25 in. Width: 34.25 in. Displacement: 361 in. (3). Bore: 5.125 in. Stroke: 4.375 in. Compression Ratio: 8.70:1. Fuel Grade: 100/130. Dry Weight: 274 lb.

Performance

Takeoff and Rated Power: 225 hp. at 3400 rpm. Full throttle fuel consumption: 22 gal. per hr.

Equipment

Fuel Injector: Simmonds Type 580. Magneto: Scintilla S4LN-21.

Remarks

Current production installation: Aerojet-General Surveillance Drone.

- **MODEL: GO-435-C2B2-6**

Data

Type: 6 cylinder, horizontally opposed, geared, air-cooled, 260 hp. FAA Type Certificate: 228.

Specs

Height: 28.02 in. Length: 38.64 in. Width: 33.12 in. Displacement: 430.0 in. Bore: 4.875 in. Stroke: 3.875 in. Compression Ratio: 7.30:1. Fuel Grade: 80/87. Dry Weight: 430 lb.

Performance

Takeoff: 260 hp at 3400 rpm. Rated Power: 240/245 hp at 3000/3100 rpm. Fuel Consumption: 13.5 gal. per hr. at 60 percent rated power and speed.

Equipment

Carburetor: Marvel-Schebler MA4-5. Magnetos: Scintilla S6LN-20, and S6LN-21.

- **MODEL: VO-435-AIE**

Data

Type: 6 cylinder, air-cooled, horizontally opposed, for vertical helicopter installation 260 hp. FAA Type Certificate: 279.

Specs

Height: 24.13 in. Width: 33.58 in. Length: 34.73 in. Fuel Grade: 80/87. Bore: 4.875. Stroke: 3.875. Displacement: 434 cu. in. Compression Ratio: 7.30:1. Weight: 392 lb.

Performance

Takeoff: 260 hp at 3400 rpm. Rated Power: 250 hp at 3200 rpm. Fuel Consumption: 18.7 gal. per hr. at 80 percent rated power.

Equipment

Carburetor: Marvel-Schebler MA4-5 AA. Magnetos: Scintilla S6LN-204 and S6RN-200. Hand cranking provisions optional. New design crankcase and oil pump.

- **MODEL: TVO-435-AIA**

Data

Type: 6 cylinder, air-cooled, horizontally opposed, turbo-charged for vertical helicopter installation, 260 hp. FAA Type Certificate: 1E-13.

Specs
Height: 36.51 in.; Length: 34.73 in.; Width: 33.58 in.: Displacement: 434 in.; Bore: 4.875 in.; Stroke: 3.875 in.; Compression Ratio: 7.3:1; Fuel Grade: 100/130; Dry Weight: 468 lb.

Performance
Maximum Continuous: 220 hp at 3200 rpm, S. L. to 20,000 ft. Takeoff: 260 hp at 3200 rpm, S. L. to 15,000 ft. Fuel Consumption: 18 gal/hr at 80% rated power.

Equipment
Carburetor: Marvel-Schebler MA-6AA. Magnetos: Scintilla, S6RN-200 and S6LN-204. Turbocharger: AiResearch Model T-1108.

- **MODEL: GO-480-G2F6**

Data
Type: 6 cylinder, gear drive, horizontally opposed, air-cooled, 295 hp. FAA Type Certificate: 275.

Specs
Height: 28.02 in. Length: 41.79 in. Width: 33.12 in. Bore: 5.125 in. Stroke: 3.875 in. Compression Ratio: 8.70:1. Displacement: 479.7 cu. in. Weight: 442 lb. Fuel Grade: 100/130.

Performance
Takeoff Power: 295 hp at 3400 rpm. Rated Power: 285 hp at 3100 rpm. Fuel Consumption: 13.5 gal. per hr. at 60 percent rated power and speed.

Equipment
Carburetor: Bendix-Stromberg PS-5BD. Magnetos: Scintilla S6LN-204, S6LN-200.

- **MODEL: GSO-480-B1B6 (O-480-1)**

Data
Type: 6 cylinder, horizontally opposed, geared, supercharged, 340 hp. FAA Type Certificate: 284.

Specs
Length: 46.22 in. Height: 33.26 in. Width: 33.12 in. Bore: 5.125. Stroke: 3.875. Displacement: 479.7 cu. in. Compression Ratio: 7.30:1. Weight: 500 lb. Fuel Grade: 100/130.

Performance
Takeoff Power: 340 hp at 3400 rpm (2180 prop. rpm). Rated Power: 320 hp at 3200 rpm. Fuel Consumption: 15.5 gal. per hr. at 60 percent rated hp and 2600 rpm.

Equipment
Carburetor: Bendix PSH-7BD. Magnetos: Scintilla S6LN-20, S6RN-21.

- **MODEL: IGSO-480-A1B6**

Data
Type: 6 cylinder, horizontally opposed, geared and supercharged, fuel injection, air-cooled, 340 hp. FAA Type Certificate: 284.

Specs
Height: 23.29 in. Length: 47.56 in. Width: 33.12 in. Displacement: 479.7 cu. in. Bore: 5.125 in. Stroke: 3.875 in. Compression Ratio: 7.30:1. Fuel Grade: 100/130. Dry Weight: 497 lb.

Performance
Takeoff Power: 340 hp at 3400 rpm. Rated Power: 320 hp at 3200 rpm. Fuel Consumption: 15.8 gal. per hr. at 60 percent rated power.

Equipment
Fuel Injector: Simmonds Type 570. Magnetos: Scintilla S6LN-204, S6RN-200.

Remarks
Current production installations: Beechcraft Twin-Bonanza, Beechcraft Queen Air.

- **MODEL: O-540-A1D5**

Data
Type: 6 cylinder, air-cooled, horizontally opposed, direct drive, 250 hp. FAA Type Certificate: 295.

Specs
Length: 38.42 in. Height: 24.56 in. Width: 33.37 in. Bore: 5.125. Stroke: 4.375. Displacement: 541.5 cu. in. Compression Ratio: 8.50:1. Weight: 397. Fuel Grade: 91/96.

Performance
Takeoff Power: 250 hp at 2575 rpm. Rated Power: 250 hp at 2575 rpm. Fuel Consumption: 12 gal. per hr. at economy cruise.

Equipment
Carburetor: Marvel-Schebler MA4-5. Magnetos: Scintilla, S6LN-200, S6LN-204. Generator: Delco-Remy 12 or 24 volt. Starter: Delco-Remy.

- **MODEL: O-540-B1A5**

Data
Type: 6 cylinder, air-cooled, horizontally opposed, direct drive, 235 hp. FAA Type Certificate: 295.

Specs
Height: 24.56 in.; Length: 38.42 in.; Width: 33.37 in.: Displacement: 541.5 in.; Bore: 5.125 in.; Stroke: 4.375 in.; Compression Ratio: 7.20:1; Fuel Grade: 80/87; Dry Weight: 395 lb.

Performance
Fuel Consumption: 12.5 gal/hr at 2350 rpm economy cruise. Takeoff and Rated Power: 235 hp at 2575 rpm.

Equipment
Carburetor: Marvel-Schebler MA-4-5. Magneto: Scintilla S6LN-200 and S6LN-204. Starter: Delco-Remy. Generator: Delco-Remy 12 or 24 volt.

- **MODEL: O-540-F1B5**

Data
Type: 6 cylinder, horizontally opposed, air-cooled, helicopter 260 hp. FAA Type Certificate: 295.

Specs
Height: 24.56 in. Length: 38.42 in. Width: 33.37 in. Displacement: 541.5 in. (3) Bore: 5.125 in. Stroke: 4.375 in. Compression Ratio: 8.50:1. Fuel Grade: 91/96. Dry Weight: 398 lb.

Performance
Maximum Power: 260 hp at 2800 rpm to 800 ft. alt. Normal Rated Power: 235 hp at 2800 rpm to 4000 ft. alt. Fuel Consumption: 13.5 gal. per hr. at 65% rated.

Equipment
Carburetor: Marvel-Schebler MA4-5. Magneto: Scintilla S6LN-200, S6LN-204. Starter: Delco-Remy. Generator: Delco-Remy.

Remarks
Current production installation: Certificated for helicopter operation.

- **MODEL: IO-540-AIA5**

Data
Type: 6 cylinder, air-cooled, horizontally opposed, direct drive, fuel injection, 290 hp. FAA T. C.: 1E4.

Specs
Length: 38.62 in. Width: 34.25 in. Height: 19.60 in.: Displacement: 541.5 cu. in. Bore 5.125 in. Stroke: 4.375 in. Compression Ratio: 8.70:1. Fuel Grade: 100/130. Dry Weight: 443 lb.

Performance
Takeoff and Normal Rated Power: 290 hp at 2575 rpm at Sea Level. Cruising: 220 hp at 2350 rpm at 6000 ft. Fuel Consumption: 16.5 gal. per hr. at 75 percent rated power. 13.5 gal. per hr. at 65 percent rated power. Oil Consumption: .012 lb. bhp per hr. at rated power.

Equipment
Fuel Injector: Bendix Type RS-10ED1 Magnetos: Scintilla S6LN-200 and S6LN-204. Starter: Delco-Remy. Generator: Delco-Remy.

- **MODEL: IO-540-B1A5**

Data
Type: 6 cylinder, air-cooled, horizontally opposed, direct drive, fuel injection, 290 hp. FAA Type Certificate 1E4.

Specs
Length: 38.62 in.; Width: 34.25 in.; Height: 19.60 in.; Displacement: 541.5 cu. in.; Bore: 5.125 in.; Stroke: 4.375 in.; Compression Ratio: 8.70:1; Fuel Grade: 100/130; Dry Weight: 437 lb.

Performance
Takeoff: 290 hp at 2575 rpm at Sea Level. Normal Rated Power: 290 hp at 2575 rpm at Sea Level. Cruising: 220 hp at 2350 rpm at 6000 ft. Oil Consumption: .012 lb. bhp per hr. at between 75 percent and rated power.

Equipment
Fuel Injector: System Bendix Type RS-10B1. Magnetos: Scintilla S6LN-200 and S6LN-204. Starter: Delco-Remy 12 volt. Generator: Delco-Remy 12 volt, 20 amp.

• **MODEL: IO-540-C1A5**

Data
Type: 6 cylinder, air-cooled, horizontally opposed, direct drive, fuel injection, 250 hp. FAA Type Certificate 1E4.

Specs
Height: 22.21 in.; Length: 39.58 in.; Width: 33.37 in.; Displacement: 541.5 in.; Bore: 5.125 in.; Stroke: 4.375 in.; Compression Ratio: 8.5:1; Fuel Grade: 91/96; Dry Weight: 403 lb.

Performance
Fuel Consumption: 12.5 gal/hr at 2350 rpm, economy cruise. Takeoff and Rated Power: 250 hp at 2575 rpm.

Equipment
Fuel Injector: AC Model B-237. Magneto: Scintilla S6LN-200 and S6LN-204. Starter: Delco-Remy. Generator: Delco-Remy 12 or 24 volt.

• **MODEL: IGO-540-A1A**

Data
Type: 6 cylinder, air-cooled, horizontally opposed, geared drive, fuel injection, 350 hp. FAA TC 1E-11.

Specs
Length: 46.38 in.; Width: 34.25 in.; Height: 21.72 in.; Displacement: 541.5 cu. in.; Bore: 5.125 in.; Stroke: 4.375 in.; Compression Ratio: 8.70:1; Fuel Grade: 100/130; Dry Weight: 506 lb.

Performance
Takeoff: 350 hp at 3400 rpm at Sea Level. Normal Rated Power: 325 hp at 3000 rpm at Sea Level. Cruising: 240 hp at 2700 rpm at 6000 ft. Fuel Consumption: 18.5 gal. per hr. at 75 percent of rated power, 15.0 gal. per hr. at 65 percent of rated power. Oil Consumption: .014 lb. bhp per hr. at rated power.

Equipment
Fuel Injection: Bendix RS10ED1. Magnetos: Scintilla S6RN-200 and S6RN-204.

• **MODEL: IGO-540-B1A**

Data
Type: 6 cylinders, horizontally opposed, air-cooled, geared drive, fuel injection, tuned induction, 4 cycle. FAA T.C. 1E11.

Specs
Length: 43.88 in.; Width: 34.25 in.; Height: 21.66 in.; Displacement: 541.5 in.; Bore: 5.125 in.; Stroke: 4.375 in.; Compression Ratio: 8.70:1; Fuel Grade: 100/130; Dry Weight: 500 lb.

Performance
Takeoff: 380 hp at 3400 rpm at 12,000 ft. Normal Rated Power: 325 hp at 3000 rpm at Sea Level. Cruising: 240 hp at 2700 rpm at 6000 ft. Fuel Consumption: (CR) .42 lb. per hp per hr.

Equipment
Bendix RS10ED4 port fuel injection. Magnetos: Bendix-Scintilla S6RN-200 and S6RN-204.

• **MODEL: IGSO-540-A1A**

Data
Type: 6 cylinder, air-cooled, horizontally opposed, geared drive, fuel injection, supercharged. FAA T.C. 1E7.

Specs
Length: 47.96 in.; Width: 34.25 in.; Height: 28.44 in.; Displacement: 541.5 cu. in.; Bore: 5.125 in.; Stroke: 4.375 in.; Compression Ratio: 7.30:1; Fuel Grade: 100/130; Dry Weight: 540 lb.

Performance
Takeoff: 380 hp at 3400 rpm at 10,500 ft. Normal Rated Power: 360 hp at 3200 rpm at 10,500 ft. Cruising: 270 hp at 2,750 rpm at 13,000 ft. Fuel Consumption: 27.0 gal. per hr. at 75 percent of rated power, 19.0 gal. per hr. at 65 percent of rated power. Oil Consumption: .015 lb. bhp per hr. at rated power.

Equipment
Fuel Injector: Bendix Type RS10FB1 Magnetos: Scintilla S6RN-600 and S6RN-604.

• **MODEL: IGSO-540-B1A**

Data
Type: 6 cylinders, horizontally opposed, air-cooled, geared drive, fuel injection, supercharged, 4 cycle, FAA Type Certificate 1E7.

Specs
Length: 48.63 in.; Width: 34.25 in.; Height: 20.29 in.; Displacement: 541.5 in.; Bore: 5.125 in.; Stroke: 4.375 in.; Compression Ratio: 7.30:1; Fuel Grade: 100/130; Dry Weight: 532 lb.

Performance
Takeoff: 380 hp at 3400 rpm at 12,000 ft. Normal Rated Power: 360 hp at 3200 rpm at 11,500 ft. Cruising: 270 hp at 2750 rpm at 13,000 ft. Fuel Consumption: (CR) .48 lb. per hp per hr. Oil Consumption: (CR) .014 lb. per hp per hr.

Equipment
Fuel Injector: Simmonds Type 580 injection pump. Magnetos: Bendix-Scintilla S6RN-600 and S6RN-604. Starter: Bendix-Utica 756-10C.

• **MODEL: VO-540-B1B**

Data
Type: 6 cylinder, horizontally opposed, vertical, air-cooled helicopter 305 hp. FAA Type Certificate: 304.

Specs
Height: 24.59 in. Length: 34.73 in. Width: 34.70 in. Displacement: 541.5 cu. in. Bore: 5.125 in. Stroke: 4.375 in. Compression Ratio: 7.30:1. Fuel Grade: 80/87. Dry Weight: 429 lb.

Performance
Takeoff Power: 305 hp at 3200 rpm. Rated Power: 305 hp at 3200 rpm. Fuel Consumption: 16.5 gal. per hr. at 60 percent rated power.

Equipment
Carburetor: Marvel-Schebler MA-6AA. Magneto: Scintilla S6RN-200, S6LN-204.

• **MODEL: VO-540-B1D**

Data
Type: 6 cylinder, horizontally opposed, vertical, air-cooled helicopter, 305 hp. FAA Type Certificate 304, dual carburetion.

Specs
Length: 34.73 in. Width: 34.70 in. Height: 24.58 in.: Displacement: 541.5 in. Bore: 5.125 in. Stroke: 4.375 in. Compression Ratio: 7.30:1. Fuel Grade: 80/87. Dry Weight: 437 lb.

Performance
Takeoff and Normal Rated Power: 305 hp at 3200 rpm at Sea Level. Cruising: 240 hp at 3200 rpm at 8000 ft. Fuel Consumption: 31.7 gal. per hr. at normal rated power.

Equipment
Carburetor: 2 Marvel-Schebler MA-6-AA. Magnetos: Scintilla S6RN-200 and S6LN-204.

• **MODEL: VO-540-C1A**

Data

Type: 6 cylinder, horizontally opposed, vertical, air-cooled helicopter, 305 hp. FAA Type Certificate 304.

Specs

Length: 34.73 in.; Width: 34.70 in.; Height: 24.58 in.; Displacement: 541.5 cu. in.; Bore: 5.125 in.; Stroke: 4.375 in.; Compression Ratio: 8.70:1; Fuel Grade: 100/130; Dry Weight: 439 lb.

Performance

Takeoff and Normal Rated Power: 305 hp at 3200 rpm to 3000 ft. Cruising: 240 hp at 3200 rpm at 9500 ft. Fuel Consumption: 22.1 gal. per hr. at 80 percent rated power, 20.3 gal. per hr. at 70 percent rated power. Oil Consumption: .014 lb. bhp per hr. at rated power.

Equipment

Carburetor: Twin Marvel-Schebler MA-6AA. Magnetos: Scintilla S6RN-200 and S6LN-204.

• **MODEL: TVO-540-A1A**

Data

Type: 6 cylinder, air-cooled, horizontally opposed, turbocharged for vertical installation, 305 hp, FAA Certificate 1E14.

Specs

Height: 37.77 in.; Length: 34.73 in.; Width: 34.70 in.; Displacement: 541.5 in.; Bore: 5.125 in.; Stroke: 4.375 in.; Compression Ratio: 7.3:1; Fuel Grade: 100/130; Dry Weight: 499 lb.

Performance

Takeoff: 305 hp at 3200 rpm, S. L. to 17,000 ft. Maximum Continuous: 305 hp at 3200 rpm, S. L. to 17,000 ft.

Equipment

Carburetor: Marvel-Schebler MA-6AA. Magneto: Scintilla S6RN-200 and S6LN-204. Turbocharger: AiResearch Model T-1112.

• **MODEL: IO-720-A1A**

Data

Type: 8 cylinder, air-cooled, horizontally opposed, direct drive, fuel injection, 380 hp, FAA Type Certificate 1E15.

Specs

Height: 21.09 in.; Length: 46.71 in.; Width: 34.25 in.; Displacement: 722 in.; Bore: 5.125 in.; Stroke: 4.375 in.; Compression Ratio: 8.7:1; Fuel Grade: 100/130; Dry Weight: 609 lb.

Performance

Fuel Consumption: 15.3 gal/hr at 2100 rpm economy cruise. Takeoff: 380 hp at 2475 rpm at S. L.; Maximum Continuous: 380 hp at 2475 rmp at S. L.

Equipment

Fuel Injector: AC Model B-350. Magneto: Scintilla S8LN-701 and S8LN-705. Starter: Delco-Remy. Generator: Delco-Remy 12 or 24 volt.

PRATT & WHITNEY AIRCRAFT DIVISION
UNITED AIRCRAFT CORPORATION
EAST HARTFORD, CONNECTICUT

• **MODEL: JT3C-2 (J57-P-43W)**

Data

Type: Twin-spool, axial-flow turbojet.

Specs

Diameter: 38.6 in. Length: 167.33 in. Fuel Grade: JP-4. Dry Weight: 3840 lb. Compressor Stages: 16. Turbine Stages: 3.

Performance

Maximum Thrust: 13,750 wet, 11,200 dry. Normal Rated Thrust: 9500. Fuel Consumption: 0.765 TSFC cruise at 75 to 90 percent normal rated thrust. Oil Consumption: 0.234 gal. per hr. average.

Remarks

Current production installation: Boeing B-52; Boeing KC-135.

• **MODEL: JT3C-6**

Data

Type: Twin-spool, axial-flow turbojet. FAA Type Certificate 290.

Specs

Diameter: 38.88 in. Fuel Grade: JP-4/JP-5. Dry Weight: 4234 lb. Compressor Stages: 16. Turbine Stages: 3.

Performance

Maximum Thrust: 13,500 wet, 11,200 dry. Normal Rated Thrust: 9500. Fuel Consumption: 0.765 TSFC at maximum cruise rating. Oil Consumption: 0.4 gal. per hr. maximum. Maximum continuous thrust 10,000; maximum cruise thrust 8100.

Remarks

Current production installation: Boeing 707; Douglas DC-8.

• **MODEL: JT3C-7**

Data

Type: Twin-spool, axial-flow turbojet. FAA Type Certificate: 290.

Specs

Diameter: 38.88 in. Fuel Grade: JP-4/JP-5. Dry Weight: 3495 lb. Compressor Stages: 16. Turbine Stages: 3.

Performance

Maximum Thrust: 12,000. Normal Rated Thrust: 10,000. Fuel Consumption: 0.765 TSFC at maximum cruise rating. Oil Consumption. 0.4 gal. per hr. maximum. Maximum continuous thrust 10,000; maximum cruise thrust 8500.

Remarks

Current production installation: Boeing 720.

• **MODEL: JT3C-12**

Data

Type: Twin-spool, axial-flow turbojet. FAA Type Certificate 290.

Specs

Diameter: 38.88 in. Fuel Grade: JP-4/JP-5. Dry Weight: 3550 lb. Compressor Stages: 16. Turbine Stages: 3.

Performance

Maximum Thrust: 13,000. Normal Rated Thrust: 11,500. Maximum Continuous Thrust: 11,500. Maximum Cruise Thrust: 10,200.

Remarks

Current production installation: Boeing 720.

- **MODEL: JT3C-26 (J57-P-20)**

Data
Type: Twin-spool, axial-flow turbojet.

Specs
Diameter: 38.9 in. Fuel Grade: JP-4. Dry Weight: 4750 lb. Compressor Stages: 16. Turbine Stages: 3.

Performance
Maximum Thrust: 18,000 with afterburner. Normal Rated Thrust: 9150. Military Rated Thrust: 10,700.

Remarks
Current production installation: Chance Vought F8U-2N.

- **MODEL: JT3D-1**

Data
Type: Twin-spool, axial-flow turbofan. FAA Type Certificate 1E8.

Specs
Diameter: 53.0 in. Fuel Grade: JP-4/JP-5. Dry Weight: 4090 lb. Compressor Stages: 13. Turbine Stages: 4. Fan Stages: 2.

Performance
Maximum Thrust: 17,000 to 90° F. Normal Rated Thrust: 14,500. Fuel Consumption: 0.50 TSFC at maximum cruise rating. Oil Consumption: 0.2 gal. per hr. maximum. Maximum continuous thrust 14,500; maximum cruise thrust 12,500.

Remarks
Current production installation: Boeing 707-120B, 720B, Douglas DC-8.

- **MODEL: JT3D-2 (TF33-P-3)**

Data
Type: Twin-spool, axial-flow turbofan.

Specs
Diameter: 53.0 in. Fuel Grade: JP-4. Dry Weight: 3900 lb. Compressor Stages: 13. Turbine Stages: 4. Fan Stages: 2.

Performance
Maximum Thrust: 17,000. Normal Rated Thrust: 14,500. Military Rated Thrust: 16,500.

Remarks
Current production installation: B52H.

- **MODEL: JT3D-3**

Data
Type: Twin-spool, axial-flow turbofan.

Specs
Diameter: 53.0 in. Fuel Grade: JP-4/JP-5. Dry Weight: 4170 lb. Compressor Stages: 13. Turbine Stages: 4. Fan Stages: 2.

Performance
Maximum Thrust: 18,000 (to 90°F with water injection). Normal Rated Thrust: 16,400. Maximum Continuous Thrust: 16,400. Maximum Cruise Thrust: 14,800.

Remarks
Current production installation: Boeing 707-320B, Douglas DC-8.

- **MODEL: JT3D-3A (TF33-P-5)**

Data
Type: Twin-spool, axial-flow turbofan.

Specs
Diameter: 53.0 in. Fuel Grade: JP-4. Dry Weight: 4275 lb. Compressor Stages: 13. Turbine Stages: 4. Fan Stages: 2.

Performance
Maximum Thrust: 18,000. Normal Rated Thrust: 16,400.

Remarks
Current installation: Boeing C-135-B.

- **MODEL: JT3D-8A (TF33-P-7)**

Data
Type: Twin-spool, axial-flow turbofan.

Specs
Diameter: 53.0 in. Fuel Grade: JP-4. Dry Weight: 4490 lb. Compressor Stages: 14. Turbine Stages: 4. Fan Stages: 2.

Performance
Maximum Thrust: 21,000 (to 90°F with water injection). Normal Rated Thrust: 18,000. Military Rated Thrust: 19,000.

Remarks
Current installation: Lockheed C-141.

- **MODEL: JT4A-9 (steel) JT4A-10 (titanium)**

Data
Type: Twin-spool, axial-flow turbojet. FAA Type Certificate 291.

Specs
Diameter: 43.0 in. Fuel Grade: JP4, JP5. Dry Weight: 5050 lb. (-9); 4845 lb. (-10). Compressor Stages: 15. Turbine Stages: 3.

Performance
Maximum Thrust: 16,800. Normal Rated Thrust: 13,500. Maximum Continuous Thrust: 13,500. Maximum Cruise Thrust: 11,850.

Remarks
Current production installation: Douglas DC-8, Boeing 707-320.

- **MODEL: JT4A-11 (steel) JT4A-12 (titanium)**

Data
Type: Twin-spool, axial-flow turbojet. FAA Type Certificate 291.

Specs
Diameter: 43.0 in. Dry Weight 5100 lb. (-11), 4895 lb. (-12). Compressor Stages: 15. Turbine Stages: 3.

Performance
Maximum Thrust: 17,500. Normal Rated Thrust: 14,900. Maximum Continuous Thrust: 14,900. Maximum Cruise Thrust: 13,800.

Remarks
Current production installation: Douglas DC-8.

- **MODEL: JT4A-29 (J75-P-19W)**

Data
Type: Twin-spool, axial-flow turbojet.

Specs
Diameter: 43.0 in. Fuel Grade: JP4. Dry Weight: 5960 lb. Compressor Stages: 15. Turbine Stages: 3.

Performance
Maximum Thrust: 26,500 (afterburning plus water) 24,500 (afterburning). Normal Rated Thrust: 14,300. Military Rated Thrust: 16,100.

Remarks
Current production installation: Republic F-105, military.

- **MODEL: JT8D-1**

Data
Type: Twin-spool, axial-flow turbofan.

Specs
Diameter: 42.5 in. Fuel Grade: JP4, JP5. Dry Weight: 2994 lb. Compressor Stages: 11. Turbine Stages: 4. Fan Stages: 2.

Performance
Maximum Thrust: 14,000. Normal Rated Thrust: 12,600. Maximum Continuous Thrust: 12,600. Maximum Cruise Thrust: 11,400.

Remarks
Current Installation: Boeing 727.

- **MODEL: JT12A-5 (J60-P-3)**

Data
Type: Axial-flow turbojet.

Specs
Diameter: 21.9 in. Fuel Grade: JP4, JP5. Dry Weight: 436 lb. Compressor Stages: 9. Turbine Stages: 2.

Performance
Maximum Thrust: 3000. Normal Rated Thrust: 2570. Military Rated Thrust: 3000.

Remarks
Current production installation: military. North American T-39.

- **MODEL: JT12A-6**

Data
Type: Axial-flow turbojet. FAA Type Certificate 1E9.

Specs
Diameter: 21.9 in. Fuel Grade: JP4, JP5. Dry Weight: 436 lb. Compressor Stages: 9. Turbine Stages: 2.

Performance
Maximum Thrust: 3000. Normal Rated Thrust: 2400. Maximum Continuous Thrust: 2400. Maximum Cruise Thrust: 2250.

Remarks
Current production installation: commercial, Lockheed JetStar.

- **MODEL: JT12A-7 (J60-P-4)**

Data
Type: Axial-flow turbojet.

Specs
Diameter: 21.9 in. Fuel Grade: JP4, JP5. Dry Weight: (steel) 465 lb., (titanium) 440 lb. Compressor Stages: 9. Turbine Stages: 2.

Performance
Maximum Thrust: 3300. Normal Rated Thrust: 2650. Military Rated Thrust: 3000.

Remarks
Current production installation: military.

- **MODEL: JT12A-8**

Data
Type: Axial-flow turbojet.

Specs
Diameter: 21.9 in. Fuel Grade: JP4, JP5. Dry Weight: 465 lb. Compressor Stages: 9. Turbine Stages: 2.

Performance
Maximum Thrust: 3300. Normal Rated Thrust: 2650. Maximum Continuous Thrust: 2650. Maximum Cruise Thrust: 2300.

Remarks
Current production installation: commercial.

- **MODEL: JT12A-21 (J60-P-)**

Data
Type: Axial-flow turbojet.

Specs
Diameter: 21.9 in. Fuel Grade: JP4, JP5. Dry Weight: 651 lb. Compressor Stages: 9. Turbine Stages: 2.

Performance
Maximum Thrust: 4025 (afterburning). Normal Rated Thrust: 2350. Military Rated Thrust: 2920.

Remarks
Current production installation: military.

ROCKETDYNE DIVISION
NORTH AMERICAN AVIATION, INC.
CANOGA PARK, CALIFORNIA

- **MODEL: P-4 (XLR64)**

Data
Type: Liquid propellant rocket engine utilizing MA F-4 (Hydyne)

Specs
Length: 21.0 in. Width: 5.0 in. Dry Weight: 16.7 lb. Total Weight: 22.0 lb.

Performance
Maximum thrust: 685 lb. @ 35,000 ft. Normal rated thrust: 550 lb. Two models, P-4 and P4-1; each can be started and stopped at any altitude from zero to 100,000 feet; while both produce same thrust, the P4-1 has dry propellant lines and dial system for thrust selection, providing for four different orifice combinations for each thrust chamber, giving total of 16 thrust combinations for each tank pressure setting.

Remarks
Two models have been produced for the Navy-Air Force XKD2B-1/Q-12 supersonic expendable missile training target for which Beech Aircraft Corp. is prime contractor. Both models employ a nitrogen gas pressurization system and hypergolic ignition.

• MODEL: F-1

Data

Type: Liquid propellant rocket engine utilizing LOX and RP-1 fuel.

Specs

Diameter: 114 in. Length: 132 in. Total Weight: 15,000 lb.

Performance

Maximum thrust: 1,500,000 pounds. Direct drive turbopump capable of moving three tons of propellant per second; develops 60,000 hp, weighs 2500 lbs., 4 feet in diameter, five feet in length.

Remarks

The F-1 engine is designed to power Nova launch vehicles. It is being developed by Rocketdyne under technical direction of NASA's Marshall Space Flight Center. Record thrust of 1,640,000 lbs. sustained for 13 seconds in thrust chamber test, April 6, 1961. First complete engine tested June 13, 1961, at Edwards Rocket Test Center in California.

• MODEL: MA-2 and MA-3 ATLAS

Data

Type: Liquid propellant rocket engine utilizing LOX and RP-1 fuel.

Performance

Rating: MA-2, 360,000 lb. thrust at sea level; MA-3, 389,000 lb. thrust at sea level.

Equipment

The ATLAS MA-2 and MA-3 rocket engines consist of a regeneratively cooled twin-chamber booster engine, a single-chamber sustainer engine, turbopump, gas generator, and control system.

Remarks

The MA-3 engine is used as the powerplant for the Atlas "E" ICBM. The MA-2 furnishes the first stage propulsion for the Atlas/Able research vehicle, the Atlas Score satellite, Atlas Agena, and Atlas Centaur. It will provide the booster first stage of Project Mercury.

• MODEL: H-1 SATURN

Data

Type: Liquid propellant rocket engine utilizing LOX and RP-1 fuel.

Performance

Rating: Each engine—up to 188,000 lb. thrust. Cluster of eight—1,500,000 lb. thrust.

Equipment

Propulsion for the Saturn vehicle consists of a cluster of eight regeneratively cooled single-chamber engines, each operating independently. Each engine has its own gas generator and turbopump, and the four outer engines are mounted on gimbal bearings to maintain directional stability.

Remarks

The Saturn H-1 cluster will be used as the first-stage booster for the NASA C-1 Saturn project.

• MODEL: MB-3 THOR

Data

Type: Liquid propellant rocket engine utilizing LOX and RP-1 fuel.

Performance

Rating: NA-9—150,000 lb. thrust. NA-11—165,000 lb. thrust.

Equipment

The Thor MB-3 rocket engine consists of a regeneratively cooled, single thrust chamber, turbopump, gas generator, and control system.

Remarks

The MB-3 NA-9 engine is used as the powerplant for the Thor IRBM. The NA-11 furnishes the booster propulsion for the Discoverer satellites, the Air Force space probes, and the Air Force Thor-Able test vehicles.

Rocketdyne's 75,000 pound thrust Redstone rocket engine on test stand.

• MODEL: S-3D JUPITER

Data

Type: Liquid propellant rocket engine utilizing LOX and RP-1 fuel.

Performance

Rating: 150,000 lb. thrust.

Equipment

The S-3D engine has a regeneratively cooled single-thrust chamber, turbopump, gas generator, and control system.

Remarks

The S-3D engine is used as the powerplant for the

Jupiter IRBM and as first-stage propulsion for the Juno space probes.

- **MODEL: A-7 REDSTONE**

Data

Type: Liquid propellant rocket engine utilizing LOX and alcohol fuel.

Performance

Rating: 78,000 lb. thrust.

Equipment

The A-7 engine consists of a double-wall single-thrust chamber, turbopump, and control system.

Remarks

The A-7 is used as the powerplant for the U.S. Army Redstone intermediate range ballistic missile. It furnished the first stage propulsion for the Explorer satellites, the Army Jupiter "C" test vehicle, and powered the NASA Mercury/Redstone missiles which hurled Astronauts Shepard and Grissom into space on ballistic flights.

Solid Propulsion Operations

MCGREGOR, TEXAS

- **MODEL: 4-NS-130,000 BOOSTER ROCKET MOTOR/M-34**

Data

Type: Solid Propellant Rocket Motor.

Specs

Diameter: 27.3 in. Length: 201.0 in. Empty Weight: 2,445 lb.; Loaded Weight: 5,377 lb.

Performance

130,000 lb. thrust for four seconds.

Equipment

The motor consists of a steel cylinder closed on the forward end. The igniter is located on the forward end and a canted nozzle, adjustable for thrust alignment, on the aft end. Thrust is transmitted through two midsection rings and thrust block to the vehicle being boosted. The rings also support the motor when attached to the vehicle.

Remarks

The M-34 rocket motor is used as a booster for zero launching of F-100-D aircraft. The M-34 also is used for zero launching of the KD2U drone, with some attachment fitting modification. The motor can be modified for zero launch of other century series aircraft and military drones.

- **MODEL: 10-NS-100,000 MEGABOOM BOOSTER**

Data

Type: Solid propellant rocket.

Performance

Rating: 100,000 lb. thrust for 10 seconds.

Equipment

The engine consists of a steel cylinder closed on the forward end. The igniter is located in the forward end and a fixed straight nozzle is on the aft end. Thrust is transmitted to the test vehicle by a forward head closure ring. The unit is held to the test vehicle by clamp rings around the cylinder.

Remarks

The 10-NS-100,000 Megaboom unit is employed to propel high velocity test sleds. A number of variations of this rocket engine with a wide range of thrust-time programs are available for track missions.

- **MODEL: 16-NS-1000 AIRCRAFT ROCKET**

Data

Type: Solid propellant rocket.

Performance

Rating: 1000 lb. thrust for 16 seconds.

Equipment

The engine consists of a steel cylinder closed on the forward end. The igniter is located on the forward end, and the exhaust nozzle and pressure release diaphragm on the aft end. Thrust is transmitted to the aircraft attachment fittings through three mounting lugs welded on the cylinder.

Remarks

The 16-NS-1000 rocket engine was developed as a smokeless JATO (jet assisted takeoff unit) for the Air Force. It has application for various types of aircraft.

WRIGHT AERONAUTICAL DIVISION

CURTISS WRIGHT CORPORATION

WOOD-RIDGE, NEW JERSEY

- **MODEL: R1820-82, 82A & 82WA**

Data

Type: 9 cylinder, air-cooled, radial.

Specs

Length: 50.07 in. Width: 55.74 in. Displacement: 1820 cu. in. Bore: 6.125 in. Stroke: 6.875. Compression Ratio: 6.80:1. Fuel Grade: 115/145. Total Weight: 1469 lb.

Performance

Takeoff hp: 1525 at 2800 rpm Normal S. L. Military Rating: 1425 at 2700 rpm at 2400 ft. Normal Rating: 1275 at 2500 rpm up to 3500 ft. Specific Fuel Consumption: .677 lb. per bhp per hr. at normal rated power. Oil Consumption: .025 lb. per bhp per hr. at normal rated power.

Equipment

Carburetor: Bendix PD-12K18. Magnetos: Bendix Scintilla D9LN-2.

Remarks

Installation: Grumman S2F. Similar to Commercial 982C9HE1 which is installed in Hurel-Dubois HD-321 and HD-323. 82A has torquemeter and total weight of 1479 lb. 82WA has wet rating of 1625 hp at 2800 rpm and total weight of 1424.

- **MODEL: R1820-84A, 84B, -90 & 90A**

Data

Type: 9 cylinder, air-cooled, radial.

Specs

Length: 52.00 in. Width: 55.74 in. Displacement: 1820 cu. in. Bore: 6.125 in. Stroke: 6.875. Compression Ratio: 6.80:1. Fuel Grade: 115/145. Total Weight: 1405 lb.

Performance

Takeoff hp: 1525 at 2800 rpm. Military Rating: 1425 at 2700 rpm at 2400 ft. Normal Rating: 1275 at 2500 rpm up to 3500 ft. Specific Fuel Consumption: .677 lb. per bhp per hr. at normal rated power. Oil Consumption: .025 lb. per bhp per hr. at normal rated power.

Equipment
Carburetor: Bendix PD-12R1. Magnetos: Bendix Scintilla D9LN-2.

Remarks
Installation: Sikorsky Helicopter H-34. Commercial version 989C9HE1, 2 installed in Sikorsky S-58 Helicopter. For operation at nominal engine attitudes of 39°, nose up. R1820-90, 90A and commercial equivalents 998C9HE1-2 are similar except have provisions for operation at engine attitudes up to 79°, nose up.

• MODEL: R3350-32W-32WA (TURBO COMPOUND)

Data
Type: 18 cylinder, air-cooled, radial.

Specs
Length: 91.80 in. Width: 56.59 in. Displacement: 3350 cu. in. Bore: 6.125 in. Stroke: 6.312. Compression Ratio: 6.70:1. Fuel Grade: 115/145. Total Weight: 3560 lb.

Performance
Takeoff hp: 3700 at 2900 rpm. Normal S.L. Military Rating: 3420 at 2900 rpm at 2400 ft. Normal Rating: 2850 at 2600 rpm at 4100 ft. Specific Fuel Consumption: 646 lb. per bhp per hr. at normal rated power. Oil Consumption: .022 lb. per bhp per hr. at normal rated power.

Equipment
Carburetor: CECO 58CPB11. Magnetos: Bendix Scintilla DLN-9.

Remarks
Installation: Lockheed P2V-5-7, Martin P5M-2. Military version of the earlier models Turbo Compound are installed in R7V-1, C119, C and RC-121, WVI, 2 and 3.

• MODEL: R-3350-91A (TURBO COMPOUND)

Data
Type: 18 cylinder, air-cooled, radial.

Specs
Length: 89.53 in. Width: 56.59 in. Displacement: 3350 cu. in. Bore: 6.125 in. Stroke: 6.312. Compression Ratio: 6.70:1. Fuel Grade: 115/145. Total Weight: 3690 lb.

Performance
Takeoff hp: 3250 at 2900 rpm. Maximum Continuous (Low Blo) (Normal Rated hp); 2600 at 2600 rpm at Sea Level. Fuel Consumption: .650 lb. per bhp per hr. at Maximum Continuous Oil Consumption: .022 lb. per bhp per hr. at Maximum Continuous.

Equipment
Carburetor: Bendix PR58S2. Magnetos: Bendix-Scintilla DLN-9.

Remarks
Installation C121C Super Constellation USAF.

• MODEL: R-3350-93 (TURBO COMPOUND)

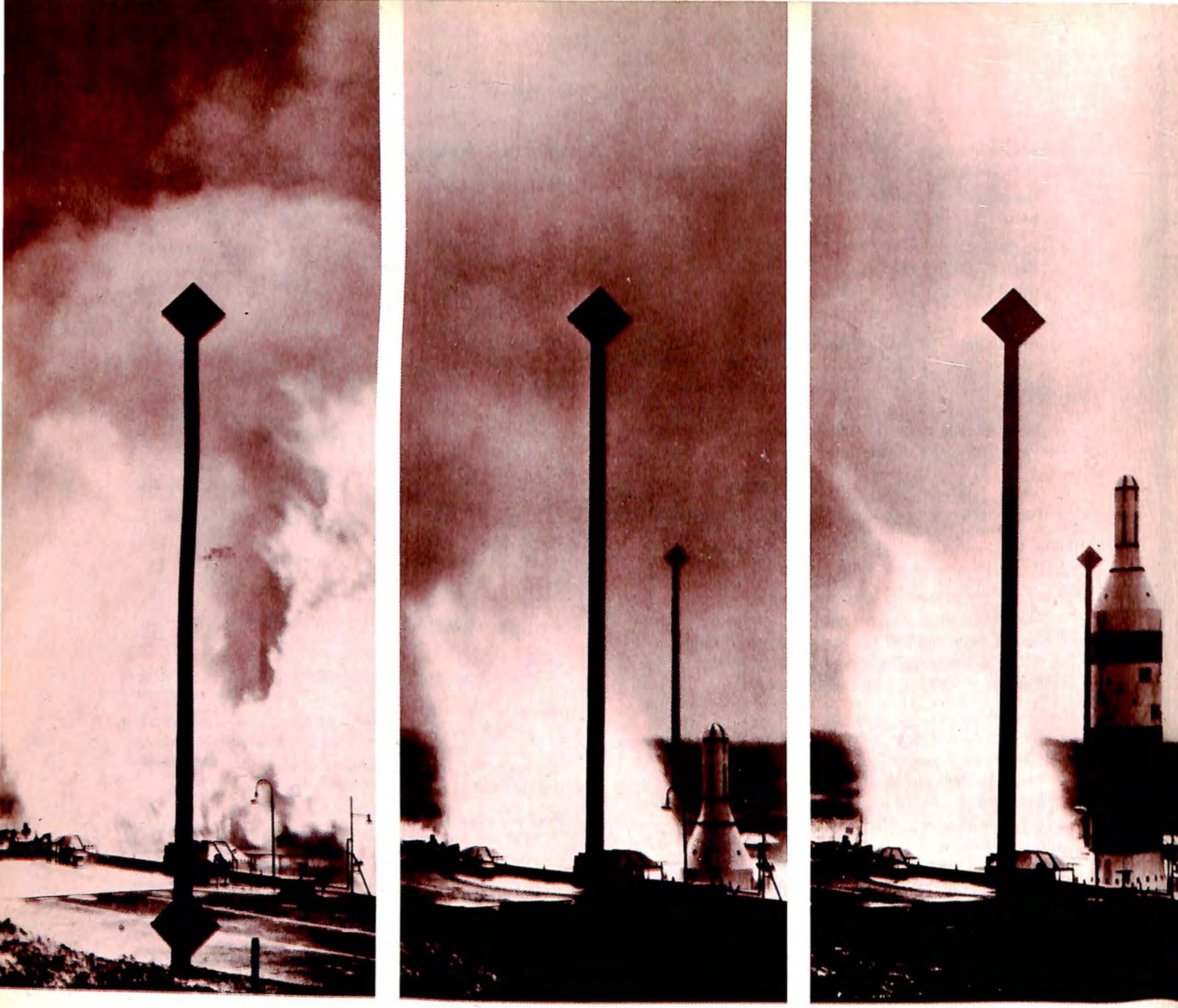
Data
Type: 18 cylinder, air-cooled, radial.

Specs
Length: 89.53 in. Width: 56.59 in. Displacement: 3350 cu. in. Bore: 6.125 in. Stroke: 6.312. Compression. Ratio: 6.7:1. Fuel Grade: 115/145. Total Weight: 3760 lb.

Performance
Takeoff hp: 3400 at 2900 rpm Maximum Continuous (Low Blo) (Normal Rated power): 2800 at 2600 rpm at Sea Level. Fuel Consumption: .667 lb. per bhp per hr. at Maximum Continuous. Oil Consumption: .022 lb. per bhp per hr. at Maximum Continuous.

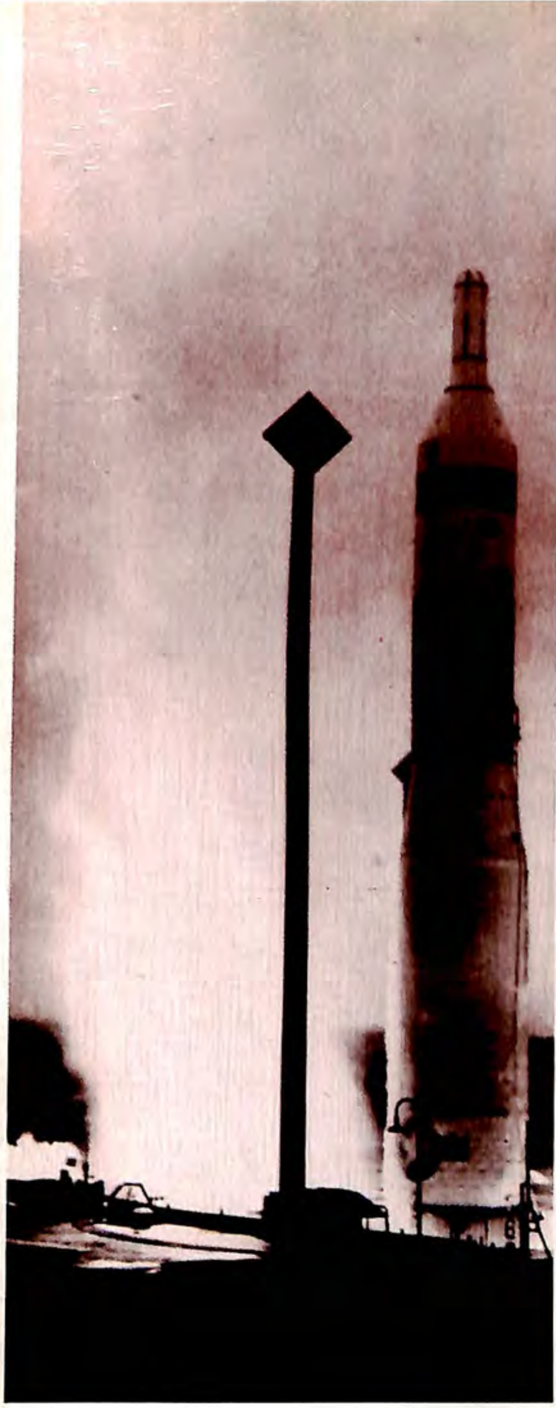
Equipment
Carburetor: Bendix PR58S2. Magnetos: Bendix-Scintilla DLN-9.

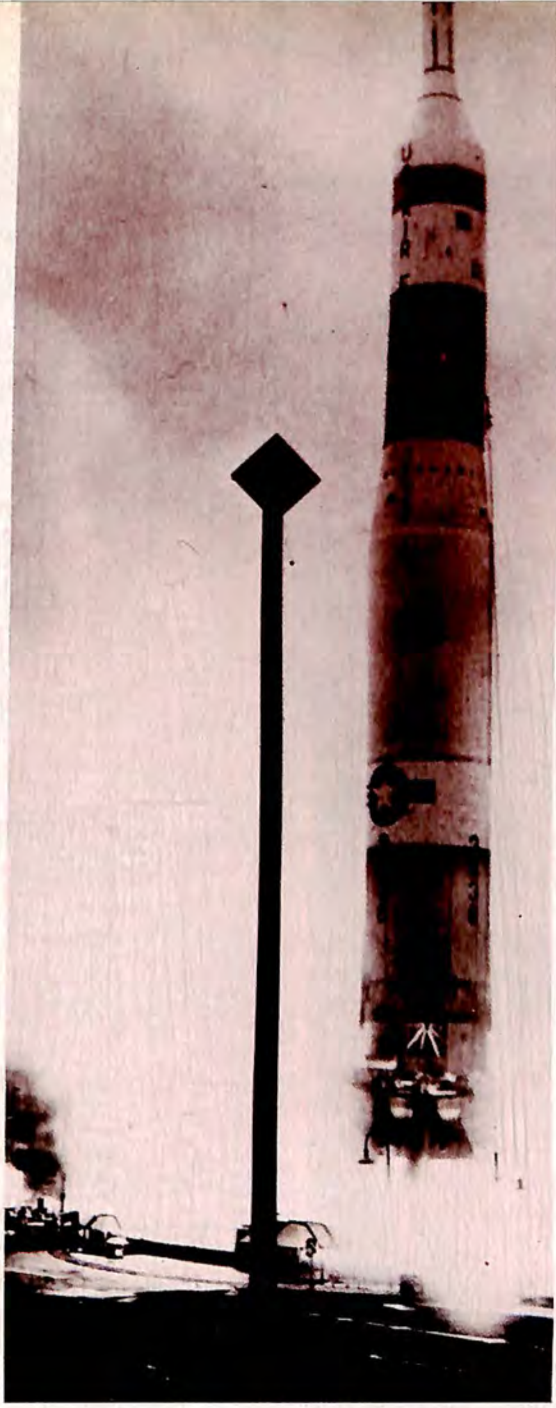
Remarks
Installation RC121D Super Constellation USAF.



MISSILES

The following pages include an explanatory display of all missiles, drones, targets and unmanned surveillance vehicles cleared for public release, with the exception of those phased out of service

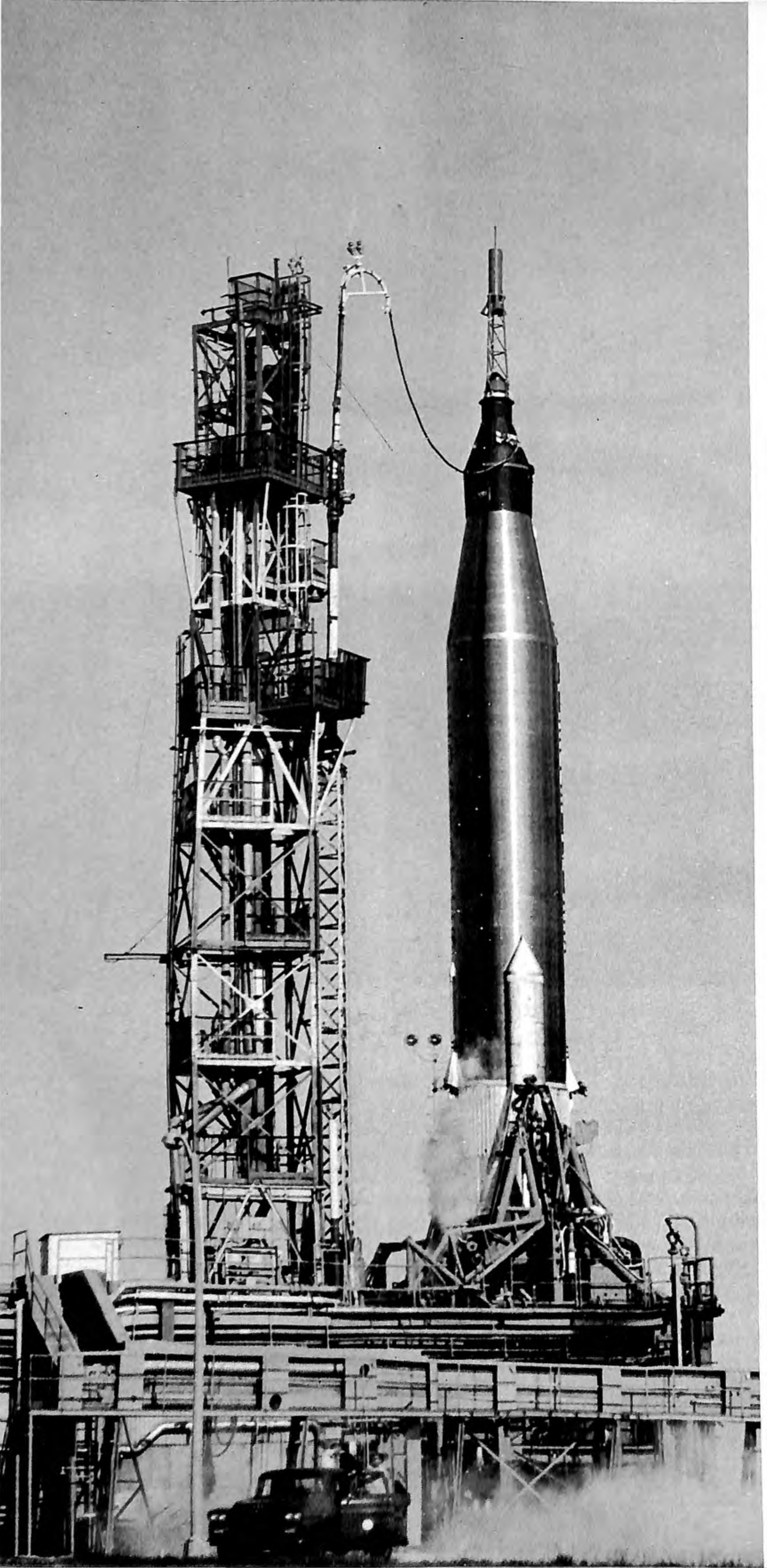
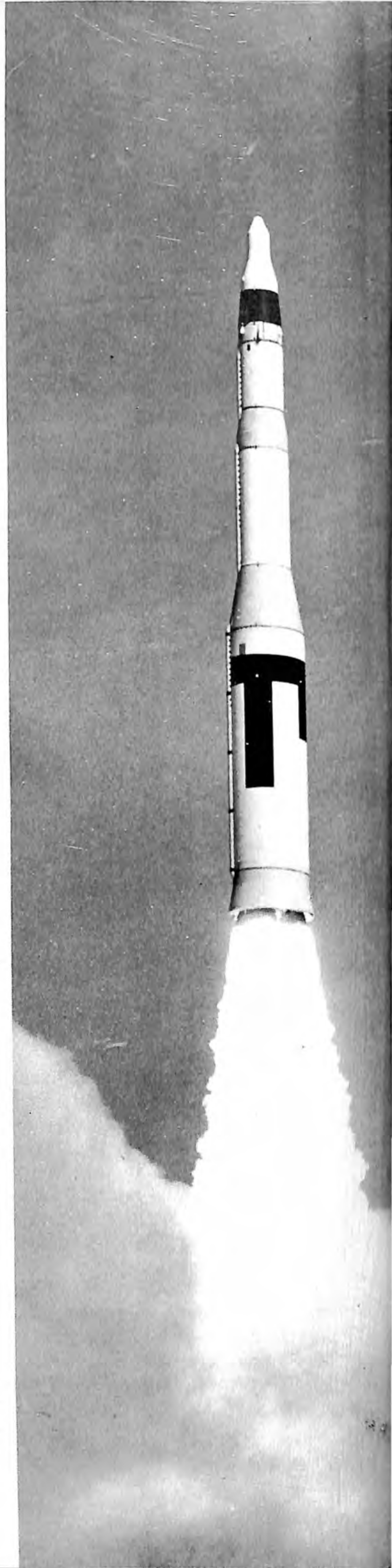


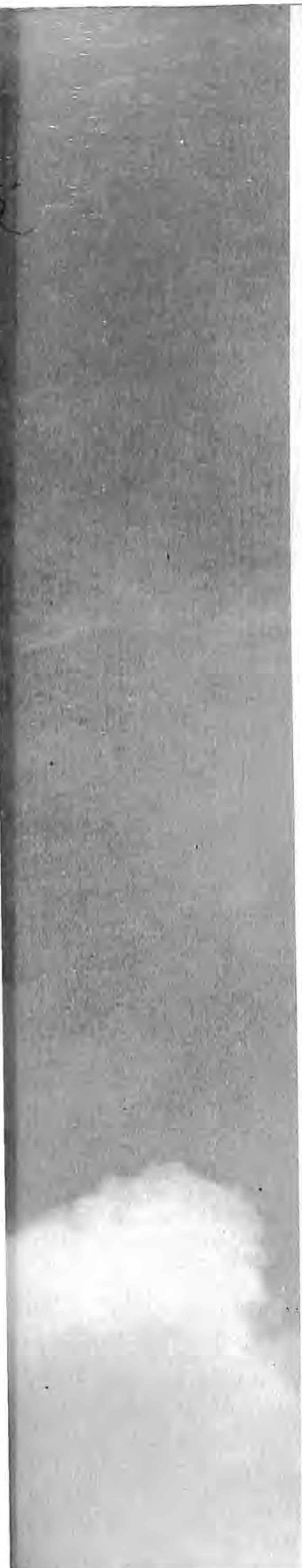


SURFACE TO SURFACE

TITAN

The SM-68 Titan, second of the USAF's ICBM's, virtually completed its test program in 1961 and was being readied for operational service, with the first two squadrons to be based at Lowry AFB, Colo., early in 1962. Later squadrons were to be established at Ellsworth AFB, S. D.; Beale AFB, Calif.; and Mountain Home AFB, Idaho. Titan I is a two-stage missile, 98 feet tall, with 300,000 pounds of propulsive thrust in the first stage and 80,000 pounds thrust in the second stage. In its two year test program it was launched 61 times and it scored 35 successes and nine partial successes, a notable record. Late in 1961, the first static test firing of Titan II was conducted. Titan II features storable propellants and greater thrust (430,000 pounds in the first stage, 100,000 pounds in the second stage). The USAF announced plans for six Titan II squadrons, two each at Davis-Monthan AFB, Ariz.; McConnell AFB, Kans.; and Little Rock AFB, Ark. Both Titan I and Titan II are designed for launch from hard silo sites. Prime contractor for the program is the Denver Division of Martin-Marietta Corp.'s Aerospace Division. Aerojet-General Corp. builds the power plant for both versions and Bell Telephone Laboratories and Remington Rand Univac share guidance responsibility. Status: Titan I, operational in early 1962; Titan II, development.

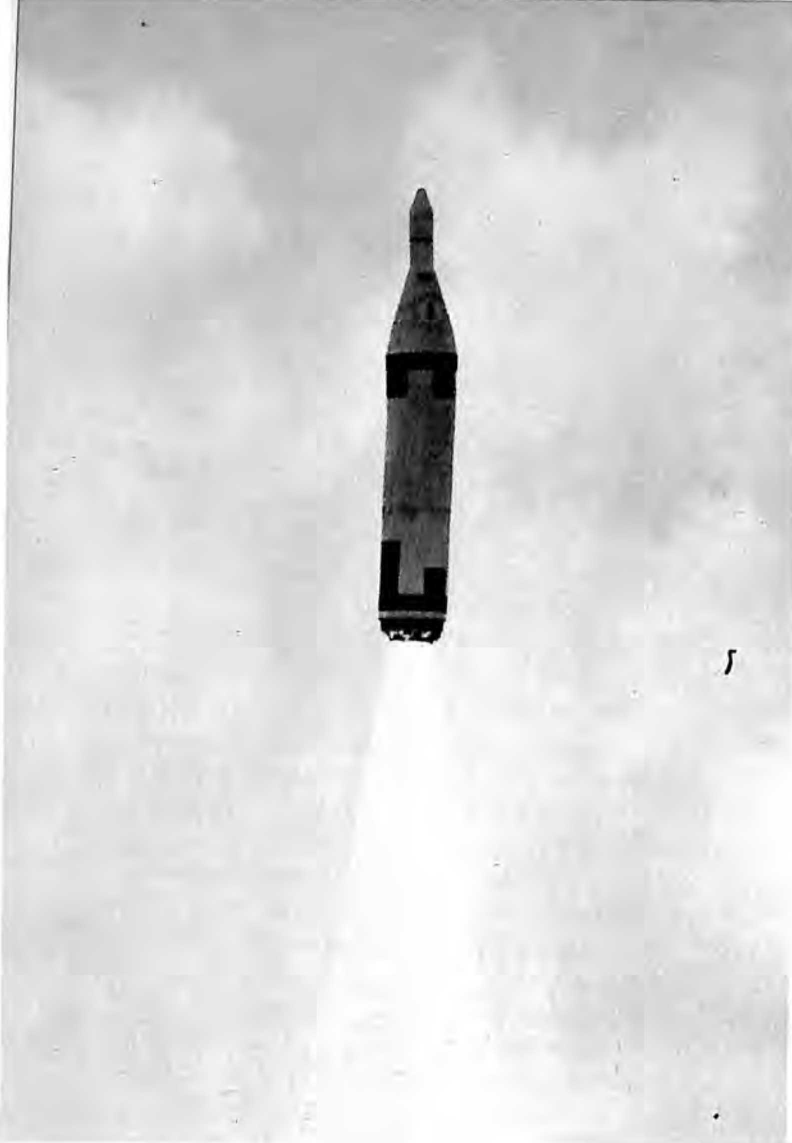


ATLAS *(Far left)*

With a large number of Atlas missiles already in operational service with Strategic Air Command, General Dynamics/Astronautics concentrated in 1961 on developing more advanced versions of the nation's first intercontinental ballistic missile. The Series E Atlas, featuring a new all-inertial guidance system and "semi-hard" launch site capability, was first test fired on February 24, 1961, and the test program was completed by year-end. In the interim, work had started on a still more advanced model, the Series F. The Atlas F, first test launched on November 22 (photo), is designed for operation from a hard silo or underground emplacement. The silo is 174 feet deep and 50 feet in diameter and is capped by steel and concrete doors which swing open rapidly at launch time. Silos were in process of construction near Salina, Kans.; Lincoln, Nebr.; Altus, Okla.; Abilene, Tex.; Roswell, N. M.; and Plattsburgh, N.Y. Series F has two 165,000 pound thrust booster engines and a 57,000 pound thrust sustainer. The engines burn RP-1, a kerosene-like fuel, and liquid oxygen. The missile can be stored with its RP-1 aboard; the liquid oxygen is pumped in when decision is made to fire. Atlas missiles are 82-52 feet long, depending on model, 10 feet in diameter and weigh approximately 240,000 pounds. Prime contractor for the Atlas program is General Dynamics/Astronautics; associated contractors include Rocketdyne Division of North American Aviation (power plants); General Electric Co. (guidance); Burroughs Corp. (radio-inertial guidance); and American Bosch Arma Corp. (all-inertial guidance). Status: Series D, operational; Series E, advanced development; Series F, development.

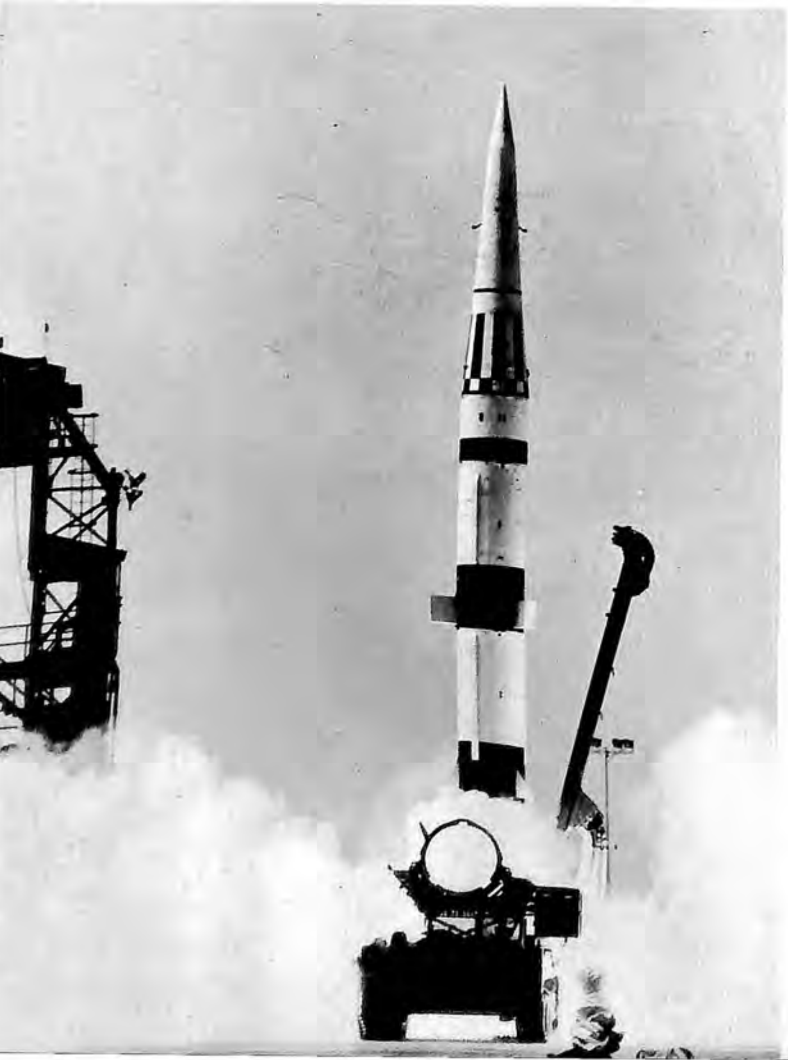
MINUTEMAN *(Left)*

The Air Force's second generation ICBM, the Minuteman, was put through a highly successful flight test program in 1961. First flight, from an ordinary launch pad, took place on February 1, and on May 19 the first silo launch test was made. Minuteman was successful on four of five test launches during the year. Designed to fill a need for a long range weapon with rapid reaction time, Minuteman has a solid fuel propulsion system. A three-stage missile, it is smaller and lighter than Atlas or Titan, yet has a range capability of about 6,000 miles. Hardened and dispersed silo sites were being prepared for Minuteman at Malmstrom AFB, Mont., and at Ellsworth AFB, S. D. In 1961, Boeing Airplane Co., prime contractor, started operating a new assembly facility at Ogden, Utah. Associated with Boeing on the program are Aerojet-General, Thiokol and Hercules Powder on the three power plants, North American Aviation's Autonetics Division on guidance, and AVCO Corp. on the nose cone. Status: Development.



POLARIS

In 1961, Lockheed Missiles and Space Company, prime contractor, completed production of the Polaris A-1 (photo) and started production of the longer ranging A-2 version. The A-1, a 1,200-mile range model, was in operational service with five Navy nuclear submarines, 16 missiles aboard each sub. The A-2, designed for 1,500 nautical miles range, is 31 feet long (three feet longer than the A-1) and four and one-half feet in diameter. It weighs approximately 30,000 pounds. Designed for launch from land or from surface vessels as well as submerged submarines, the A-2 has two-stage solid fuel rockets and an inertial guidance system. Lockheed was also working on an advanced A-3 version, capable of 2,500 nautical miles range. Contractors associated with Lockheed on the A-2 included Aerojet-General Corp. and Hercules Powder Co. (power plants) and General Electric's Ordnance Department and Hughes Aircraft Co. (guidance). Status: A-1, operational; A-2, production; A-3, development.

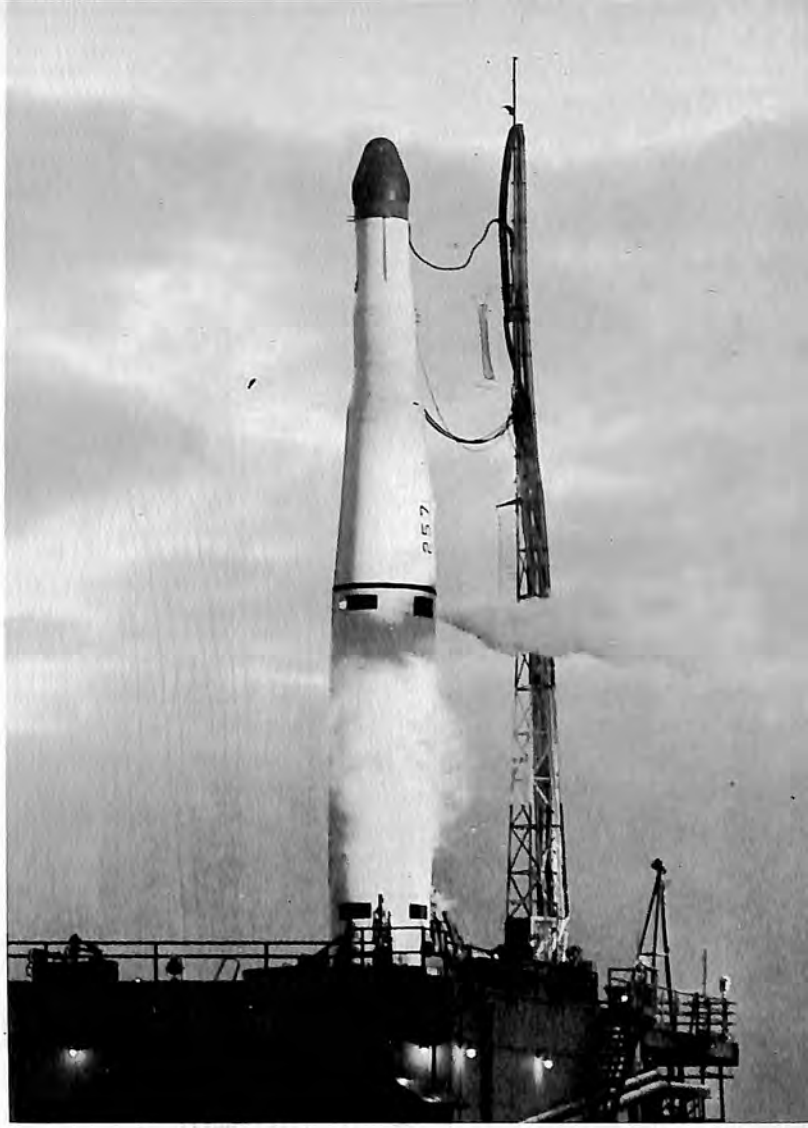


PERSHING

Designed for general support of field units, Pershing is an Army selective range ballistic missile. A two-stage weapon with both stages solid propelled, Pershing is 34 feet long and a diameter of 40 inches. It carries a nuclear warhead and it is inertially guided. Although its maximum range has not been disclosed, it is longer-ranging that the 200-mile Redstone which it will replace. The flight test program started in 1960 continued in 1961 with a high reliability rate. Ground support equipment developed for Pershing was integrated into the flight test program; the entire fire unit may be carried on four lightweight tracked vehicles, or airlifted by helicopter or fixed wing aircraft. The prime contractor, Orlando Division of Martin-Marietta Corp., has received an initial production contract. Powerplant is built by Thiokol Chemical Corp. and Bendix Eclipse-Pioneer Division manufactures the guidance system. Status: Advanced development.

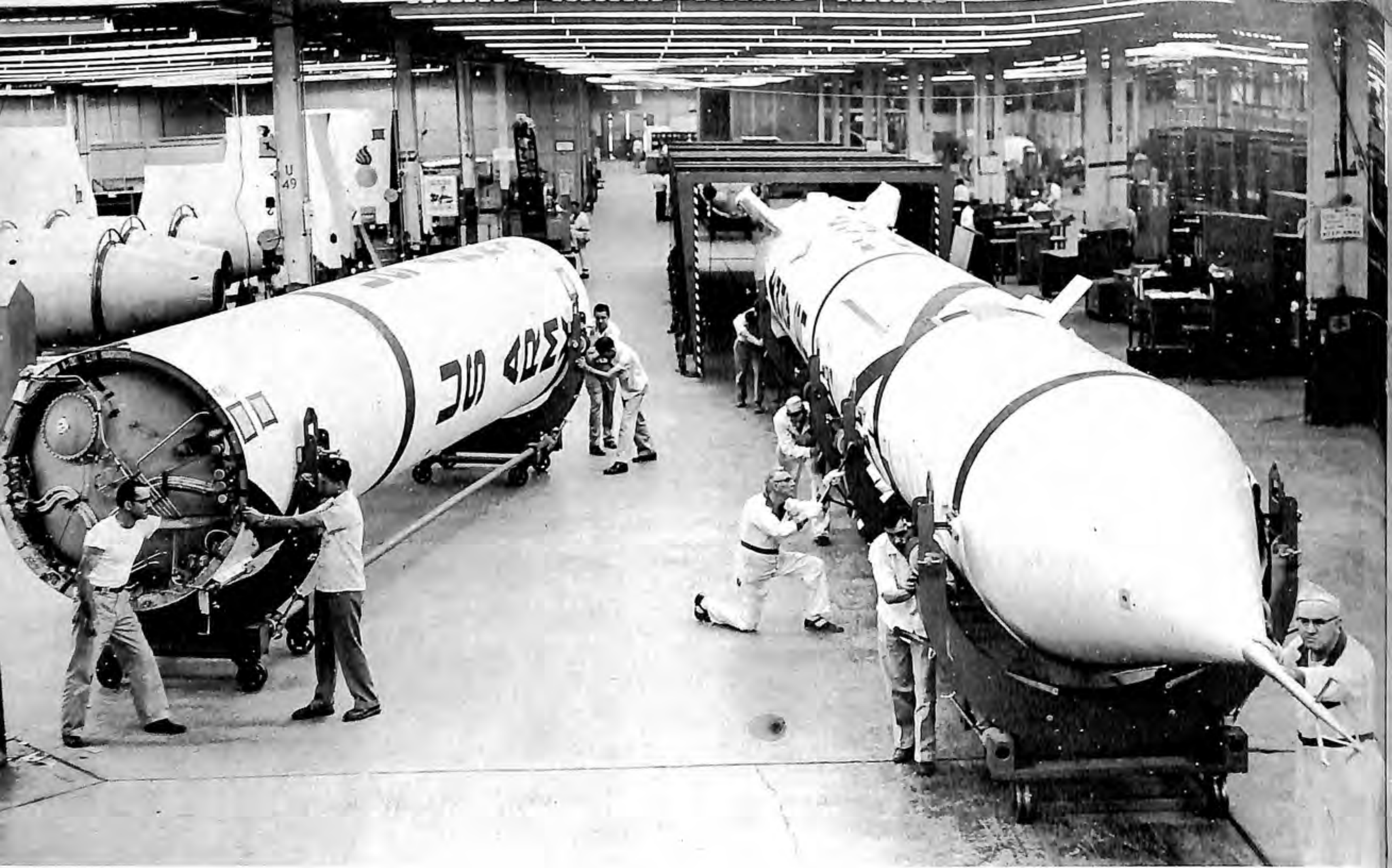
THOR

The first American intermediate range ballistic missile to achieve operational capability, Thor has been on station in the United Kingdom since September, 1958. Powered by a 150,000 pound thrust liquid rocket engine, Thor is 65 feet long and has a range of 1,500 nautical miles. Douglas Aircraft Co. and Space Technology Laboratories shared prime contractor responsibility for the missile and Douglas also built the airframes. Rocketdyne supplied the power system and AC Spark Plug the inertial guidance systems. Status: Operational.



JUPITER

The first U. S. IRBM to be successfully fired, Jupiter was originally developed by the Army and turned over to the Air Force for operational use. It has been deployed at European sites since 1959. Jupiter is 60 feet long, weighs 110,000 pounds and has a range of 1,500 nautical miles. It was developed by the Army Ballistic Missile Agency and turned over to Chrysler Corp. for production. Rocketdyne produced the 150,000 pound thrust rocket engines and Ford Instrument Co. manufactured the inertial guidance system. Status: Operational.



REDSTONE

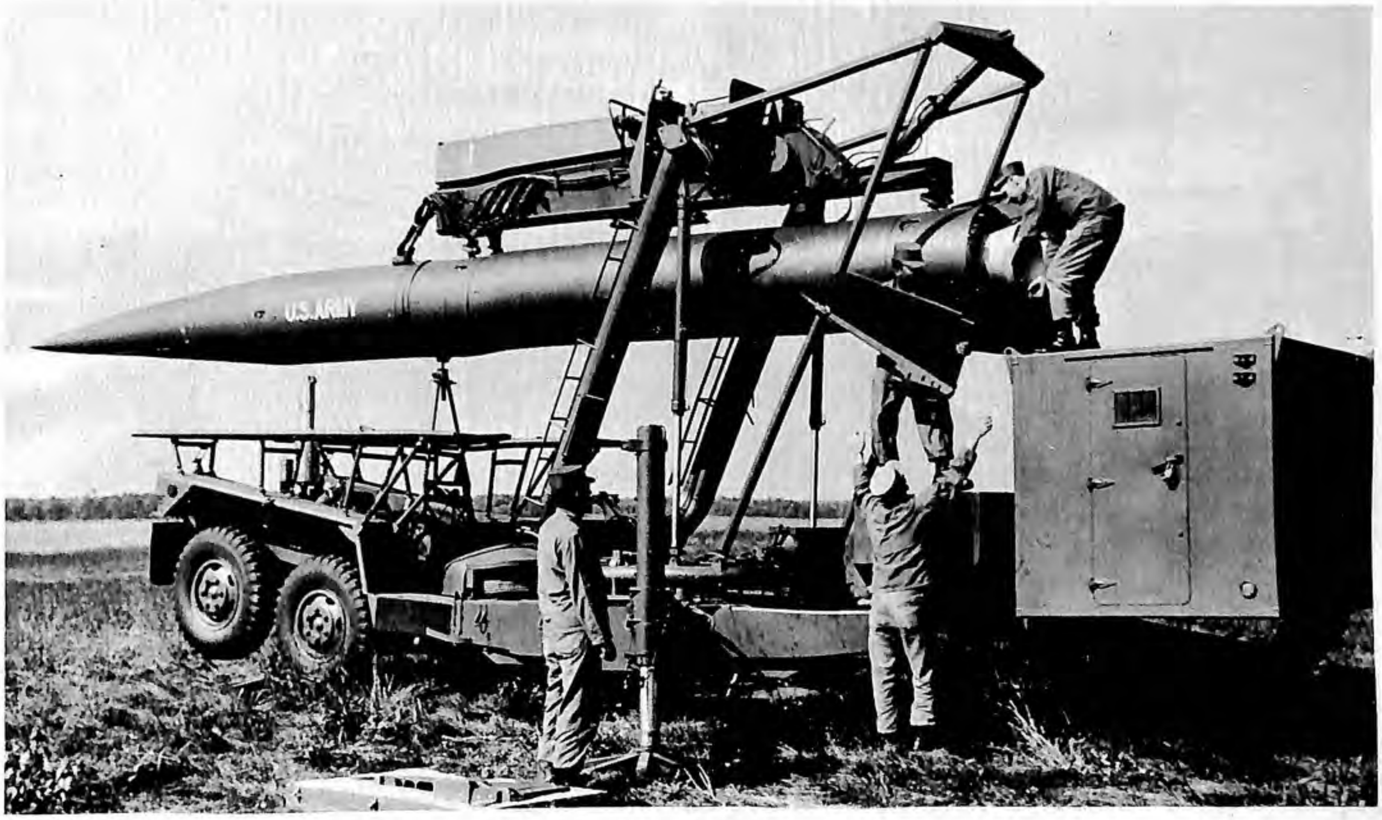
An Army artillery missile which can deliver a conventional or nuclear warhead up to 200 miles, Redstone was the first ballistic missile to be deployed overseas. It is 63 feet long and powered by a 75,000 pound thrust Rocketdyne engine. Chrysler Corp. built the airframe and Ford Instrument Co. provided guidance systems. Status: Operational.

MACE

The TM-76 Mace, replacement for the Air Force's Matador, is a 44-foot winged missile powered by an Allison J33-A-41 engine in sustained subsonic flight and boosted by a solid rocket. It comes in two versions, the TM-76A, which is guided by the Goodyear ATRAN map-matching system, and the TM-76B, which uses an AC Spark Plug inertial system. The latter has a 1,200 nautical mile range, the "A" a 650 mile range. Thiokol supplied the 100,000 pound thrust booster. Prime contractor is the Space Systems Division (Baltimore) of Martin-Marietta Corp. Status: Operational.

CORPORAL

Still in service and deployed in Europe, Corporal, the Army's Corporal is slated for gradual phase-out starting in 1961. The first Army ballistic missile, it is 45 feet long and weighs 11,000 pounds. It can deliver a conventional or nuclear warhead a distance of 75 miles. Originally developed by Jet Propulsion Laboratory, it was turned over for production to co-prime contractors Firestone Tire and Rubber Co. and Gilfillan Brothers, Inc. Status: Operational, in process of retirement.



SERGEANT

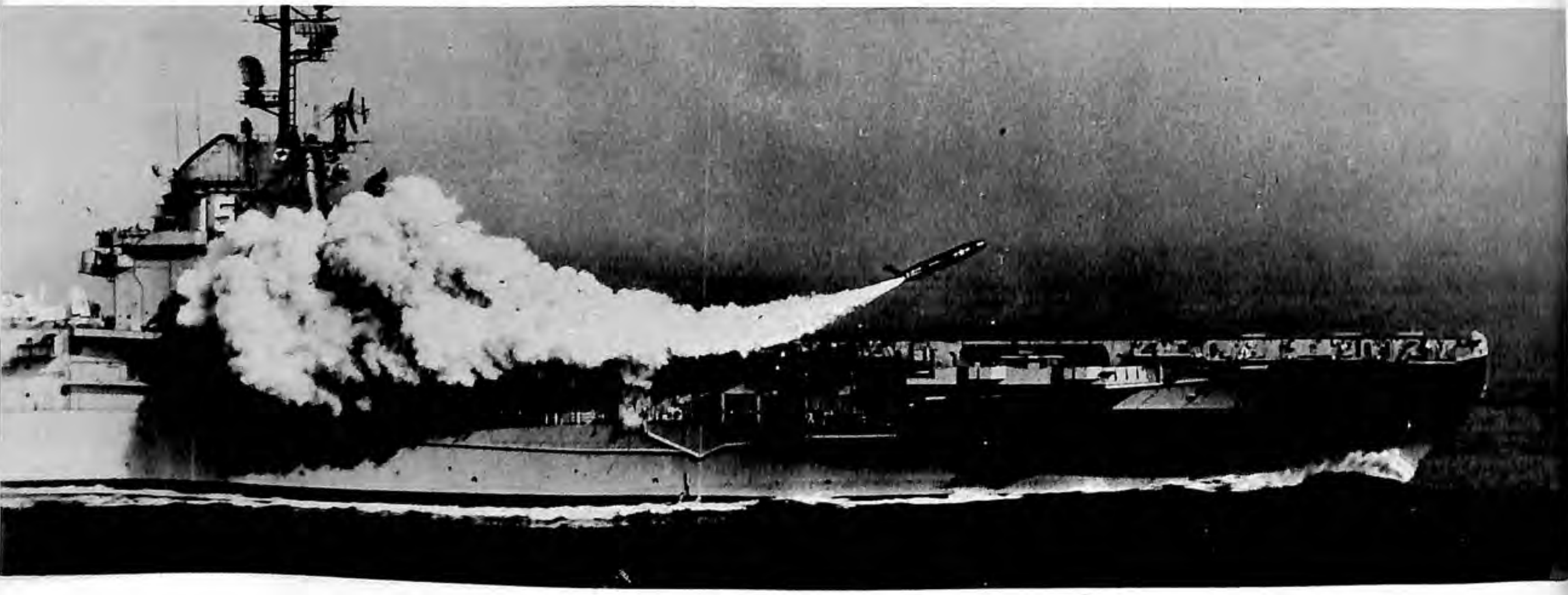
Smaller than its predecessor, but with greater range, mobility and accuracy, the Army's Sergeant is a replacement for the veteran Corporal missile. In 1961, Sergeant was introduced to operational status and it will gradually replace all Corporal units. Sergeant is 35 feet long, 31 inches in diameter and weighs 10,000 pounds. It has a solid fuel power plant built by Thiokol Chemical Corp. and a guidance system manufactured by Sperry Utah Engineering Laboratory. Sperry Utah is also prime contractor. Status: Operational.

LITTLE JOHN

A 10-mile range supplement to Honest John in Army operations, Little John features a high degree of accuracy, simplicity of design and ease of operation. A free flight rocket without electronic controls, it is 14.5 feet long, 12.5 inches in diameter and weighs 760 pounds. Power is supplied by an Allegany Ballistics Laboratory solid rocket. Emerson Electric builds the airframe. Status: Operational.

HONEST JOHN

Unguided and capable of carrying either conventional or nuclear warheads, Honest John is an Army battlefield weapon designed for close support operations. The missile is 27 feet long and has a range of 12 miles. It is launched from a self-propelled mobile launcher and is solid propelled. Weight is 5,800 pounds. Advanced version, originally designated XM-50, has improved range and accuracy. Honest John was developed by the Army Ordnance Missile Command. Contractors associated with the project include Douglas Aircraft Co. and Emerson Electric Co. Status: Operational.



REGULUS

One of the earliest operational missiles, Regulus was still in service on two Navy surface ships during 1961. An air-breathing weapon, it is boosted to flight speed by a solid rocket and sustained in flight by an Allison J33 turbojet. It weighs 14,000 pounds, is 34 feet long and has a wing span of 21 feet. It has a range of about 500 miles and a speed of 600 miles per hour. Prime contractor is Chance Vought Corp.

MATADOR

The first Air Force missile to attain operational status, the Matador is 39.6 feet long, spans 28.7 feet and has a range of about 600 miles at a speed of 650 miles per hour. It is rocket boosted and powered in sustained flight by an Allison J33 turbojet. It has been in service overseas since 1954. Prime contractor is Martin-Marietta Corp.'s Space Systems Division. Status: Operational.

SHILLELAGH *(No photo)*

A new, lightweight missile being developed for close support of ground troops, Shillelagh will provide greatly increased firepower against armor, troops and field fortifications. Extremely accurate, designed for minimum maintenance, Shillelagh will result in a low cost-per-tank-kill "at ranges far exceeding those of historical anti-tank warfare." In one application, the weapon will be vehicle mounted; the Army is developing an Armored Reconnaissance/Airborne Assault Vehicle (ARAAV) which will be Shillelagh-armed. Shillelagh is expected to become operational in the mid-1960's. Prime contractor is Aeronutronic Division of Ford Motor Co. Associated contractors include Raytheon Manufacturing Co. (fire control sub-system); Genisco, Inc. (accelerometer); and Whitaker Gyro Division, Telecomputing Corp. (two-axis free gyro). Status: Development.

LACROSSE

The first Army missile developed for close support of ground troops, Lacrosse has been in service since 1959. Carrying either conventional or nuclear warheads for a range of about 20 miles, the missile is 19.2 feet long and 20.5 inches in diameter. Power is a single Thiokol rocket. Lacrosse is launched from a tube and track assembly mounted on a standard two and one half ton truck. It is guided by an external command system, employing a forward station. All elements of the system are vehicular mounted and can be airlifted. Three battalions are deployed in Europe, one in the Far East. Prime contractor is the Orlando Division of Martin-Marietta Corp. Status: Operational.

UNDERWATER TO UNDERWATER

SUBROC

Fired from the torpedo tube of a submerged submarine, Subroc is an anti-submarine warfare weapon which is programmed through the air to re-enter the water a short distance from an enemy sub and continue to its target like a torpedo. The Subroc system can detect an enemy submarine at long range, compute its course and speed, and fire the missile on an intercept course. The spent rocket power plant, which provides initial boost, drops away on emergence from the water and the warhead continues to its target. Range is "greatly in excess of present ASW torpedo ranges." Prime contractor is Goodyear Aircraft Corp., working under the direction of the Naval Ordnance Laboratory. Status: Development.

SURFACE TO UNDERWATER

ALPHA

A simple rocket, Alpha represents an extension of the depth charge technique in anti-submarine warfare. It provides greater range and latitude of attack by eliminating the necessity of positioning the attacking ship close to enemy subs. Instead, the weapon is fired through the air from a launcher resembling a conventional gun turret. The weapon is eight and one half feet long, rocket powered, weighs 500 pounds, and carries a conventional high explosive charge. Status: Operational.

ASROC

A solid-propelled rocket torpedo, Asroc is another Navy anti-submarine weapon, fired from surface ships and projected by rocket power to the target area. On striking the water, it is guided to the target submarine by acoustic homing devices. Prime contractor is Minneapolis-Honeywell Regulator Co.'s Ordnance Division. Status: Operational.

SURFACE TO AIR

NIKE ZEUS

Potentially one of the most important missiles in the U. S. arsenal, the Army's Nike Zeus reached advanced development status in 1961 with a series of successful firings at White Sands Missile Range, N. M., on one of which Zeus intercepted and destroyed a Nike Hercules missile. Zeus is designed to intercept enemy warheads within or above the atmosphere despite electronic or nuclear countermeasures, decoys or multiple targets in a saturation raid. It is a three-stage weapon, each stage powered by solid rockets, the third stage carrying a defensive nuclear warhead. Integrated into the Nike Zeus system are very high speed digital computers providing fully automatic operation and three types of highly sophisticated radars linked to the computers. A long range acquisition radar, capable of tracking a number of enemy warheads simultaneously, first detects the attack. It passes tracking data on to a target track radar, which follows the target until it is intercepted by Zeus. A third and smaller radar, tracks the Zeus and the target, and guides the Zeus to intercept. Zeus is designed to operate from hardened underground launch cells, where it is stored in "ready to fire" position. At year-end, preparations were being made for tests of tactical Zeus missiles, in which Zeus would attempt to intercept, after launch from a base at Kwajalein, Atlas missiles fired from Vandenburg AFB, Calif. Prime contractor for Nike Zeus is Western Electric Co. Bell Telephone Laboratories handles research and development, and Douglas Aircraft Co. builds the missile and its ground support equipment. Status: Advanced development.

NIKE AJAX

In service since 1953, Nike Ajax is gradually being replaced by the more advanced Hercules. Liquid-propelled, supersonic and guided by radio command, it is 21 feet long and has a range of 25 miles. Contractors are the same as those for Zeus and Hercules: Western Electric, Bell Telephone Laboratories and Douglas Aircraft. Status: Operational, phasing out.

REDEYE

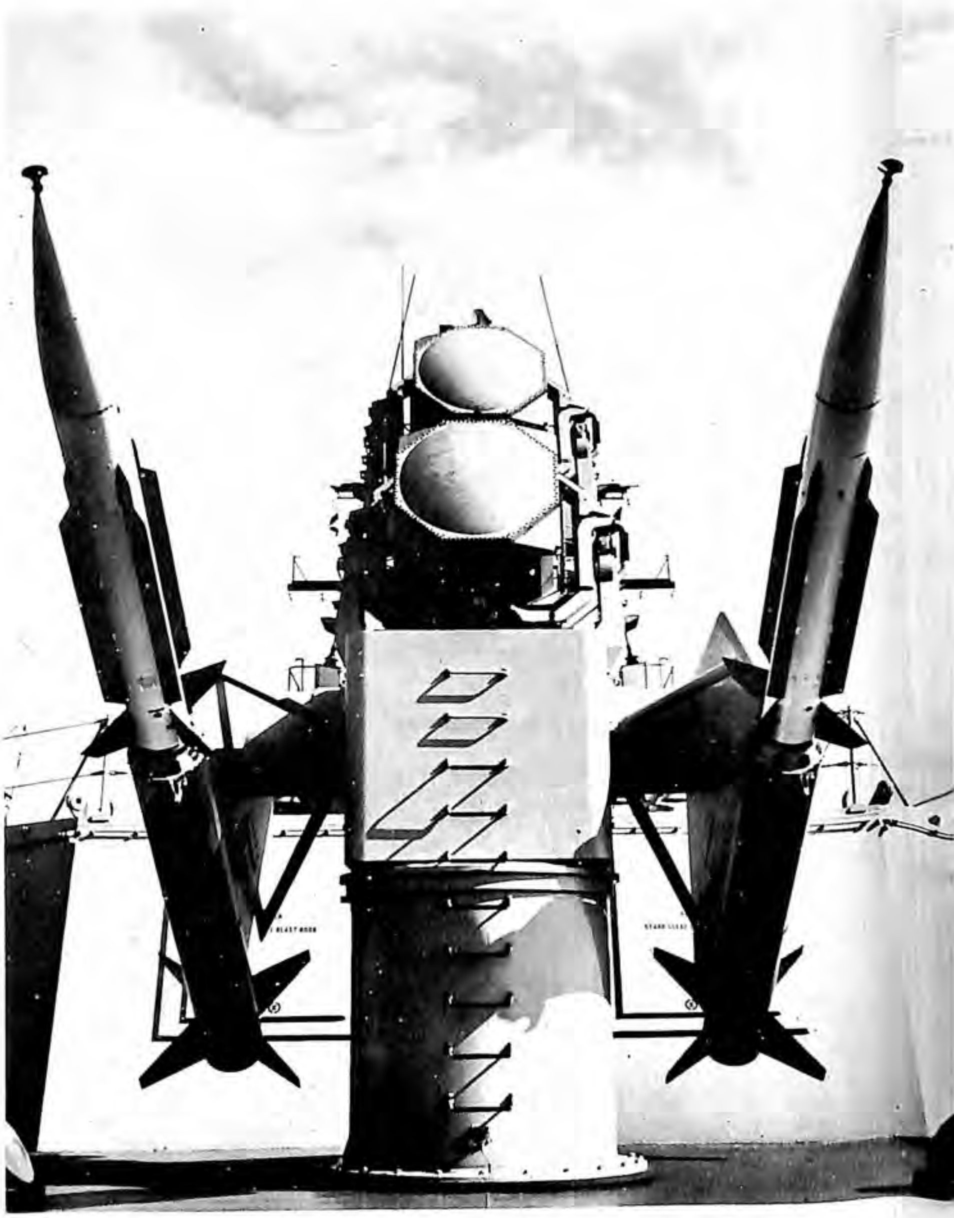
A shoulder-fired, bazooka-type missile, Redeye is an Army and Marine Corps weapon designed to provide individual troops with defense against low flying aircraft. The Redeye is fired from its own shipping container. It is solid-propelled, infrared-guided, weighs 20 pounds, is four feet long and three inches in diameter. General Dynamics/Pomona is prime contractor and Philco Corp. supplies the guidance system. Status: Development.

NIKE HERCULES

Nike Hercules demonstrated a new capability in October, 1961, that of being fired from a mobile transport vehicle. The weapon was launched from an Army experimental GOER vehicle, a large rubber-tired prime mover similar to large earth-moving machines. Designed for use against attacking aircraft or air-breathing missiles, Hercules is a command guidance missile carrying either conventional or nuclear warheads. Hercules is 27 feet long and 31.5 inches in diameter; with its solid propellant booster attached it is 41 feet six inches long. Range is over 75 miles, speed is Mach 2.5 and weighs 10,000 pounds. The weapon is in service guarding major metropolitan areas and strategic military installations. The contractor team includes Western Electric, Bell Telephone Laboratories and Douglas Aircraft. Status: Operational.

HAWK

A supplementary weapon to the Nike family of missiles, Hawk is used by the Army and the Marine Corps for defense against low level attack. It is 16.8 feet long and 18 inches in diameter. Three of the solid-propelled, radar-guided Hawk missiles can be fired from a single launcher; a battery consists of 12 launchers. Prime contractor is Nortronics, A Division of Northrop Corp. Thiokol Chemical Corp. supplies the rocket booster and Raytheon Manufacturing Co. the guidance system. Status: Operational.



TALOS

A Navy weapon designed to destroy enemy aircraft attacking at high altitude, Talos is beam-rider guided and carries either a conventional or nuclear warhead. It is boosted by a solid rocket and sustained in flight by a 40,000 horsepower ram-jet engine. Talos has a range of 65 miles and a speed of Mach 2.5. The missile is 30 feet long, 30 inches in diameter and weighs 3,000 pounds (7,000 pounds with booster). Prime contractor is Bendix Aviation Corp.; McDonnell Aircraft Corp. builds the airframe. Status: Operational.

ADVANCED TERRIER

The Navy's Advanced Terrier, at year-end in service aboard 15 ships, is an anti-aircraft weapon which doubles the performance of its predecessor, the original Terrier, which became operational in 1956. Advanced Terrier is supersonic, 30 feet long with its solid fuel booster and weighs 1,174 pounds. It employs a beam-riding guidance system. The weapon is scheduled to arm two aircraft carriers, three guided missile cruisers, 22 guided missile frigates, the nuclear-powered guided missile cruiser USS Long Beach, and the nuclear-powered guided missile frigate USS Bainbridge. The Marine Corps also uses the missile for land-based anti-aircraft defense. Prime contractor is General Dynamics/Pomona, which also supplies guidance equipment. The powerplant is built by Allegany Ballistics Laboratory. Status: Operational.

MAULER

Under development by the Army Rocket and Guided Missiles Agency, Mauler is a highly mobile, self-propelled, high-kill-probability weapon designed to provide all-weather air defense of forward combat elements against low flying aircraft and short range missiles. Launched from a tracked tactical carrier, it is radar guided. Power is supplied by a solid propellant rocket manufactured by Grand Central Rocket Co. Prime contractor is General Dynamics/Pomona. Status: Development.

TARTAR

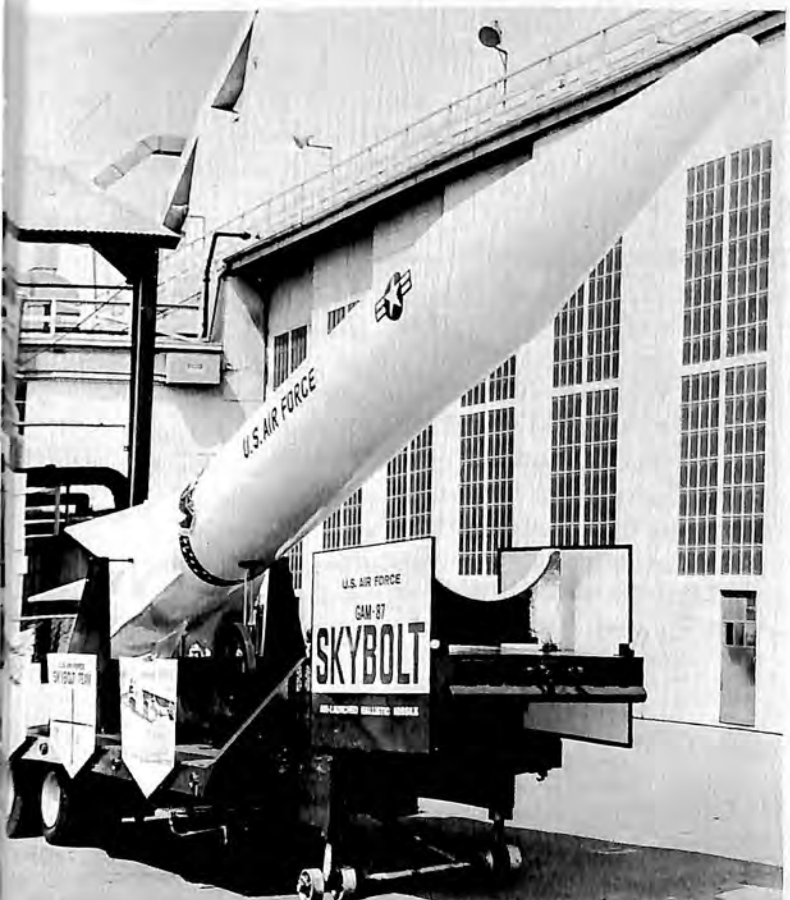
A supersonic homing missile, Tartar, in 1961, was becoming the primary anti-aircraft battery aboard Navy destroyers. A new class of destroyers was being commissioned for Tartar use; seven of them had been commissioned by the end of 1961. Tartar was scheduled for installation on 23 destroyers and three cruisers. The missile, 15 feet long and one foot in diameter, has a range of more than 10 miles. Prime contractor is General Dynamics/Pomona. Status: Operational.

BOMARC

An intermediate range pilotless interceptor, the IM-99 Bomarc is designed to engage enemy aircraft some distance from the intended target. Powered by twin Marquardt ramjet engines and an Aerojet-General solid rocket booster, Bomarc weighs 15,000 pounds, is 47 feet long and has a wing span of 18 feet. The latest model, IM-99B, has a range of 500 miles, the earlier IM-99A has a 200-mile range. Bomarc carries either conventional or nuclear warheads. The missile is ground controlled by SAGE during mid-course, and by a seeker system at target. Prime contractor is Boeing Airplane Co.; Westinghouse Electric supplies guidance equipment. Status: Operational.

TYPHON *(No photo)*

Typhon is an advanced Navy air defense weapon system which combines the programs formerly known as Super Talos and Super Tartar. It consists of two missiles, a long range version and a medium range model, each with significant performance increases over existing weapons in those categories. The missiles, being developed under the supervision of Johns Hopkins University, will be powered by solid boosters with ramjet sustainers. For the long range version, Typhon LR SAM-N-9, the contractors include Bendix Mishawaka (prime), McDonnell Aircraft (airframe), and McDonnell/Bendix on the power plant. No contractors announced for Typhon MR. Status: Development.



SKYBOLT

The flight test program of Skybolt, the Air Force's air-launched ballistic missile, got under way in 1961 with a series of drop tests from B-52 bombers, to gather data on the missile's drop characteristics and trajectory. Skybolt is a two-stage solid-propellant missile being developed by Douglas Aircraft Co. It flies at hypersonic speed and can drop a nuclear warhead on targets up to 1,000 miles from its launch point. The Boeing B-52H bomber can carry four Skybolts in under-wing mounts. Associated with Douglas in the program are Aerojet-General (power plants), Nortronics (guidance) and General Electric (nose cone). Status: Development.

QUAIL

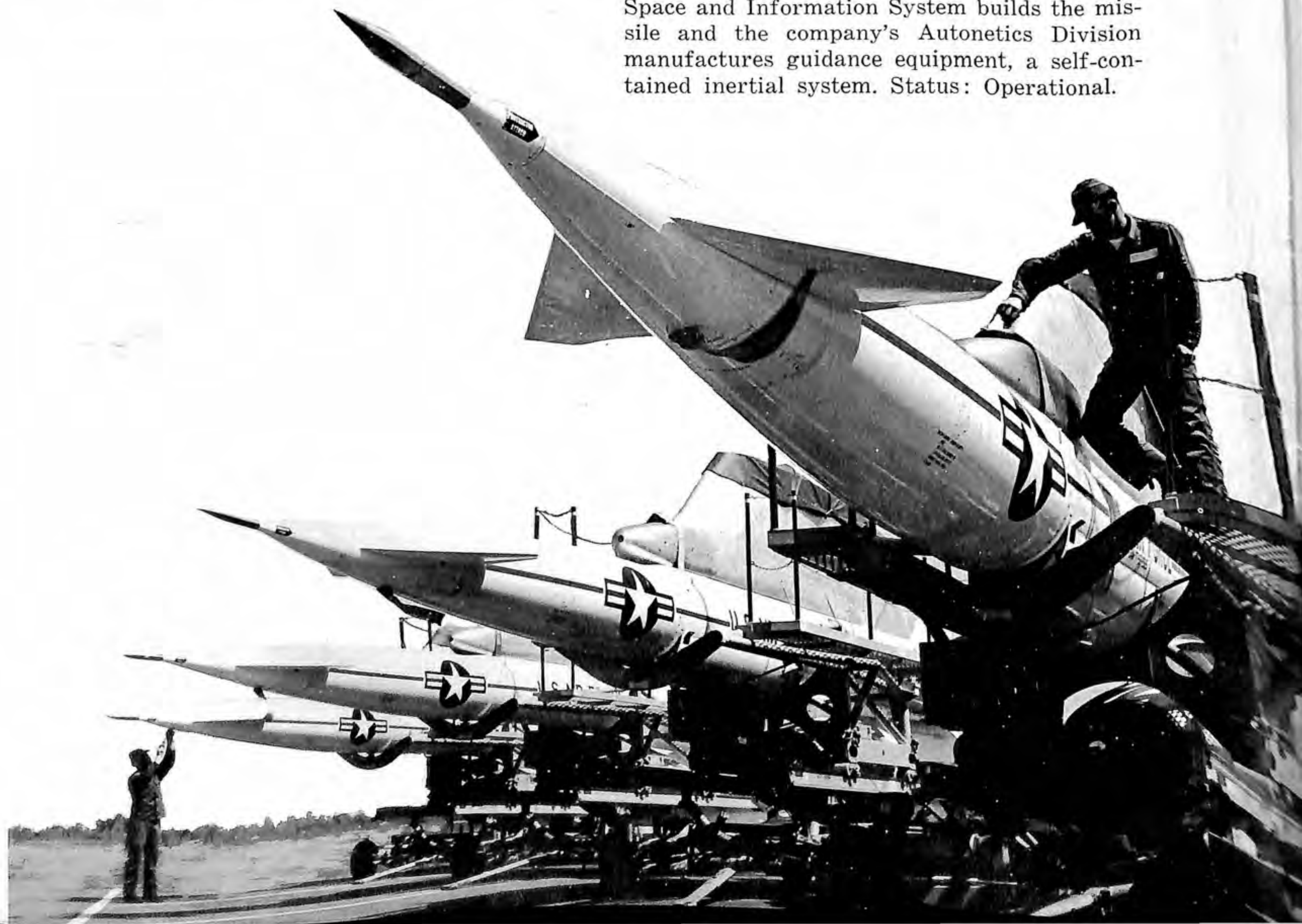
A diversionary or decoy missile, Quail is designed to confuse enemy air defense systems by presenting on enemy radar screens a blip identical to that of the B-52 mother plane from which it is launched. Quail, also known as GAM-72, became operational with the Air Force's Strategic Air Command in 1961. It is 13 feet long and has a wingspan of 5.4 feet. Weighing only 1,200 pounds, its speed is in the high subsonic range, with power provided by a General Electric J85 engine and guidance by a gyro autopilot. McDonnell Aircraft is prime contractor, airframe manufacturer and guidance manufacturer. Status: Operational.

BULLPUP

Latest in the series of Bullpup missiles built by Orlando Division, Martin-Marietta Corp. is the Bullpup B, which carries a 1,000 pound conventional warhead in comparison with the 250-pound warhead in the Bullpup A, already in service on a number of Navy aircraft. The "B," also a Navy missile, is 13.6 feet long, weighs 1,785 pounds and is radio command guided. It started its flight test program in 1961. Also under development was the GAM-83B, an Air Force nuclear-tipped weapon. Thiokol built the power plants for the Navy versions. Status: Bullpup A, operational; Bullpup B, development; GAM-83A, operational; GAM-83B, development.

HOUND DOG

Designed to extend the capability of SAC's bombers, the GAM-77 Hound Dog can deliver a nuclear warhead more than 500 miles after launch from a Boeing B-52G. It is powered by a Pratt & Whitney J52 turbojet which provides supersonic speed. Forty-two and one-half feet long, it has a diameter of 28 inches. North American Aviation is prime contractor, NAA's Space and Information System builds the missile and the company's Autonetics Division manufactures guidance equipment, a self-contained inertial system. Status: Operational.

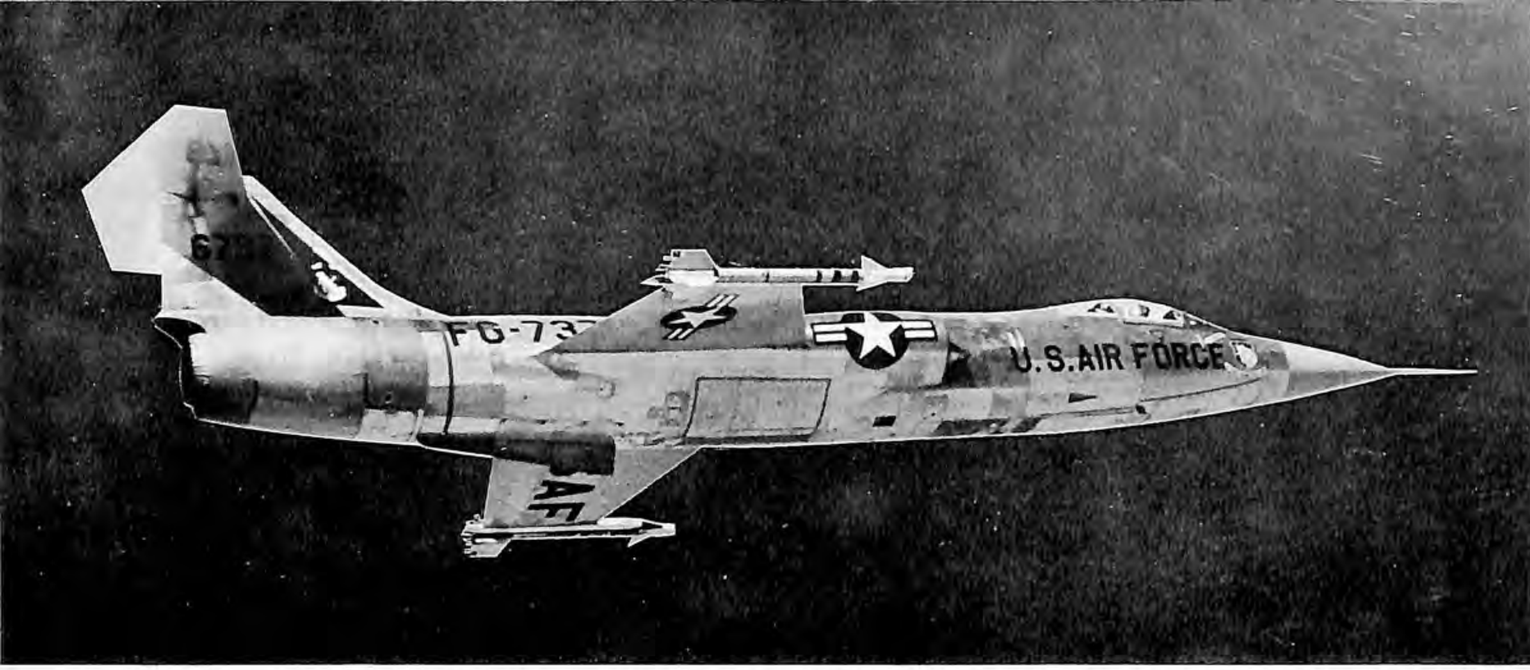


SPARROW III

A Navy and Marine Corps air defense weapon, Sparrow is solid-propelled and guided by a homing system. It is 12 feet long, weighs 380 pounds and has a speed capability of Mach 2-plus. Warhead is conventional. A later version, for F4H aircraft, has a prepackaged, storable liquid-fuel power plant. Prime contractor and guidance manufacturer is Raytheon Manufacturing Co. Aerojet-General provides the power plant. Status: Operational.

FALCON

Among the smallest missiles in service, the Air Force's Falcon family consists of several different types which are fired and guided automatically either by radar or by a heat-seeking homing device. The 1961 addition to the family was the GAR-11 Falcon (in photo), the first nuclear warhead Falcon. The missiles can be carried internally or slung under the wings of interceptor aircraft. The basic Falcon is about six feet long and 6.4 inches in diameter; the GAR-11 is slightly larger. The missiles weigh about 100 pounds and are solid propelled. Prime contractor is Hughes Aircraft Co. Status: Operational.



SIDEWINDER

A simple aluminum tube powered by a solid rocket, Sidewinder is a rugged, inexpensive missile for Air Force and Navy fighter aircraft. Nine feet long and five inches in diameter, the basic Sidewinder has a Mach 2.5 speed capability. An advanced version, with interchangeable infrared and radar guidance heads, is faster and capable of greater range. Warhead is conventional. Philco Corp. is prime contractor and General Electric provides guidance. Status: Operational.

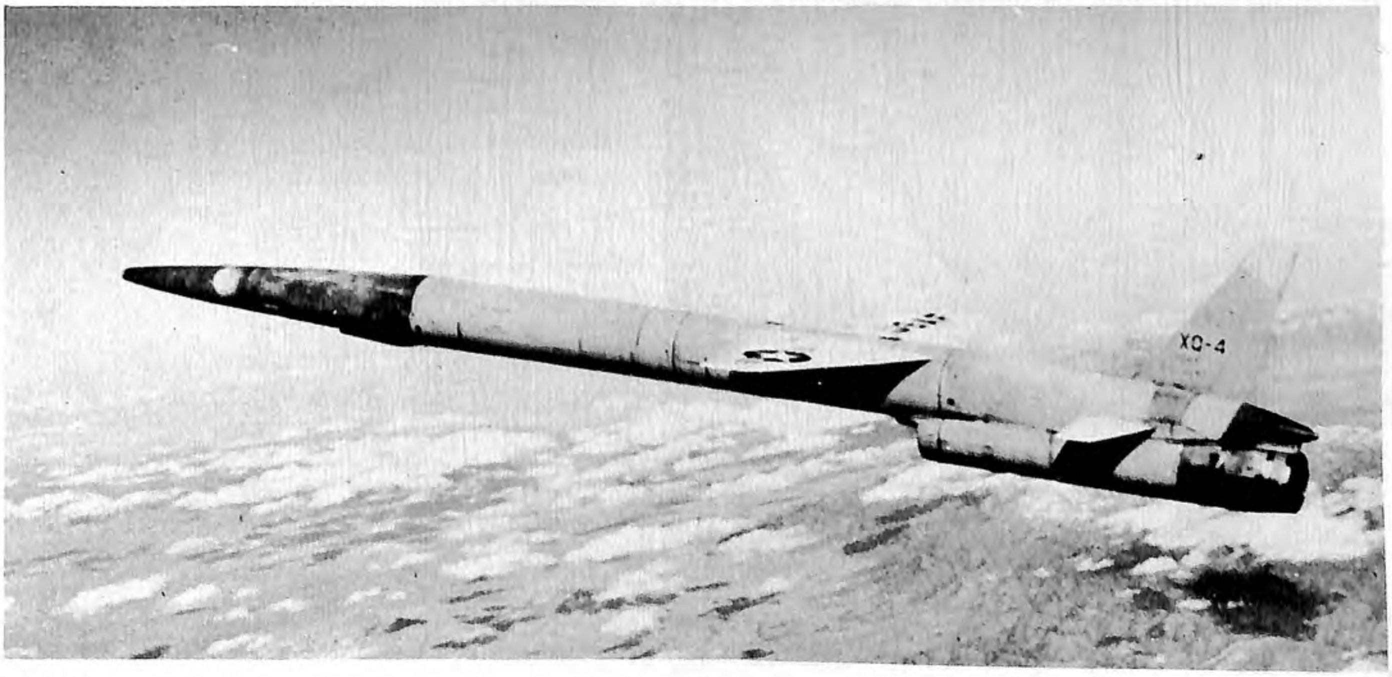
DRONE AIRCRAFT

Q2C FIREBEE

The most widely used target drone is the Q-2C Firebee, in service with the Army, Navy, Air Force and Royal Canadian Air Force. With a high subsonic speed, it is powered by a Continental J69 turbojet. Q2C is 23 feet long, has a wingspan of 12.9 feet, weighs 2,500 pounds and is radio guided. It is launched either from the ground by JATO or from an aircraft. Manufacturer is Ryan Aeronautical Co.

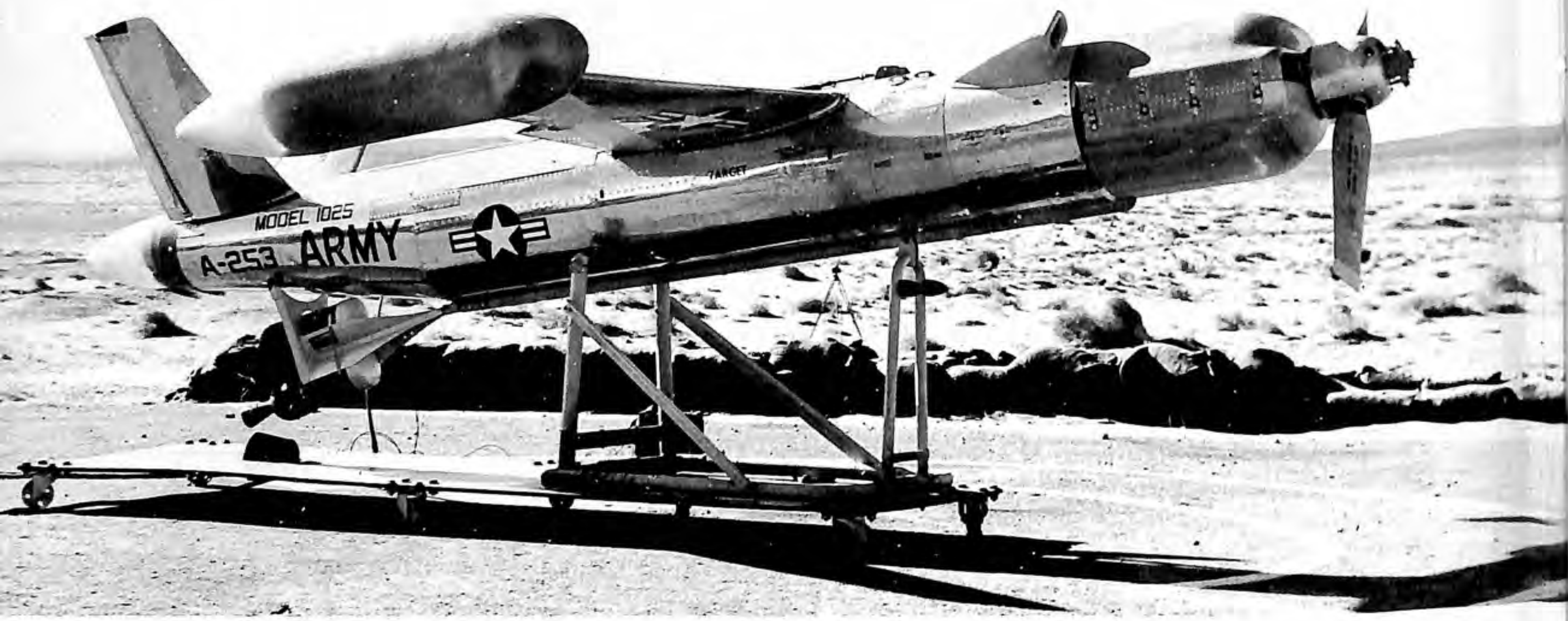
GENIE

The MB-1 Genie, a high velocity rocket equipped with a nuclear warhead, was the first nuclear air-to-air weapon. Unguided, it is powered by an Aerojet-General solid rocket. Nine and one-half feet long and 18 inches in diameter, Genie weighs 800 pounds and has a range of six miles. It is carried in under-wing mounts by Air Force F-101 and F-106 aircraft. Prime contractor is Douglas Aircraft Co. Status: Operational.



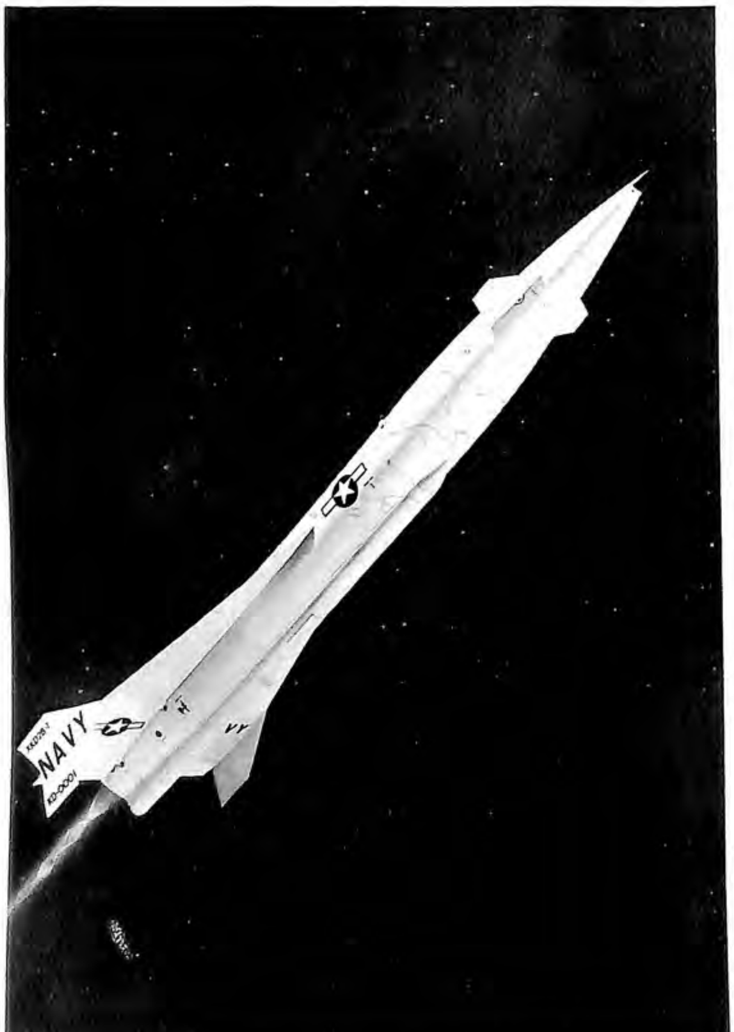
Q-4B

First tested in 1960, the Q-4B supersonic target drone was in use in 1961 by both the USAF and the Navy. The 35-foot long target is powered by a General Electric J85 engine. It is built by Radioplane Division of Northrop Corp.



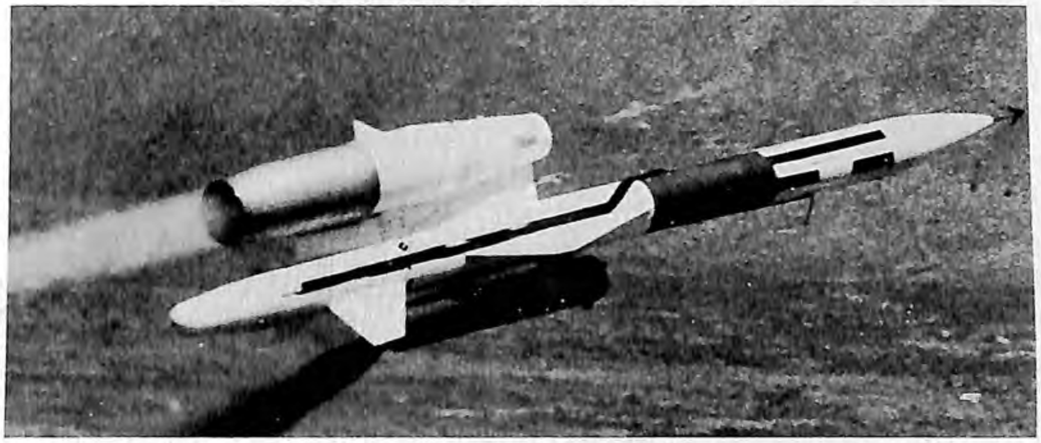
KDB-1

Known in the Navy as KDB-1 and in the Army as Model 1025 Cardinal, the all-metal target is 15 feet long, has a wing span of 13 feet and a gross weight of 635 pounds. It cruises for one hour at 305 knots, with power supplied by a McCullough turbo-supercharged engine. The drone is built by Beech Aircraft Corp.



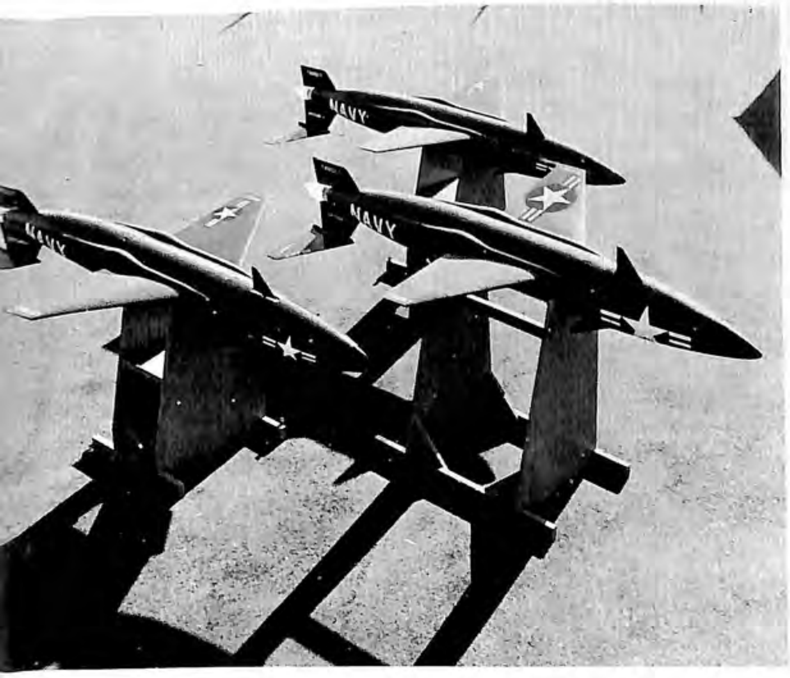
KD2B-1

First flown in 1961, the Navy KD2B-1 (used in the Air Force as the Q-12) is a supersonic target drone designed for air-to-air and surface-to-air weapon system training and development testing. The target is 13 feet five inches long, spans 39 inches and weighs 560 pounds. It has a 70,000 foot altitude and Mach 2 speed capability. Power is supplied by a compact Rocketdyne engine producing 600 pounds thrust. The drone is built by Beech Aircraft Corp.



REDHEAD-ROADRUNNER

First tested in 1961, the Redhead-Roadrunner is the Army's latest supersonic target missile. One foot in diameter and 19 feet long, the drone is launched by a 6,000 pound thrust Rocketdyne booster, then powered in sustained flight by a Marquardt ramjet engine. It weighs about 400 pounds and has a Mach 2 speed capability. The target is built by North American Aviation's Columbus Division.

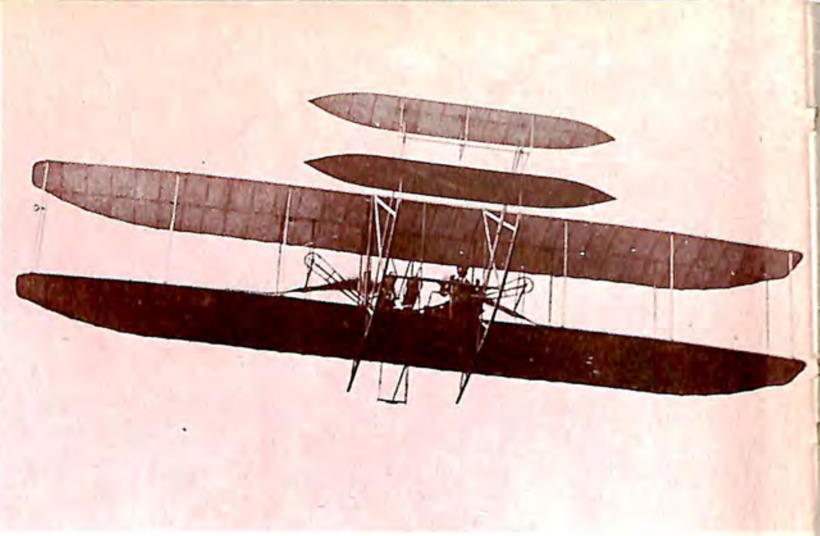


RP-76

A target drone for surface-to-air missiles, the RP-76 is powered by a solid fuel rocket which provides speed in the high supersonic range. Air-launched and radio-controlled, it is operable up to 40,000 feet. It is built by Radioplane.

USD-5

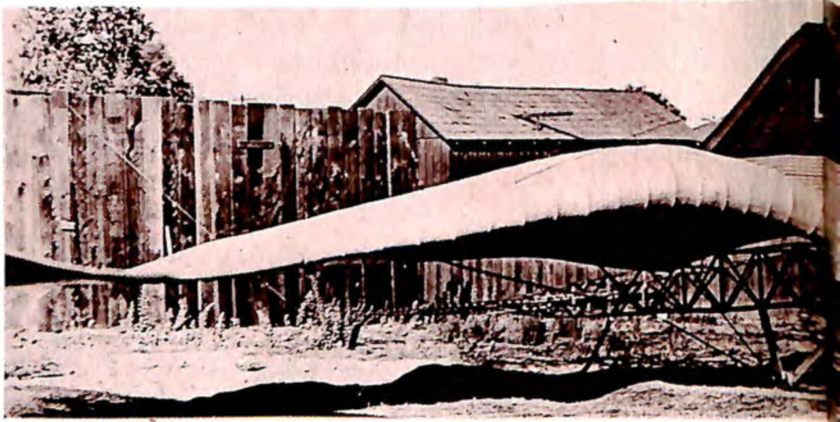
Under development for the Army is the USD-5 surveillance drone, which can be equipped with various combinations of sensory equipment for reporting battlefield reconnaissance information. The drone is rocket-boosted from a zero-launcher and sustained in flight by a turbojet engine. It is being developed by Fairchild Stratos Corp.



LEFT: *Glenn H. Curtiss, gliding down hill in the Hammondsport glider, 1908.*

ABOVE: *Wright 1908 military airplane flight 1 hour, 2¼ minutes, Fort Myer, Virginia.*

BELOW: *Burke 1909-1910 "Mechanical Bird".*



UNITED STATES CHRONOLOGY

A historical summary of the milestones of American Aerospace progress from the first balloon ascents of 1784 thru 1961.

ABOVE: *Curtiss NC-4.*

ABOVE RIGHT: *First Sikorsky VS-300 in flight with Igor Sikorsky at the controls.*

RIGHT: *Third engine is mounted on top wing of Curtiss America, 1914.*

1784, January 16—Airborne troops proposed by Benjamin Franklin in reporting on the first balloon ascents.

1784, June 24—First U.S. balloon flight in Peter Carnes' captive balloon, Baltimore, Md.

1784, November 30—First ascent by an American abroad, by Dr. John Jefferies, physician, with French aeronaut Blanchard, at London. On January 7, 1785, they made the first Channel crossing by air.

1793, January 9—Balloon flight by Jean Pierre Blanchard from Philadelphia, Pa., to Woodbury, N.J. (Letter from George Washington carried on this flight.)

1837, September 18—Parachute demonstration in America when John Wise drops animals from a balloon at Philadelphia.

1838, August 11—John Wise safely lands with his parachuted balloon at Easton, Pa.

1840, September 8—Col. John H. Sherburne urges Secretary of War to use night balloons to locate Seminoles.

1842, October 22—John Wise proposes to capture Vera Cruz by air.

1844, October 16—America's first air patent to Muzio Muzzi in direction of balloons.

1845, September 18—Rufus Porter proposes steam airship line, New York-California, to carry goldseekers at $100 a trip. Stock sales unsatisfactory. His 1849 booklet illustrates a jet-propeller passenger rocket.

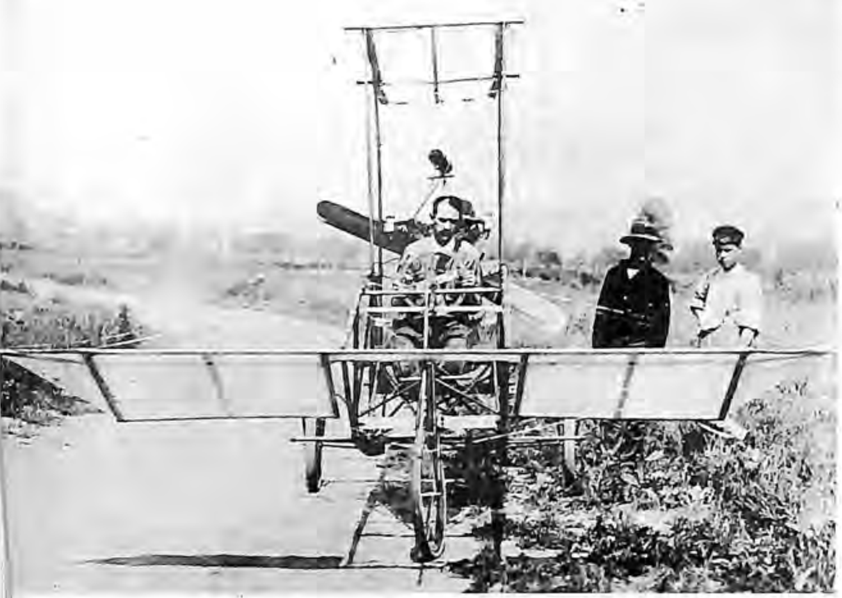
1859, July 2—World record balloon trip, 809 miles, St. Louis to Henderson, N.Y., by John Wise and three companions.

1859, August 16—Airmail carried by John Wise in balloon flight from Lafayette to Crawfordsville, Ind.

1860, August 21—Capt. E. B. Hunt, Corps of Engineers, U.S.A., advocates balloon telegraphy.

1860, October 13—Successful aerial photos taken by William Black from a balloon, Boston, Mass.

1861, June 10—Military flight by James Allen, first Rhode Island State Militia, in balloon over Washington, D.C.



Curtiss vehicle consists of tricycle gear, wing section, V-engine, propeller and elevator, 1908

1861, June 18—Balloon telegraph demonstrated by T. S. C. Lowe. (Message to Abraham Lincoln.)

1861, June 22-24—Military reconnaissance by T. S. C. Lowe and Army officers from balloon using telegraph, over Arlington and Falls Church, Va. Military air observation continues into 1863.

1861, August 3—Civilian aeronaut La Mountain inaugurates aircraft carrier operations with his war balloon. Lowe follows.

1861, September 24—Air Artillery adjustment from Lowe's Army balloon near Washington.

1861, November 7—Helicopter proposed for Union Army. After experiments, a machine is partly built before Appomattox ends the project.

1862, March 9—War helicopter bomber designed and urged by William C. Powers of Mobile, Ala.

1866, May 25—Solomon Andrews' airship maneuvers over New York with 4 passengers.

1873, October 6—Unsuccessful trans-Atlantic flight by W. H. Donaldson, Alfred Ford and George A. Lunt in balloon, *Graphic*, from Brooklyn, N.Y., to New Canaan, Conn.

1877—Prof. William H. Pickering, Harvard University, begins experiments with model helicopters. In 1903 a rabbit is sent aloft.

1880—Thomas A. Edison conducts helicopter experiments for James Gordon Bennett.

1883, March 17—First of a series of glider flights by John Joseph Montgomery, Otay, Cal.

1885, January 7—Russell Thayer, C. E., a graduate of West Point, urges on Secretary of War Robert T. Lincoln a compressed-air airship of his design. No action.

1886, July—W. E. Irish, publisher of *Aeronautical World*, proposes balloon radio.

1887, January 30—Thomas E. Baldwin makes his first parachute jump at San Francisco.

1887—American altitude record made by aeronaut Moore and Prof. H. A. Hazen of U.S. Signal Service, at St. Louis; 15,400 feet, in balloon of St. Louis *Post Dispatch*.

1890, July 31—During the month, L. Gathmann, of Chicago, explodes a shell at high altitude in attempt to produce rain.

1890, October 1—President Harrison approves legislation creating the Weather Bureau and re-establishing the Signal Corps which is charged with collection and transmission of information, among other duties. Military aeronautics is then considered as among such means, and Army aeronautics is revived.

1892, October 10—Balloon section is being organized with each telegraph train by Chief Signal Officer, General A. W. Greely, who anticipates military airships and airplanes.

1892, November 5—Wingless aerial torpedo suggested by Prof. A. F. Zahm.

1893, August 1-4—International Conference on Aerial Navigation held at Chicago; Octave Chanute, Chairman; Dr. A. F. Zahm, Secretary.

1893, October 9—The Chief Signal Officer, General Greely reports the purchase of a Lachambre balloon for the Signal Corps balloon section. First ascents since the war are made at the Chicago exposition from October 31, 1893.

1896, April 29—First American wind tunnel begins operation at M.I.T.

1896, May 6—Steam-powered airplane model flown by Samuel Langley, Washington, D. C.

1898, April 29—War and Navy Departments examine Langley's work, approve, and Board of Ordnance and Fortification makes two allotments of $25,000 each to build his airplane.

1898, December 22—The Secretary of War approves a Fort Myer site for barracks, officer quarters, administration building and a balloon house to concentrate Signal Corps schools at one point.

1901, September 1—Simon Newcomb, Ph.D., LL.D., writes in *McClures* for September: "The first successful flyer will be the handiwork of a watchmaker and will carry nothing heavier than an insect."

In December, Rear Admiral Melville, USN says in the *North American Review:* "A calm survey . . . leads the engineer to pronounce all confident prophecies at this time for future success as wholly unwarranted, if not absurd."

1902, September 15—A. Leo Stevens sails his airship *Pegasus* over Manhattan Beach in a race with Edward C. Boyce in the latter's Santos Dumont airship.

1903, March 23—Orville and Wilbur Wright apply for patent on their flying machine. (Patent issued May 22, 1906.)

1903, December 8—Samuel Langley's flying machine, piloted by Charles Manly, plunges in the Potomac and is wrecked on its second test, Washington, D. C.

* **1903, December 17**—First sustained controllable flight of powered heavier-than-air machine by Orville and Wilbur Wright, Kitty Hawk, N. C.

1904, August 3—Circuit flight in airship (Curtiss motor) by Capt. Thomas S. Baldwin at Oakland, Cal.

1904—Wright brothers make 104 flights, covering 20 miles. British representative visits the Wrights in November.

1905, January 18—Wright brothers open negotiations with U. S. War Department for disposition of their invention. Correspondence is had through 1907.

1905, April 29—Daniel Maloney begins series of glides with Montgomery glider, taking off from captive balloon. Later killed.

1905, August 5—Charles K. Hamilton begins series of kite flights, towed by cars and boats.

1905, September 26-October 5—Wright brothers make 55 flights, the longest being 24 miles in 38 min. 3 sec. Frank S. Lahm, in France, obtains report on Wrights' flying from Ohio relative. French remain skeptical. In October the French government is negotiating along with British.

1905—Lt. Frank P. Lahm becomes first Army balloon pilot.

1906, January 13-20—First indoor aero exposition, New York.

1906, March—French and British visit Wright brothers at Dayton.

1906, September 30—First Bennett international balloon race won by Lt. F. P. Lahm—Paris to England.

1906, December 1-8—Second indoor air exhibition of Aero Club of America.

1907, June 8—Building devoted exclusively to aeronautics dedicated at Jamestown (Va.) Exposition.

1907, August 1—Aeronautical Division established, Army Office of Chief Signal Officer.

1907, September 2—Walter Wellman airship *America* fails in polar attempt.

1907, September 30—Ornithopter of H. C. Gammeter, multigraph inventor, lifts temporarily.

1907, October 1—Aerial Experiment Association formed by Dr. A. Graham Bell, F. W. Baldwin, J. A. D. McCurdy, Glenn H. Curtiss and Thomas E. Selfridge.

1907, October 3—Record altitude of 23,110 feet by U. S. Weather Bureau meteorological kite.

1907, October 18—Air bombing prohibition signed at second Hague conference.

1907, October 21—Second Bennett international balloon race, St. Louis, won by Oscar Erbsloh of Germany. Airship races are held Oct. 22-23.

1907, October 28-29—International Aeronautic Congress held in New York.

1907, October 28—Admiral C. M. Chester urges anti-submarine airships and shipboard airplanes at International Aeronautic Congress.

1907, December 6—Seven-minute towed flight from motor boat tug in Dr. Bell's kite, flown by Lt. T. E. Selfridge.

1907, December 16—Chief Signal Officer advertises for airship bids, resulting in purchase of Baldwin airship.

1907, December 23—Chief Signal Officer advertises for airplane bids, after visit of Wrights.

1908, February 10—First Army plane contract signed by Signal Corps with Wright brothers. (Other contracts signed with A. M. Herring and J. F. Scott.) *

1908, March 12—First Aerial Experiment Association's plane, *Red Wing*, flown by F. W. Baldwin. Later, three other machines fly.

1908, May 6-18—Wright brothers renew flying preliminary to delivery of Army airplane. Charles Furnas is first airplane passenger. *

1908, May 13—Balloon radio reception demonstrated by Signal Corps.

1908, May 31—G. H. Curtiss Manufacturing Company announces planes for sale.

1908, June 10—Aeronautical Society formed in New York and Morris Park Airfield shortly obtained—first of kind in U. S.

1908, June 20—Anthony radio-controlled airship model demonstrated.

1908, July 4—*Scientific American* Trophy awarded Glenn H. Curtiss for first public flight of one kilometer circuit in his biplane, *June Bug*, Hammondsport, N. Y.

1908, July 17—First air ordinance passed by Kissimmee, Fla., with registration and regulation.

1908, August 8—Demonstration flights under French Syndicate control begin near LeMans, France, by Wilbur Wright, continuing through December, making a number of astounding records. Training of students follows.

1908, July 31-August 8—Henri Farman of France makes first exhibition airplane flights in U. S.

1908, August 22—First Army Baldwin airship accepted.

1908, September 17—First plane fatality, killing Signal Corps Lt. Thomas E. Selfridge and severely injuring Orville Wright, in delivery of first Army airplane, Fort Myer, Va.

1908, December 28—Matthew B. Sellers makes several flights with 7 hp quadroplane.

1909, January 22—Commercial airplane, built by Glenn Curtiss, sold to Aeronautic Society of New York.

1909, April 16-28—Wilbur Wright delivers an airplane in Italy and teaches pupils.

1909, June 10—President Taft presents Aero Club of America medal to Wright brothers. Congressional medal presented at a celebration at Dayton, June 17-18.

1909, June 26—Glenn H. Curtiss demonstrates at the Aeronautical Society's meet, Morris Park, New York, the machine ordered January 22. Further flights are made at the Society's meet July 5, before removal of the machine to Mineola and the instruction of member Charles F. Willard.

1909, July 17—Curtiss flies 52 mins. in longest U. S. flight except Wrights and wins *Scientific American* trophy for second time. On this success in the Mineola flights the Aero Club of America names him as America's entry in the Bennett international race.

1909, August 22-29—Glenn H. Curtiss wins first Bennett international airplane race and other events of first International Flying Meet, Rheims, France. Speed: 45.7 mph.

1909, August 25—First Army airfield leased at College Park, Md.

1909, August 28—After instruction by Glenn H. Curtiss and subsequent practice in the machine contracted by the Aeronautical Society, Charles F. Willard gives his first exhibition at Scarsborough Beach, Toronto—America's first exhibition pilot. His exhibitions continue over several years.

1909, September 7-October 15—At Berlin, Orville Wright makes flights under German contract, with more records.

1909, September 30—Inception of Wright-Curtiss patent litigation.

1909, September 30—Emile Berliner describes a proposed guided missile.

1909, October 3—At Zurich, Switzerland, E. W. Mix wins the Bennett International balloon race the second time for America.

1909, October 4—Wilbur Wright makes sensational flight, Governors Island to Grant's Tomb and return. Glenn H. Curtiss makes a short flight Sept. 29 and Oct. 3.

1909, October 7—Glenn H. Curtiss flies his first exhibition at St. Louis. Chicago is next. The same month, Charles K. Hamilton and Otto Brodie learn to fly, followed by others. An exhibition company is formed and Curtiss returns to his development work.

1909, October 8-November 5—First Army aviators taught to fly by Wilbur Wright, College Park, Md.: Lt. Frank P. Lahm, Lt. Frederic E. Humphreys, and Lt. B. D. Foulois.

1909, November 27—Anti-aircraft firings begin at Sandy Hook by Ordnance Department.

1909, November 22—The Wright Co. formed with $1,000,000 capital. In 1914, Orville Wright buys the company back. On Oct. 13, 1915, a syndicate buys the company and adds the Simplex Co. In 1916 it becomes the Wright-Martin Co.

1910, January 10-20—First flying meet held at Los Angeles; Louis Paulhan, of France, the star performer.

1910, May 29—Record flight from Albany to New York by Glenn Curtiss, 142.50 mi. in 2 hr., 50 min.

1910, March 25—Wright patent condemnation urged by William M. Page, attorney for C. F. Bishop, president, Aero Club of America.

1910, June 13—Charles K. Hamilton flies New York-Philadelphia and return for N. Y. *Times* and Philadelphia *Public Ledger* and $10,000 prize—149.5 miles in flying time 3 hr. 27 min.; elapsed time, 6 hr. 57 min.

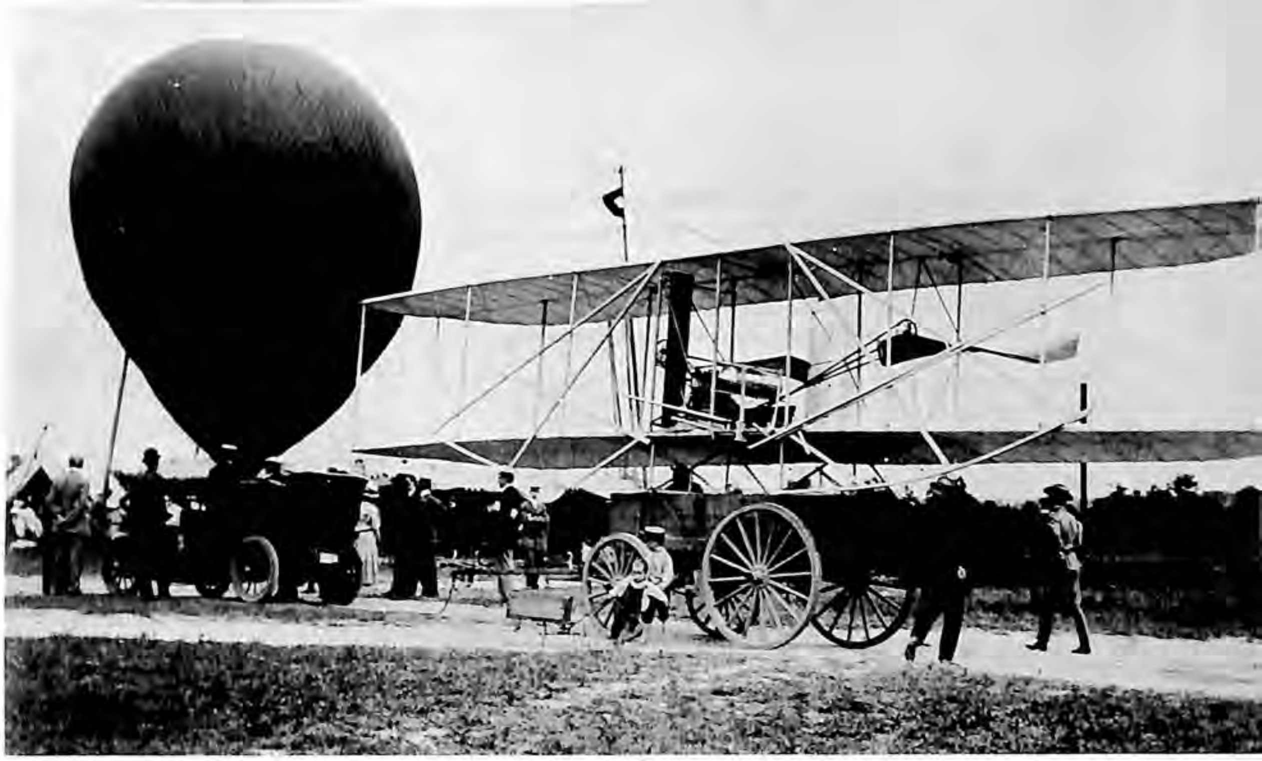
1910, June 13-18—First show of Wright exhibition team, Indianapolis, Ind., where Walter Brookins is star and make new records. Exhibitions by single pilots or groups continue about the country until the Wright exhibition business is discontinued in Nov. 1911.

1910, June 30—Dummy bomb demonstration made by Glenn H. Curtiss to Army and Navy officers.

1910, August 4—Plane-ground radio demonstrated by E. N. Pickerill.

1910, August 8—Tricycle landing gear installed by Lt. B. D. Foulois on Army Wright at San Antonio.

1910, August 27—Air-land plane radio used by J. A. D. McCurdy, Sheepshead Bay, N. Y.



Automobile pulls Wright military airplane on wagon at Fort Myer, Virginia, 1908.

1910, September 2—First American woman pilot solos: Blanche Stuart Scott. First exhibition at Fort Wayne, Oct. 22.

1910, October 8-10—Former President Theodore Roosevelt is flown at St. Louis exhibition by Arch Hoxsey.

1910, October 22-31—Second Bennett international airplane race won by C. G. White (Bleriot) at 61 mph during Belmont Park meet where numerous records are made.

1910, November 14—First battleship takeoff by Eugene Ely from U.S.S. *Birmingham* in Hampton Roads, Va.

1910—Night flights by Walter R. Brookins (Montgomery, Ala., Apr. 18) and Charles Hamilton (Camp Dickenson, Nashville, Tenn., June 21-26).

1911, January 7—Didier Masson flies Los Angeles-San Bernardino to deliver *Times* newspapers. Mail and papers delivered Feb. 17 by Fred J. Wiseman.

1911, January 7-25—Dive bombing, aerial photography, airplane radio demonstrated by Army officers in San Francisco meet.

1911, January 27-28—Lieut. T. G. Ellyson, U.S.N., is first U. S. naval aviator when he takes his Curtiss off at San Diego during Curtiss exhibitions.

1911, January 30—J. A. D. McCurdy attempts Key West-Havana flight but lands in water ten miles short and is rescued by Navy destroyer. In 1913 Domingo Rosillo makes the entire distance.

1911, February 17—Curtiss flies tractor seaplane from North Island to cruiser *Pennsylvania*. Plane hoisted on board and return flight later made.

1911, March 3—Lt. B. D. Foulois and P. O. Parmalee fly record cross-country Laredo-Eagle Pass, Tex., 106 mi. in 2 hr 10 min. in Wright plane loaned Army by R. J. Collier. Messages dropped en route, radio received and sent.

1911, March 13—Capt. W. Irving Chambers, U.S.N., is assigned the Bureau of Navigation to devote exclusive efforts to naval aeronautics.

1911, March 31—About this date Missouri National Guard Signal Corps establishes air section and members taught flight and ballooning.

1911, May 8—First Navy airplane ordered, Curtiss Triad, amphibian. By July the three 1911 planes of the Navy are delivered—Curtiss A-1, A-2; Wright B-1.

1911, May 13—Lieuts. H. H. (Hap) Arnold and Thomas DeWitt (Tommy) Milling complete flying training at Wright School: 7th and 8th Army pilots.

1911, June 7—Lieut. John P. Kelley, Med. Res. Corps, assigned Army School at College Park—first U. S. air medical officer.

1911, June 8—Connecticut state air regulation is first state air law.

1911, June 21—Short-lived Aeronautical Manufacturers Ass'n incorporated; Ernest L. Jones, president.

1911, June 30-July 11—Boston-Washington flown by Harry N. Atwood. Charles K. Hamilton flies with him most of way—longest continuous air journey to this date.

1911, July 1—Third Bennett plane race won for U. S. by Charles T. Weyman (Nieuport-Gnome 100) at 78 mph.

1911, July 31—During the month, Frank E. Boland begins flying his tailless, allegedly non-infringing airplane.

1911, August 5—Lincoln Beachy wins over Eugene Ely and Hugh Robinson in New York-Philadelphia race for Gimbel $5000 purse. Elapsed time: 1 hr. 50 min. 18 sec.; one stop for fuel.

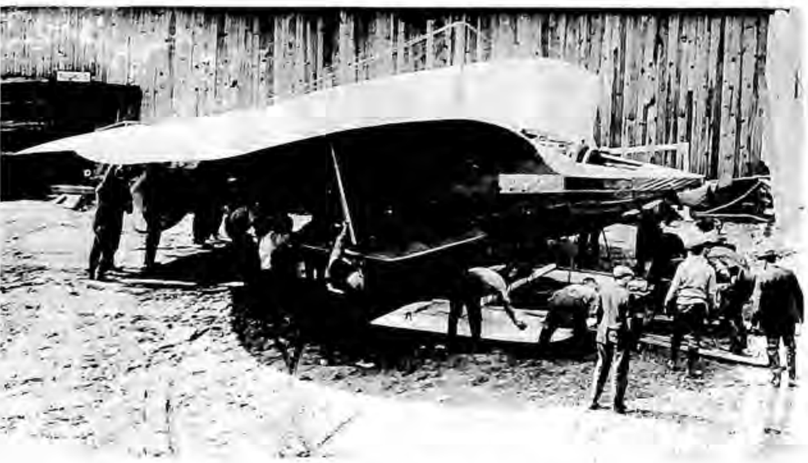
1911, August 14-25—Harry N. Atwood flies St. Louis-New York, 1155 miles by route; longest cross-country flight to this date.

1911, August 20—World altitude record set at 11,642 ft. by Lincoln Beachy in Curtiss biplane.

1911, September 4—Earle L. Ovington (Bleriot-Gnome 70) wins over Lieut. T. D. Milling (Burgess-Wright-Wright 30) in 160-mile tri-state race during Boston meet, in 3 hr. 6 min. 22 sec.

1911, September 7—Lt. T. G. Ellyson, U.S.N., demonstrates shipboard launching by taking off from aerial cable at Hammondsport, N. Y.

1911, September 17-November 5—Transcontinental flight by Calbraith P. Rodgers from New York to Pasadena, Calif.—3,390 mi., 49 days.



Curtiss Goupil "Duck", 1914

1911, September 23-30—Earle L. Ovington appointed Airmail Pilot No. 1, flying mail from Nassau Boulevard to Mineola, L. I., N. Y.

1911, September 30—Lt. H. H. Arnold is "stunt man" for the lead in pioneer air movies at Nassau Boulevard meet where Army pilots compete.

1911, October 9—Demonstration of Tarbox automatic pilot made before officers at College Park. Other similar inventions follow.

1911, October 10—Bombsighting and dropping device demonstrated by Riley Scott, College Park, Md.

1911, October 19-February 12, 1912—Eastbound transcontinental flight of Robert G. Fowler (Wright B), Los Angeles-Pablo Beach, Fla., 2520 mi. in 116 days.

1911, October 24—Orville Wright makes soaring record of 9 min. 45 sec. at Kitty Hawk.

1912, February 12—Frank T. Coffyn takes automatic movie aerials over New York harbor.

1912, February 17—First pilot physical exam published by U. S. Army.

1912, March 1—Attached type parachute jump by Bert Berry from Benoist pusher plane, St. Louis.

1912, April 16—First U. S. licensed woman pilot, Harriet Quimby, flies English Channel. (Killed at Boston Aviation Meet, July 1.)

1912, May 24—Paul Beck makes American duration record of 4 hr. 23 min. 5 sec. in biplane with Berliner Gyro engine.

1912, May 30—Death of Wilbur Wright by typhoid.

1912, June 7-8—Machine gun fired from Wright biplane by Capt. Charles DeForest Chandler, College Park, Md.

1912, July 2—Vaniman airship *Akron* crashes off Atlantic City in renewed trans-Atlantic attempt.

1912, July 31—Plane launched from sea wall by catapult, Navy Lt. T. G. Ellyson in Curtiss AH-3.

1912, August 12—First Army tractor plane, Burgess, received; flown by Lts. H. H. Arnold and Roy C. Kirtland from Marblehead, Mass.

1912, October 6—In night flight, Lt. J. H. Towers, U.S.N., (Curtiss A-2) makes world seaplane duration record, 6 hr. 10 min. 35 sec. at Annapolis; American record for any plane.

1912, October 8—First Navy physical exam for pilots published by Bureau of Medicine and Surgery.

1912, October 9—First competition for Mackay Trophy won by Lt. H. H. Arnold.

1912, November 5-13—First U. S. airplane artillery adjustment, Ft. Riley, Kans., Lt. H. H. Arnold and observer Lt. Follett Bradley.

1912, November 6-December 15—Antony Jannus (Benoist seaplane Roberts 2-cycle 100 hp) flies Omaha-New Orleans, with mail and merchandise, carrying passengers at stops en route —1835 mi., flying time: 31 hr. 43 min.

1913, January 13-March 31—Air parcel post flight, Boston-New York, by Harry M. Jones (Wright B).

1913, February 11—James Hay bill in Congress inaugurates the project of a separate air service.

1913, February 13—Langley Field Aerodynamical Laboratory project inaugurated.

1913, April 27—First cross-Isthmus flight by Robert G. Fowler and cameraman R. A. Duhem, Panama-Cristobal. Publication of story and pictures results in arrest.

1913, **May 10**—Didier Masson and bomber Dean attack Mexican federal gunboats in Guayamas Bay. A number of other Americans fly for Villa in this and subsequent years.

1913, **May 28**—Lt. T. D. Milling and Lt. W. C. Sherman make 2-man duration and distance record of 4 hr. 22 min. and 220 miles (Burgess tractor-Renault 70), Texas City-San Antonio.

1913, **May 30**—About this date is instituted M.I.T.'s aerodynamics course under Asst. Naval Constructor Jerome C. Hunsaker.

1913, **June 20**—First Naval aviator killed when Ensign W. D. Billingsley is thrown from seaplane.

1913, **July 19**—Sky writing initiated by Milton J. Bryant over Seattle.

1913, **October 12**—Eighth Bennett international balloon race won for U. S. for fourth time at Paris by R. H. Upson and R. A. D. Preston, landing in England.

1913, **November 27**—First exhibition loop by Lincoln Beachy in Curtiss biplane, Coronado, Cal.

1913, **December 4**—Tactical Air Unit, First Aero Squadron, set up as provisional organization, San Diego, Cal.

1913, **December 12**—Wright pilot Oscar Brindley reports at San Diego as Army's first civilian instructor. Scores of others subsequently employed through 1918.

*1913, **December 31**—Orville Wright demonstrates automatic pilot; awarded Collier Trophy.

1914, **January 1**—First scheduled airline begins operations with Benoist flying boat between St. Petersburg and Tampa, Fla.; Tony Jannus, pilot.

1914, **January 31**—During the month first U. S. Navy air station established at Pensacola, following temporary camps at San Diego and Annapolis, 1911-1912.

1914, **February 17**—Seaplanes and flying boats classed as "vessels" by the Department of Commerce and the license No. 1 is issued to Antony Jannus.

1914, **February 24**—Army Board condemns all pusher type airplanes.

1914, **April 15**—Electric self starter fitted to Anzani 200-hp engine of Collier flying boat.

1914, **June 23**—Curtiss' Wanamaker trans-Atlantic flying boat tested. With outbreak of World War I the project is abandoned.

1914, **July 2**—Lawrence Sperry wins French War Dept. prize for "stable airplane" flown by early automatic pilot over Seine River in Paris.

1914, **July 18**—Aviation Section of Signal Corps created by Congress, authorizing 60 officers and students and 260 enlisted men.

1914, **December 1-16**—Two-way plane-ground radio demonstrated by Lt. H. A. Drague and Lt. J. O. Mauborgne, Manila, P. I.

1915, **March 3**—National Advisory Committee for Aeronautics established by Congress.

1915, **May 14**—Contract let for first Navy airship D-1 to Connecticut Aircraft Co. In July is contracted a floating airship shed.

1915, **June 22**—Wisconsin State Forester, E. M. Griffith, flown by Jack Vilas, in first air forest patrol.

1915, **September 17**—Joseph Dolgos of Philadelphia demonstrates air incendiary bombs.

1916, **February 9**—Cpl. A. D. Smith (Martin S-Hall Scott 125) makes world seaplane duration record of 8 hr. 42 min.

1916, **February 12**—Invitation for bids on airmail issued by Post Office in Massachusetts and Alaska.

Wright airplane in flight at Fort Myer, Virginia, 1909.

1916, **March 15**—First Aero Squadron, under command of Capt. B. D. Foulois, begins operations at Columbus, N. M., with Gen. Pershing's Punitive Expedition.

1916, **April 5**—The Governors Island Training Corps organized by Philip A. Caroll.

1916, **April 14**—A power-driven turret is proposed without result by Col. F. P. Cobham.

1916, **June 3**—National Defense Act increases strength of Aviation S. C. from 60 to 148 officers over 5-year period. President may fix increase of enlisted men from old figure of 260.

1916, **June 18**—U. S. aviator H. Clyde Balsley shot down. (Member of Lafayette Escadrille, flying for France.)

1916, **August 29**—First U. S. Coast Guard Aviation Division organized.

1916, October 2—Allocation airship development to Army or Navy raised by Chief Signal Officer. Rigids later assigned Navy.

1916, November 2—Chicago-New York commercial airmail line asked by Glenn Muffly. Sponsored by New York *Times,* Victor Carlstrom flies mail demonstration, November 2-3.

1916, November 14—More than 60 civilians are sent to Curtiss contract school at Newport News, Va., beginning this date and before Apr. 6, 1917. Others are sent to Curtiss school at Miami. Gen. Mitchell learns to fly here at this period.

1916, November 18-20—Group National Guard cross-country flight under Capt. R. C. Bolling from New York to Princeton, N. J., and return. On December 30, another is made to Philadelphia.

1916, November 19-20—Ruth Law flies her 1914 Curtiss pusher Chicago-New York, with 2 stops en route, for new cross-country record.

1916, December 17—To this date the Aero Club of America has certified 636 airplane pilots. In addition are many other pilots who have never flown for the Aero Club certificate. On Dec. 31, the Army has graduated 122 pilots since 1909.

1916, December 18—Non-exclusive licenses are offered by Wright-Martin Aircraft Corp. on royalty basis. Terms are considered prohibitory and in 1917 Congress appropriates $1,000,000 to acquire basic patents. Solution is the cross-license agreement of the Aircraft Manufacturers Association.

1917, February 13—Capt. Francis T. Evans, U. S. M.C., loops and spins a seaplane at Pensacola.

1917, February 15—Aircraft Manufacturers Association completes organization.

1917, March 14—Navy places orders for 16 non-rigid B-type airships, the first Navy dirigibles.

1917, April 6—U. S. declares war on Germany.

1917, April 6—Official strength of the Aviation Section, S. C., is 131, including regular and reserve. Of these, 112 are airplane pilots or student pilots. Enlisted strength is given variously from 1087-1800. At armistice the figures are: total officers, 20,708 (pilots and student pilots, 12,449); enlisted, 174,315. Airplane strength, "less than 300." Produced in U. S., Apr. 6, 1917—Nov. 1, 1919: 13,894; received from Allies, 5,229; total: 19,123.

1917, May 10—Arrangements made for eight ground schools for theoretical training Reserve officer candidates.

1917, May 16—Aircraft Production Board created. Superseded by the Aircraft Board Oct. 1. Dissolved May 19, 1919.

1917, May 23—French Premier Ribot asks U. S. to furnish 5,000 pilots, 50,000 mechanics, 4,500 planes for active service by spring 1918.

* **1917, May 29**—Liberty engine project inaugurated. An 8-cylinder Liberty is flown in an L.W.F., July 25. The 12-cylinder production Liberty follows in December.

1917, June 1—Barlow robot bomber urged. Armistice ends project.

1917, July 13—Fiske torpedo plane tested with dummy missile. Experiments continue.

1917, July 24—First great U. S. air appropriation, $640,000,000. Act also provides for increase in organization of Aviation Section, S. C.

1917, July 27—Secretary of Navy authorizes a Naval Aircraft Factory at Philadelphia.

1917, July 27—First British DH-4 arrives to be the first American service plane put into production, with Liberty engine. First American DH-4 completed is flown Oct. 29 by civilian test pilot H. M. Rinehart.

1917, August 5—Original First Aero Squadron leaves Columbus, N. M., for overseas under Maj. Ralph Royce.

1917, August 13—First AEF squadron program calls for 89 wings and 508 squadrons. One wing equals six squadrons (5 airplanes, 2 balloons). A brigade comprises two or more wings.

1917, September 5—Bristol fighter project started. Condemned July 20, 1918, after 27 planes are built.

1917, September 22—Montgomery heirs sue Wright-Martin Aircraft Corp. for infringement. Suit withdrawn June 6, 1921. Suit of same date against U. S. is dismissed May 28, 1928.

* **1917, October 16**—Airplane to airplane radiophone conversation is demonstrated.

1917, October 18—McCook Field established as Signal Corps Experimental Laboratory.

1917, October 18—Aviation Medical Research Board established by Signal Corps.

1917, November 15—J. Newton Williams' helicopter proposal results in recommendation of N.A.C.A. for Government prize of $20,000, not accomplished.

1917, November 21—Robot bomber demonstrated to Army and Navy officers.

1917, November 27—Brig. Gen. B. D. Foulois made Chief of Air Service, AEF.

1917—Gen. William Mitchell claimed as first officer to fly over enemy lines.

1918, January 19—U. S. School of Aviation Medicine begins operations under Signal Corps Maj. William H. Wilmer, Hazelhurst Field, Mineola, L. I., N. Y.

1918, **February 28**—Under President Wilson's proclamation, licenses are required for civilian pilots or owners; more than 800 are issued.

1918, **March 8**—Maj. Edward C. Schneider and Maj. James L. Whitney, in simulated altitude flight, reach artificial altitude of 34,000 ft. in 24 min. at Signal Corps, Mineola, N. Y. laboratory.

1918, **March 11**—First D.S.C. awarded Army air service personnel goes to Lt. Paul Baer of 103rd Squadron for his performance this date.

1918, **March 14**—Two pilots of First Pursuit Group (95th Squadron) go on patrol.

1918, **May 9**—Flight Surgeons are organized at flying fields.

1918, **May 11**—U. S. built DH-4 Liberty planes received by AEF.

1918, **May 15**—Congress establishes Air Mail Flyer's Medal of Honor. First award is to M. F. Freeburg, 1932.

1918, **May 15**—Regular airmail service flown by Army between New York and Washington, D. C.

1918, **May 20**—Army aeronautics severed from Signal Corps; two departments created: Bureau of Military Aeronautics and Bureau of Aircraft Production.

1918, **June 26**—A trans-Atlantic flight is urged by Gen. William L. Kenly, Director Military Aeronautics as "most necessary." On August 8, Roy N. Francis is assigned to study project. Experiments continue to 1919 when Navy's NC4 makes the flight.

1918, **July 4**—Plan to distribute tons of propaganda by balloon over Germany this day fails attainment. Previously extended experiments had been conducted and contracts let.

1918, **August 2**—First DH Liberty patrol by 135th Aero Squadron.

1918, **August 17**—First Martin bomber flown at Cleveland by Thomas Eric Springer.

1918, **September 7**—First U. S. demonstration of troop transport by air.

1918, **September 12-13**—Greatest air concentration of history at St. Mihiel under Gen. William Mitchell—1481 planes.

1918, **September 16**—German attached type parachutes being in use at least as early as May 1, 1918, the AEF cables need and suggests Floyd Smith, test pilot, prosecute development. Smith develops free type 'chute. Leslie L. Irving makes first free jump Apr. 28, 1919.

1918, **September 18**—Altitude of 28,899 ft. reached by Maj. R. W. Schroeder.

1918, **September 25**—First Congressional Medal of Honor awarded for air activity voted 1st Lt. Edward V. Rickenbacker of 94th Aero Squadron.

1918, **September 26**—First phase of Meuse-Argonne attack.

*1918, **September 28**—Pilotless airplane maneuvered from another airplane by radio, after some months of experiment. Various automatic pilots and radio controllers tried over the years.

*1918, **October 2**—First successful flights of Army's guided missile. Its prototype had been flown by H. M. Rinehart in July, substituting for the explosive load and the automatic controls.

*1918, **October 3**—Flight refueling demonstrated by Lt. Godfrey L. Cabot, U.S.N.R., continuing into 1920.

1918, **October 12**—Use of oxygen tanks ordered all pilots over German lines.

1918, **October 25**—Charles E. Hughes reports on his investigation of dishonesty in aircraft production.

1918, **November 11**—Armistice signed.

1918, **December 4**—First Army transcontinental flight made by Major Albert D. Smith's group of JN4 planes, San Diego-Jacksonville-New York-San Diego. Major Smith's plane alone completes the full round trip.

1919, **January 2**—Maj. Gen. Charles T. Menoher becomes Director of Air Service.

1919, **January 21-30**—Army second transcontinental flight; Major T. C. Macauley (DH-4 Liberty), Ft. Worth-San Diego-Miami-Ft. Worth. Repeated in April.

1919, **January 24**—At Issoudun, France, 1st Lt. Temple M. Joyce (Morane) makes 300 consecutive loops.

1919, **March 3**—U. S.-Canada airmail flown by Edward Hubbard in Boeing seaplane, Type C.

1919, **April 26**—Lt. Comdr. H. B. Grow, U.S.N. in F5L flying boat makes non-stop endurance record: 20 hr. 10 min.

1919, **April 28**—Leslie L. Irving makes first free type manually operated airplane parachute jump over McCook Field. (See 9/16/18.)

1919, **May 8-31**—Trans-Atlantic crossing by Lt. Albert C. Read and crew from Rockaway Beach, N. Y., to Plymouth, England, in NC-4, 53 hr. 58 min.

1919, **May 14**—Navy airship C-5 makes American non-stop record of 25 hr. 50 min., Montauk Pt., L. I. to St. Johns, N.F.

1919, **May 18**—In first trans-Atlantic takeoff, H. C. Hawker and McKenzie Grieve alight in ocean 1200 miles and $14\frac{1}{2}$ hours out with engine trouble. Rescued.

1919, May 19—First award of DFC made to M/Sgt. Ralph W. Bottriell for first jump by Army personnel with free-type 'chute.

1919, June 1—First organized and sustained forest fire patrol inaugurated at Rockwell.

1919, June 14—First non-stop Atlantic crossing by Capt. John Alcock and Lt. A. W. Brown (Vickers-2 Rolls 375) St. Johns to Clifden, Ireland: 1890 mi. in 16 hr. 12 min.

1919, June 28—Treaty of peace with Germany signed at Versailles.

1919, July 1—Aerial fish patrols inaugurated at San Diego by Comdr. E. W. Spencer, Jr., U.S.N.

1919, July 2-6—First airship ocean crossing, British R-34, E. Fortune, Scotland, to Mitchel Field, N. Y., 3270 mi. in 108 hr. 12 min.; Lt. Comdr. L. Lansdowne, U.S.N. on board. Return made July 9-12, Col. William M. Hensley, representing Air Service.

1919, August 14—Airmail from Aeromarine flying boat to White Star liner, *Adriatic.*

1919, August 27-29—New York-Toronto race of military and civilian pilots.

1919, August 28-September 19—Lawson "air liner," 26-passenger, twin Liberty biplane, makes demonstration trip Milwaukee-Washington via Chicago, New York and other cities. It returns Sept. 25-Nov. 6.

1919, September 1—Dive bombing demonstrated about this date at Aberdeen Proving Ground.

1919, September 16—Flood relief provided by four JN4D's from Corpus Christi to stranded inhabitants.

1919, September 18—Roland Rohlfs (Curtiss triplane-K12 Curtiss 400) makes world altitude record of 31,420 ft.

1919, October 8-31—Army transcontinental reliability and endurance test New York-San Francisco and return. Forty-four compete westbound; 15 eastbound. Ten planes make round trip.

1919, October 30—Reversible pitch propeller tested at McCook Field, Dayton, Ohio.

1919, November 12-June, 1920—Six Navy F-5L's cruise New York to West Indies and return, covering 12,731 nautical miles.

1920—Moon eclipse observed by Lts. J. H. Tilton and W. H. Cushing of Rockaway Naval Air station from height of some three miles.

1920, February 27—World altitude record of 33,113 feet set by Maj. R. W. Schroeder (Le Pere-Liberty).

1920, March 29-April 22—Marine Corps group flight Washington-San Domingo and return, 4842 miles.

1920, June 7—Lt. John H. Wilson makes unofficial world parachute jump record of 19,800 ft.

1920, June 4—Army Reorganization Bill approved, creating Air Service in Army.

1920, July 7—FP-5L Navy seaplane flown by radio compass from Hampton Roads, Va., to U.S.S. *Ohio,* at sea.

1920, July 15-October 20—New York-Alaska flight; Capt. St. Clair Street, 1st Lt. Clifford Nutt, 2nd Lts. Ross C. Kirkpatrick, Eric H. Nelson and C. E. Crumrine, Sgts. James Long and Joseph E. English, Capt. Howard Douglas, advance officer; Mitchel Field, N. Y., to Nome and return.

1920, September 8—Transcontinental mail route, combination plane-train, New York-Chicago-San Francisco, completed.

1920, November 1—U. S. international passenger service started by Aeromarine West Indies Airways between Key West, Fla., and Havana, Cuba.

1920, November 25—1st Lt. C. C. Moseley (Verville-Packard 600) wins first Pulitzer race at 156.54 mph; 24 contestants finish, 13 others start but do not finish.

1920, December 13-14—Navy balloon of Lts. L. A. Kleer, Walter Hinton and S. A. Farrell land beyond Moose Factory, Ont., after 25 hours, 852 miles from start at Rockaway, N.Y.

1921, February 18—First U. S. airplane parachute escape by C. C. Eversole, airmail pilot.

1921, February 22-23—Night airmail flown by Jack Knight from North Platte, Neb., to Chicago, Ill.

1921, February 24—Lt. W. D. Coney completes transcontinental flight, San Diego-Jacksonville, 2180 mi. in 22 hr. 27 min.; 57 hr. 24 min. elapsed time.

1921, March 23—Lt. A. G. Hamilton drops 23,700 ft. by parachute, Chanute Field.

1921, June 21—Navy F5L planes sink German sub U-117 in demonstration.

1921, July 18-21—Sinking of captured German cruiser, *Frankfurt,* and battleship, *Ostfriesland,* by U. S. bombs proves vulnerability of naval craft to aerial attack.

1921, August 10—Navy Bureau of Aeronautics formed with Rear Admiral W. A. Moffett as Chief.

1921, September 28—New world altitude record of 34,508 ft. set by Lt. J. A. Macready.

1921, November 5—Bert Acosta (Curtiss Navy-C12 Curtiss 400) wins Pulitzer race at 176.7 mph.

1921, November 12—Refueling in air: Earl S. Daugherty transfers *Wesley May* with can of gasoline from wing of another plane.

First continuous scheduled air mail between Washington and New York in Curtiss J. N. plane, 1918.

1921, November 15—Italian airship *Roma* makes initial ascent in U. S. at Langley Field.

1921, December 1—Helium airship, Navy dirigible C-7, flown from Hampton Roads, Va. to Washington, D. C.

1921, December 29—World endurance record of 26 hr. 18 min. 35 sec. made at Roosevelt Field by Edw. Stinson and Lloyd Bertaud (CJL6 BMW 185).

1922, January 1—Underwriters Laboratories starts registration of aircraft for benefit of insurance companies.

1922, January 1—Aeronautical Chamber of Commerce organized, New York, with I. M. Uppercu, president.

1922, February 21—Airship *Roma* destroyed.

1922, March 20—Airplane carrier U.S.S. *Langley*, commissioned at Norfolk, Va.

1922, June 16—Helicopter demonstrated by Henry Berliner, Washington, D.C.

1922, July 14—Aeromarine Airways starts Detroit-Cleveland flying boat service.

1922, August 5-7—Lt. Clayton Bissell completes first model airway flight, Washington-Dayton-Washington.

1922, August 16—Sperry airway light beacon demonstration, McCook Field.

1922, September 4-5—Transcontinental speed flight by Lt. James H. Doolittle, Pablo Beach, Fla.-San Francisco, Cal., in 22 hr. 35 min. elapsed time.

1922, September 14-23—Transcontinental Army airship flight with Maj. H. A. Straus commanding crew of Capt. G. W. McEntire and others, from Langley Field, Va. to Arcadia, Cal.

1922, October 5-6—World endurance record, 35 hr. 18 min. 30 sec., Rockwell Field, by Lts. J. A. Macready and O. G. Kelly (Fokker T2 Liberty 375.)

1922, October 14—Lt. R. L. Maughan wins Pulitzer race at 206 mph (Army Curtiss-D12-Curtiss 375.)

1922, October 18—World speed record of 222.97 mph set by Brig. Gen. William Mitchell in Curtiss racer.

1922, October 22—Harold R. Harris becomes first pilot to use parachute after plane failure in flight. Event occurred over Dayton, O.; plane was an experimental Loening Monitor Plane Fighter.

1922, October 23—American Propeller Co. demonstrates reversible propeller at Bolling Field.

1922, December 18—Army's De Bothezat helicopter makes first successful flight, 1 min. 42 sec., Dayton, Ohio.

1923, March 29—Lt. R. L. Maughan makes world speed record 236.58 mph (Curtiss R6-Curtiss 465), Dayton, Ohio.

1923, April 16-17—World duration—distance records by Lts. J. A. Macready and O. G. Kelly (Fokker T2 Liberty 375), 36 hr. 4 min. 34 sec. 2516.55 miles.

1923, May 2-3—Cross-country non-stop flight by Lts. J. A. Macready and Oakley G. Kelly in Fokker T-2, from New York to San Diego, 2,520 miles in 26 hr. 50 min. 3 sec.

The giant Barling Bomber in the air at the International Air Races, Dayton, Ohio, 1924.

1923, August 27-28—Lts. L. H. Smith and J. P. Richter (DH-4E Liberty 400) made world duration-distance refueled records: 3293.26 miles, 37 hr. 15 min. 14.8 sec.; Rockwell Field.

1923, September 5—Smoke screen demonstrated by Thomas Buck Hine during naval bombing maneuvers, Cape Hatteras, N. C.

1923, September 5—Langley Field bombers sink naval vessels *New Jersey* and *Virginia*.

1923, October 6—Lt. A. S. Williams, U.S.N. wins Pulitzer race (Curtiss R2C1-D12 Curtiss 460) at 243.68 mph.

1923, October 25-27—Barling bomber makes series weight-carrying records with greatest weight 3000 kg.; duration, altitude records, 1 hr. 19 min. 11.8 sec., 5,344 ft. Pilot, Harold R. Harris.

1923, November 4—Lt. A. J. Williams, U.S.N. (Curtiss R2C1-D12A Curtiss 500) makes world speed record 266.59 mph.

1923, December 18—For $100,000 the Christmas Aeroplane Co. assigns its aileron patent to U. S. Government.

1924, January 16—Navy airship *Shenandoah* tears loose from mast in storm and rides it out during the night.

1924, February 21—Alaskan airmail flown by Carl B. Eielson from Fairbanks to McGrath.

1924, February 22—Lt. J. A. Macready (Lepere-supercharged Liberty 400) reaches 41,000 ft. indicated altitude.

1924, April 6-September 28—Round-the-world flight by Lts. Smith, Nelson, Arnold, and Harding, Seattle to Seattle, 26,445 miles, 175 days (368 hours flying time.)

1924, June 2—Lt. James T. Neely and storm-riding meteorologist Dr. C. L. Meisinger, Weather Bureau, killed by lightning in balloon near Monticello, Ill.

1924, July 1—Through transcontinental airmail service begun by U.S. Post Office.

1924, October 4—Lt. H. H. Mills wins Pulitzer trophy (Verville Sperry-Curtiss HC D12A) at 216.55 mph.

1924, October 7-25—Navy airship *Shenandoah* makes record cross-country cruise over 7080 miles in 235 hr. 01 min. Air hours total of 422 hr. 23 min. includes time moored.

1924, October 12-15—U. S. Navy's German airship *ZR3 (Los Angeles)* makes fourth aircraft Atlantic crossing, Friedrichshafen-Lakehurst, in delivery under reparations.

1924, October 29—Fog dispersal by electrified silica and sand demonstrated at Bolling Field.

1925, January 29—Eclipse pictures and astronomic data secured at high altitudes by Air Service pilots.

1925, February 2—Kelly Bill signed by President Coolidge authorizing private contract air transport of mail.

1925, March 1—San Diego Airline service started by Ryan Airlines, Inc.—first daily scheduled service on all-season basis.

1925, April 7—Navy carrier *Saratoga* launched.

1925, May 21-July 6—Amundsen-Ellsworth polar flight.

1925, July 15—Dr. A Hamilton Rice Expedition, first to employ planes in exploration, returns from Amazon; Lt. Walter Hinton, pilot, in Curtiss Seagull.

1925, August 1—Survey flight of Pacific Air Transport flown by T. Claude Ryan and Vern Gorst in first Ryan M-1 mail plane.

1925, August 4-22—MacMillan polar expeditions with Navy assistance.

1925, August 5—Seven American pilots leave Paris to fly for the French in the Riff campaign in Africa. Others follow to a total of 17 pilots, 5 observers.

1925, August 31-September 8—In Navy's attempted San Francisco-Honolulu flight, Commander John Rodgers and crew (PN9-2 Packard 500 flying boat) alight short of mark, making non-stop cross-country seaplane record of 1,841 miles.

1925, September 3—Navy dirigible, *Shenandoah,* collapsed in storm over Ava, O., killing 14 of 43 on board.

1925, September 12—Morrow Board appointed by President Coolidge. (Laid down U. S. air policy.)

1925, October 12—Lt. Cyrus Bettis wins 6th Pulitzer race (Curtiss R3C1-V1400 Curtiss 619) at 248.97 mph.

1925, October 26—Lt. J. H. Doolittle wins 8th international Schneider Seaplane Trophy race in first contest in America (Curtiss R3C2-V1400 Curtiss 619) at 232.57 mph.

1925, December 17—Gen. William Mitchell found guilty of violating 96th Article of War; had risked insubordination by demanding unrestricted use of air power. Sentenced five years suspension of rank, pay and command. Resigned.

1926, January 18—A $2,500,000 air promotion fund established by Daniel Guggenheim.

1926, January 29—Lt. J. A. Macready (XCO5A-Liberty 400) makes American altitude record: 38,704 ft.

1926, February 11—Strip bombing tests made at Kelly Field.

1926, April 16—First cotton dusting plane purchased by Department of Agriculture.

1926, April 30—Capt. G. H. Wilkins and Lt. Carl B. Eielson complete third round trip Fairbanks-Pt. Barrow-Fairbanks.

1926, May 8-9—Flight over North Pole by Richard Byrd, navigator, and Floyd Bennett, pilot, in Fokker monoplane.

1926, May 20—Air Commerce Act (Bingham-Parker Bill) signed by President Coolidge; Aeronautics Branch, Department of Commerce, established.

1926, May 30—Bennett international balloon race, Brussels, brought to America by the win of W. T. Van Orman and W. W. Morton in Goodyear III balloon. Capt. H. C. Gray, Air Service, second.

1926, July 2—Army Air Service renamed Army Air Corps.

1926, July 2—First reforesting by airplane, Hawaii.

1926, July 14—Armstrong seadrome model demonstrated at Wilmington, Del. to Air Service.

1926, August 18—Metal-clad airship contract let at not over $300,000.

1926, August 25—JN training plane dropped by parachute, San Diego Naval Air Station.

1926, September 15—Pacific Air Transport begins operation of contract air mail service with Ryan M-1 monoplanes between Los Angeles and Seattle.

1926, December 7—Airway beacon erected by Aeronautics Branch, Department of Commerce, on Chicago-Dallas route.

1927, March 9—American balloon altitude record of 28,508 ft. made by Capt. H. C. Gray.

1927, April 12—New American duration record of Clarence D. Chamberlin and B. B. Acosta (Bellanca-15 Wright 200) 51 hr. 11 min. 25 sec.

1927, May 4—Record balloon altitude attempt by Capt. H. C. Gray, 42,470 ft.

1927, May 15-19—Greatest concentration since World War I (109 planes) in maneuvers under Brig. Gen. J. E. Fechet.

*1927, **May 20-21**—Non-stop trans-Atlantic solo flight by Charles A. Lindbergh, New York-Paris, 3,610 miles, 33 hr. 30 min. (13th aircraft to make completed crossing.)

1927, May 25—Outside loop demonstrated by Lt. James H. Doolittle.

1927, June 4—First nonstop flight to Germany, Clarence D. Chamberlin and passenger (Bellanca-15 Wright 200), 3,911 miles, 43 hr. 49 min. 33 sec.

1927, July 25—World airplane altitude record by Lt. C. C. Champion, U.S.N. (Wright-P & W 425 supercharged) 38,484 ft.

1927, August 16-17—A. C. Goebel and Lt. W. V. Davis, U.S.N. (Travelair-15 Wright 200) win Dole Oakland-Honolulu race. One team finishes. Two teams lost.

1927, September 1—Air express operations begun by American Railway Express and major airlines.

1927, September 10—Bennett international balloon race, Dearborn, Mich., won by E. J. Hillard and A. G. Schlosser with 745 miles; 15 contestants.

1927, October 12—Wright Field dedicated.

1928, February 3-December 28—Lt. H. A. Sutton conducts a series of spin tests; awarded Mackay Trophy.

1928, March 1-9—Transcontinental amphibian flight by Army Lt. Burnie R. Dallas and civilian Beckwith Havens in Loening.

1928, March 28-30—Edw. A Stinson and George Holderman (Stinson-Wright 200) make endurance record of 53 hr. 36 min. 30 sec.

1928, April 12-13—First non-stop westbound North Atlantic airplane crossing made by Baron G. von Huenefeld, Capt. Hermann Koehl and Maj. James Fitzmaurice (Junker-Junker 280/310 metal cabin land monoplane) from Baldonnel, Ireland to Greenly Island, N.F., 2,070 miles in 37 hours.

1928, April 15-21—First eastbound Arctic crossing made by Capt. G. H. Wilkins and Lt. C. B. Eielson (Lockheed-Wright 225) Pt. Barrow-Green Harbor, Spitzbergen, 2,200 miles, 20 hr. 20 min.

1928, May 24—Gen. Umberto Nobile's airship is over the Pole in trip from Spitzbergen. It is wrecked May 25, with loss of lives of crew and rescuers.

1928, May 31-June 8—First U.S.-Australian flight, by Capt. C. Kingsford-Smith, Capt. C. T. P. Ulm, H. W. Lyon and James Warner (P7 Fokker-3 Wright 200) Oakland-Brisbane, 7,410 miles; 83 hr. 19 min.

1928, June 11-12—Mexico-Washington flight by Capt. Emilio Carranza (Bryan-Wright 200.)

1928, June 17-18—First woman to fly Atlantic, Amelia Earhart with Wilmer Stultz, pilot, from Trepassey Bay, N. F., to Burryport, England, in trimotored Fokker, 2,140 miles, 20 hr. 40 min.

1928, July 30-31—Twenty-second Bennett international balloon race, Detroit, won by Capt. W. E. Kepner and Lt. W. O. Fareckson; 460 miles, 43 hr.

1928, September 19—First Diesel engine to power heavier-than-air craft; designed by I. M. Woolson, manufactured by Packard Motor Car Co.; flight-tested at Utica, Mich.

1928, October 19—Parachute troop demonstration at Brooks Field.

1928, November 11—First Antarctic flight made by Lt. C. B. Eielson and Sir Hubert Wilkins (Lockheed-Wright 22). Other flights subsequently.

1928, November 23-December 30—New York-Girardot, Columbia, flight by Capt. Benjamin Mendez, 4,600 miles.

1928, December 19—Autogiro flight by Harold F. Pitcairn, Pitcairn Field, Willow Grove, Pa.

1929, January 1-7—Refueling endurance record set by Maj. Carl Spaatz and Capt. Ira C. Eaker, Lt. Elwood R. Quesada, Lt. Harry A. Halverson, S/Sgt. Roy W. Hooe in 150 hr., 40 min., 51 sec.

1929, April 3—Floyd Smith trap-door parachute demonstrated.

1929, April 30—Jack Barstow makes duration glider record of 15 hr. 13 min. at Point Loma, Calif.

1929, June 28-29—Round transcontinental flight by Capt. Frank M. Hawks (Lockheed-P & W) in 40 hr. 4 min. 32 sec. Capt. E. G. Harper repeats the performance July 11-26.

1929, July 13-30—World endurance record of 420 hr. 17 min. by Forrest O'Brien and Dale Jackson (Curtiss Robin-Curtiss 70.)

1929, July 18-20—N. Y.-Alaska flight by Capt. Russ G. Hoyt. Return flight ends at Edmonton, after covering 6,000 miles out of 8,469 itinerary.

1929, August 5-6—Group transcontinental flight of 9 Keystone bombers under Major Hugh J. Knerr.

1929, September 24—Demonstration by Lt. James H. Doolittle results in Guggenheim report blind flying solution.

1929, October 21—Air Ambulance Service organized by Colonial Flying Service and Scully Walton Ambulance Co., New York.

1929—Bennett international balloon race won by W. T. Van Orman and aide, 341 miles, 9 contestants.

1930, March 15—Glider, piloted by Capt. Frank Hawks, released from seaplane, Port Washington, N.Y.

1930, April 6—Transcontinental glider in tow, piloted by Capt. Frank Hawks; San Diego to New York; 2,860 miles in 36 hr., 47 min.

1930, May 20—Dirigible-launched Vought observation plane, flown by Lt. Comdr. Charles A. Nicholson from U.S.S. *Los Angeles* to U.S.S. *Saratoga,* Lakehurst, N. J.

1930, June 4—New world altitude record of 38,560 ft. set by Navy Lt. Apollo Soucek, Anacostia, D.C.

1930, June 11-July 4—World endurance record of 553 hr. 41 min. 30 sec. established by John and Kenneth Hunter (Stinson-Wright 200).

1930, July 21-August 17—Refueling endurance record raised to 647 hr., 28 min. by Forrest O'Brien and Dale Jackson in a Curtiss Robin, St. Louis, Mo.

1930, July 22—German air mail plane catapulted 250 miles out en route to New York; 198 such ship-shore flights 1929-1938.

1930, September 1—Bennett international balloon race again won for U. S. by W. T. Van Orman and aide, 542 miles.

1931, February 14-19—Lts. W. W. Lite, Clement McMullen fly New York-Buenos Aires, 6,870 miles, 5 days, 5 hours elapsed time; 52:15:00 flying.

1931, March 30—Airplane-airship mail transfer at Scott Field.

1931, April 10—Airship sub-cloud observation car demonstration by Lt. W. J. Paul.

1931, May 25-28—World endurance record, nonrefueled, set by Walter E. Lees and F. A. Brossi, Bellanca, Packard Diesel 225 hp.; 84 hr., 33 min., 1¼ sec., Jacksonville, Fla.

1931, May 14-28—Transcontinental autogiro flight by John M. Miller, from Philadelphia to San Diego.

1931, June 4—Rocket glider flown by William G. Swan; remained aloft for 30 min. with 10 rockets, Atlantic City, N.J.

1931, June 23-July 1—World flight by Wiley Post and Harold Gatty (Lockheed-PW 550), New York-Harbor Grace-Berlin-Moscow-Irkutsk - Khabarovsk - Solomon Beach-Fairbanks-Edmonton-Cleveland-New York, 8 days 16 hours, 16,500 miles.

1931, July 25-26—Glider duration record of 16 hr. 38 min. by 2nd Lt. John C. Crain, Honolulu.

1931, July 28-August 6—Herndon and Pangborn (Bellanca-PW 420) left New York July 28 on world trip and had reached Japan Aug. 6, abandoning attempt to better Post-Gatty record.

1931, October 3-5—Trans-Pacific non-stop airplane flight by Clyde Pangborn and Hugh Herndon, Samushiro Beach, Japan, to Wenatchee, Wash.

1931, October 6-9—Navy bomber tests on U.S.S. *Pittsburgh* in Chesapeake Bay.

1931, November 3—Dirigible, *Akron,* carried record number of 207 persons in flight over New York and Philadelphia.

1931, December 17-18—Glider duration record of 21 hr. 34 min. by Lt. Wm. A. Cocke, Honolulu.

1932, May 9—First solo blind flight, by Capt. Albert F. Hegenberger, Wright Field, Dayton, O.

1932, May 20-21—Amelia Earhart solos across Atlantic, St. Johns, New Brunswick to Londonderry, Ireland, in Wasp-powered Lockheed Vega.

1932, August 25—First woman to complete non-stop transcontinental flight, Amelia Earhart, Los Angeles to Newark.

1932, December 1—Teletypewriter weather map service inaugurated by Department of Commerce.

1933, January 19—Rocket guided by sound waves from enemy aircraft proposed.

1933, January 23—Steam airplane project launched by Great Lakes Aircraft and General Electric Co. Later Besley brothers fly their steam airplane.

1933, April 4—Navy dirigible, *Akron,* crashes into sea, killing 73; Comdr. Herbert V. Wiley, commanding.

1933, May 3-26—Airborne troop logistics part of West Coast maneuvers, with 283 aircraft.

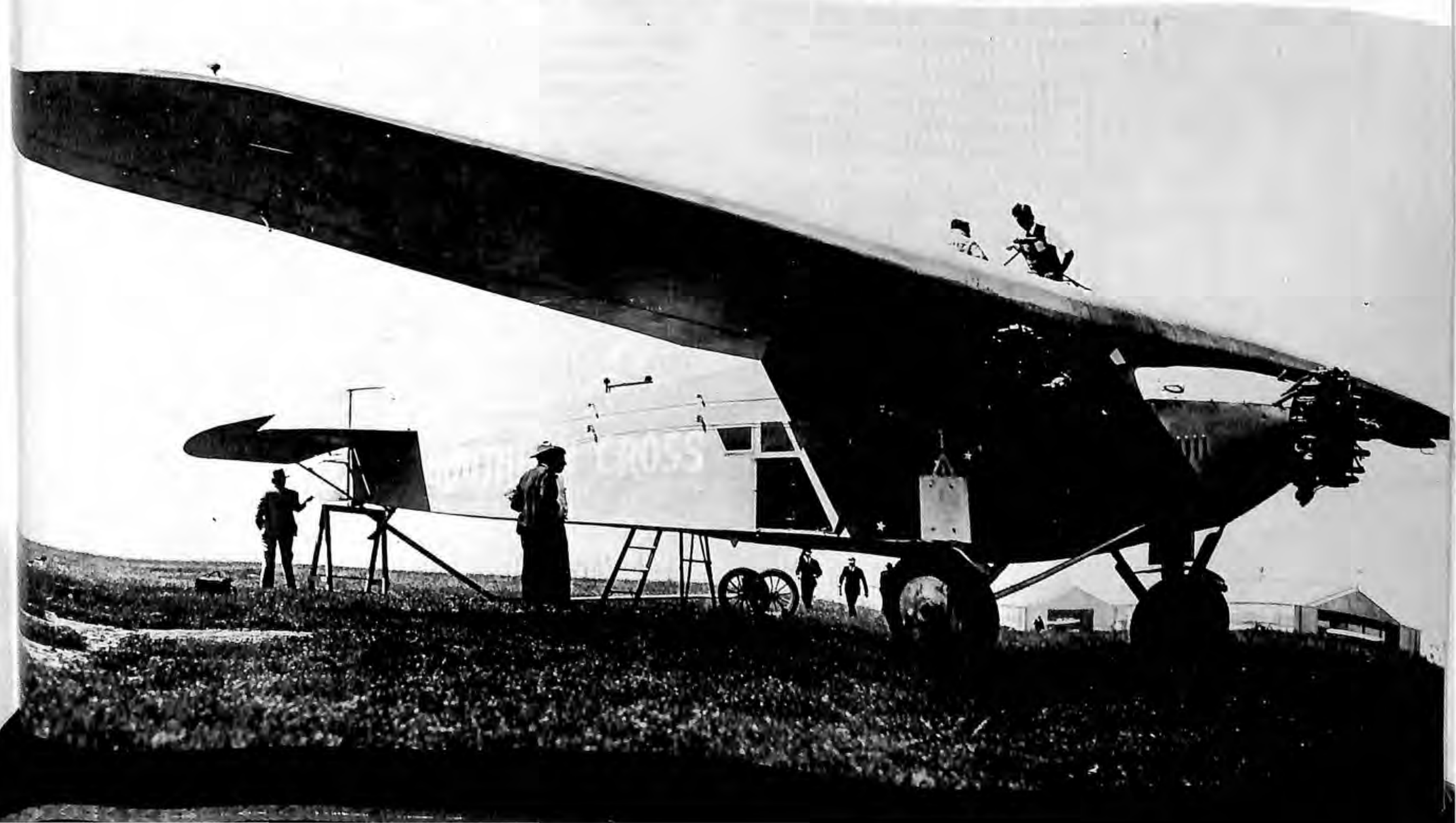
1933, July 15-22—Solo round-the-world flight by Wiley Post in Lockheed Vega monoplane, *Winnie Mae,* in 7 days, 18 hr., 49 min.

1933, September 4—World speed record for land planes set at 304.98 mph by James R. Wedell in Wasp-powered Wedell-Williams racer.

1933, November 20-21—World balloon altitude record set at 61,237 ft. by Lt. Comdr. T. G. W. Settle and Maj. C. L. Fordney over Akron, O.

1934, January 10-11—Longest non-stop over-water mass flight completed by six P2Y-1 Navy flying

Fokker Trimotor "Southern Cross" being conditioned for its flight across the Pacific, 1928.



boats under command of Lt. Comdr. Knefler McGinnis, San Francisco to Honolulu.

1934, February 9—Postmaster General Farley cancels certain mail contracts. Air Corps flies the mail Feb. 19-Mr. 10; Mar. 19-May 5.

1934, June 12—Howell commission to study airmail act and report on all phases of aviation by Feb. 1, 1935.

1934, December 31—War Department announces instruction governing GHQ Air Force organization and operation.

1935, January 3—Antarctic flight by Ellsworth and Kenyon (Northrop-PW 600).

1935, February 12—Navy dirigible, *Macon*, crashes into sea, killing 2.

1935, June 12-August 14—Washington-Alaska-Washington flight (Douglas Amphibian-2 Wasps) in test of practicability of such flight with standard equipment and as any ordinary flight. Capt. Hez McClellan and crew of two.

1935, August 15—Will Rogers and Wiley Post killed in take-off crash near Point Barrow, Alaska.

1935, November 11—Balloon altitude record of 72,394 ft. by Capt. O. A. Anderson and Capt. Albert Stevens.

1935, November 21-December 5—Antarctic flights renewed by Ellsworth and Kenyon (Northrop-PW 600).

1935, November 22-29—Trans-Pacific airmail flight by Capt. Edwin C. Musick, Pan American Airways, from San Francisco to Honolulu, Midway Island, Wake Island, Guam and Manila, in Martin *China Clipper*.

1936, June 7—All-instrument transcontinental flight by Maj. Ira C. Eaker, between New York and Los Angeles.

1936, September 10-October 20—Regular trans-Atlantic flying boat service by Deutsche Lufthansa. (Dornier twin Diesel engine 600.) Continued in 1937 and 1938.

1936, September—Trans-Atlantic round-trip flight by Henry (Dick) Merrill and Harry Richman. New York to London and return.

1937, May 6—German dirigible, *Hindenburg*, burned on mooring, killing 36, Lakehurst, N. J.

1937, May 20-July 3—Amelia Earhart Putnam and Fred Noonan lost in Pacific in round-the-world attempt.

1937, June 25—Non-stop transcontinental amphibian flight by Richard Archbold in PBY-1, Catalina, from San Diego to New York.

1937, July 3-September 3—Regular trans-Atlantic service test by Pan American Airways. Imperial Airways also similarly operate July 5-Aug. 2 and continue in 1938.

1937, August 12—In joint coast defense exercise, Navy patrol planes locate target ship *Utah* 300 miles off San Francisco; Air Corps planes attack.

1937, August 23—Wholly automatic landings made, "first in history," at Wright Field by Capt. Carl J. Crane with 2 passengers; awarded DFC.

1938, February 26—Government acquires monopoly on helium by purchasing production facilities at Dexter, Kan.

1938, April 22—Capt. E. V. Rickenbacker purchases Eastern Air Lines from North American Aviation, Inc., for $3,500,000.

1938, June 23—Civil Aeronautics Authority with five members, an administrator, and a three-man Safety Board, created under Civil Aeronautics Act signed by President. This supersedes Aeronautics Branch, Department of Commerce.

1938, July 10-14—Howard Hughes and crew of four fly short northern course around world in 3 days, 19 hr., 8 min.

1938, July 17-18—Douglas (Wrong-Way) Corrigan flies from New York to Ireland in nine-year-old Curtiss Robin.

1938, August 10-11—First Berlin-New York non-stop flight by Capt. Alfred Henke and crew (Focke-Wulf Condor 200), 4,577 miles, 24 hr. 54 min.

1938, August 22—Civil Aeronautics Act becomes effective.

1939, February 4-6—Langley Field-Santiago Red Cross flight by Major C. V. Haynes in XB bomber with medicinal supplies.

1939, March 5—Non-stop airmail system by pick-up demonstrated by Norman Rintoul and Victor Yesulantes in Stinson Reliant planes, Coatesville, Pa.

1939, April 3—The National Defense Act, providing for aerial rearmament, signed by President Roosevelt.

1939, April 17—Inclined runways for assisted take-off studied by Air Corps Board.

1939, June 27—Bill authorizing Civilian Pilot Training Program signed by President.

1939, July 6—Army Air Corps adopts monoplane type for primary training for first time by ordering quantity of Ryan PT-16 military trainers.

1939, September 1-3—Germany invades Poland, England and France declare war on Germany.

1940, March 26—U. S. commercial airlines complete a full year of flying without a fatal accident or serious injury to a passenger or crew member.

1940, July 1—Air Safety Board abolished with its functions delegated to the Civil Aeronautics Board. Civil Aeronautics Administration transferred to Department of Commerce.

1940, September 23—House committee asks $80 million for airport development, in $500 million program; $40 million voted.

1941, March 17—Milwaukee renames its airport as General Mitchell Field.

1941, April 15—First officially-recorded rotor helicopter flight in western hemisphere, Vought-Sikorsky VS-300A, piloted by Igor I. Sikorsky; flight time, 1 hr., 5 min., 14.5 sec., Stratford, Conn.

1941, May—Barrage balloon defense transferred from Air Corps to Coast Artillery.

1941, June 5—Ferry Command, for delivery of planes to Britain, organized by Army Air Corps.

1941, June 20—Army Air Force, comprising office of Chief of Air Corps and Air Force Combat Command, created.

1941, June —First woman to ferry bomber across Atlantic, Jacqueline Cochran, Canada to British Isles.

1941, September 5—Mass trans-Pacific flight of heavy bombers completed by nine Army B-17 Flying Fortresses.

1941, December 7—Pearl Harbor.

1942, April 8—First flight of Ferry Command over Himalayan "Hump" made by Lt. Col. William D. Old, between Assam, India and Kunming, China.

1942, April 18—First bombing attack on Japanese mainland by 16 B-25 Mitchell bombers from Navy carrier, *Hornet;* Lt. Col. James H. Doolittle commanding.

1942, May 4-9—Battle of Coral Sea.

1942, June 20—Ferry Command redesignated Air Transport Command under Maj. Gen. Harold L. George.

1942, June 3-7—Battle of Midway.

1942, June 17—AAF tow planes successfully pick up gliders in tests at Wright Field.

1942, August 17—First official bombing raid of Eighth Air Force, 12 Flying Fortresses, Brig. Gen. Ira C. Eaker commanding, Rouen, France.

1942, September—Fifty Americans Eagle squadron pilots, RAF, all Americans, transferred to Eighth Air Force. (Fourth Fighter Group.)

1942, October 1—First U. S. jet plane built and flown by Robert M. Stanley; Bell Airacomet (XP-59A), Muroc Dry Lake, Cal.

1942, October—First non-stop cross-country flight of a fighter airplane. Jack Woolams flies Bell P-39 from March Field, Calif., to Bolling Field, Wash.

1943, March 1-4—Battle of Bismarck Sea.

1943, March 19—Lt. Gen. Henry H. Arnold, commanding general of the AAF, advanced to full four-star general, the first in air history.

1943, June 24—World's longest parachute drop, 40,200 ft., made by Lt. Col. W. R. Lovelace at Ephrata, Wash.

1943, June 11—First ground victory by air power when Pantelleria, Italy, surrenders unconditionally to Lt. Gen. Carl Spaatz. First case in history of a well-fortified citadel being defeated without aid of ground forces.

1943, October—World's longest freight line opened by Capt. J. L. Okenfus and crew of five in 28,000-mile round-trip flight, Ohio to India.

1944, June—Army Air Force reaches peak with 78,757 aircraft.

1944, June 7—Delivery of Ryan FR-1 Fireball fighters to U. S. Navy marks first Navy jet airplanes and world's first composite aircraft using jet and piston engines.

1945, May 8—War in Europe ends.

1945, August 6—Atomic bomb dropped on Hiroshima from B-29; *Enola Gay,* under command of Col. Paul W. Tibbets, Jr.

1945, August 14—Japan's surrender ends World War II.

1945, October 3—Ensign Jake C. West of Navy VF-66 Squadron makes first jet landing aboard an aircraft carrier.

1945, September 28-October 4—Round-the-world air service begun by Air Transport Command, Douglas C-54E, Globester, 9 passengers, 23,147 miles in 149 hr., 49 min.

1946, January 26—Jet-propelled P-80, flown by Col. William H. Council, sets non-stop transcontinental record of 4 hr., 13 min., 26 sec., between Long Beach, Cal., and New York.

1946, March 12—First commercial helicopter license granted by Civil Aeronautics Administration for Bell 2-place Model 47.

1946, March 22—First American-built rocket to escape earth's atmosphere, reaches 50-mile height. Constructed by Douglas.

1946, July 21—The McDonnell XFH-1 Phantom is first U.S. jet to operate from carrier, U.S.S. *Franklin D. Roosevelt.*

1946, August 6—Two B-17 radio-controlled bombers with stand-by crews, fly non-stop, Hilo, Hawaii, to Muroc, Lake, Cal.

North American P-51-D "Mustang", one of the outstanding Allied fighters of World War II.

1946, October 1—The "Truculent Turtle," a Lockheed P2V Neptune Navy patrol bomber, sets new world record for a long-distance nonstop flight, flying from Perth, Australia, to Columbus, O., an unofficial distance of 11,822 miles, in slightly over 55 hr.

1946, October 5—Col. C. S. Irvine flies Boeing B-29 "Pacusan Dreamboat" from Honolulu to Cairo, 9,500 miles, in 39 hr. 36 min.

1947, February 28—Lt. Col. Robt. E. Thacker and Lt. John M. Ard, in a North American F-82 (Rolls Royce V-1650) fly longest known flight by fighter aircraft, Honolulu to N.Y., 4,968 miles in 14 hr. 31 min. 50 sec.

1947, July 18—Air Policy Commission established by President.

1947, July 26—Army-Navy Merger Bill signed by President, making Department of the Air Force co-equal with Army and Navy, and creating Department of Defense.

1947, October 14—First faster-than-sound flight by Capt. Charles E. Yeager in rocket-powered Air Force research plane, Bell XS-1, betters 760 mph. (Not announced officially until June 10, 1948.)

1948, June 18—Air parcel post system established by Congress; to begin Sept. 1.

1948, June 26—Berlin Airlift begins "Operation Vittles" with Douglas C-47's carrying 80 tons of supplies the first day. During first five months, Airlift tops cargo volume of all U.S. airlines by flying 93,000,000 ton-miles.

1948, September 15—USAF recaptures world speed record with North American F-86 jet fighter at 670.981 mph, flown by Maj. Richard L. Johnson.

1948—Northrop's YB-49 Flying Wing, first eight-jet bomber in the U. S. Air Force, makes longest jet-propelled flight on record of approximately 3,400 miles at average speed of 382 mph.

1949, January 7—Air Force announces a new unofficial climbing speed record set by the Bell X-1 at Muroc Air Force Base with Capt. E. Yeager at the controls, climbing more than 13,000 ft. per min., compared with 8-10,000 ft. per min. for jet planes.

1949, January 14—Capt. William Odom, flying a specially modified Beechcraft Bonanza, sets a new light-plane distance record, crossing from Honolulu to Oakland, Calif.

1949, February 7—Eastern Air Lines reports new trans-continental speed record for transport aircraft set February 5 by new-type Lockheed Constellation on delivery flight from Los Angeles to La Guardia Field in 6 hr. 17 min. 39-2/5 sec.

1949, February 8—Boeing XB-47 jet bomber sets cross-country speed record to Andrews Field, Washington, D.C. from Moses Lake, Wash. in 3 hr. 46 min.

1949, March 2—Air Force completes the first nonstop round-the-world flight in history, as a Boeing B-50 bomber, *Lucky Lady II*, lands at Carswell AFB, Ft. Worth, Tex. at 9:30 CST, after a 94-hour trip; piloted by Capt. James Gallagher, assisted by a crew of 13, the B-50 flew a total of 23,452 miles at an average speed of 249 mph. Four refueling contacts were made with Flight Refueling, Ltd.'s Probe and Drogue System from B-29 tankers.

1949, March 8—New world distance record for light planes set by Capt. William Odom in a Beechcraft *Bonanza*, flying 5,273 miles from Honolulu to Teterboro, N.J., in 36 hr. 2 min.

1949, May 3—The Martin *Viking*, 45-ft. research rocket, is fired successfully at White Sands Proving Ground, Las Cruces, N.M., reaching an altitude of 51½ miles and a speed of 2,250 mph.

1949, May 6—Sikorsky S-52-1 helicopter sets new international speed record of 122.75 mph.

1949, October 3—Navy jet-rocket special research plane, the Douglas D-558-II Skyrocket, reaches a top speed of slightly over 700 mph at an altitude of 25,000 ft. in test flight at Muroc, Calif.

1950, January 3—Jacqueline Cochran sets new official F.A.I. 500 kilometer closed course record flying a North American F-51 (Packard-built Merlin V1650) at 444 mph.

1950, January 22—Paul Mantz sets new transcontinental record flying a North American F-51 Mustang (Allison) from Burbank, Calif., to La Guardia Field, N.Y. in 4 hr. 52 min. 58 sec.

1950, February 9—Navy Lockheed P2V Neptune (Wright 3350) patrol bomber completes 5,156 mile flight in 25 hr. 57 min.

1950, March 31—Ana Louisa Branger, flying a Piper Cub Special powered by a Continental C-90-8F engine, sets official new lightplane international altitude record of 24,504 feet.

1950, September 5—North American Aviation announces successful completion of tests at Edwards AFB in which heavy bombs were dropped for first time at speeds over 500 mph with a B-45 Tornado (GE-J47).

1950, September 22—Col. David C. Schilling and Lt. Col. William D. Ritchie fly London-New York nonstop with three in-flight refuelings in two Republic F-84E (Allison J-35A-17) jet fighters. (Schilling completed flight; Ritchie bailed out over Newfoundland and was later rescued by helicopter.)

1950, November 10—A Lockheed F-80 shoots down a Russian-built MiG-15 in first jet aerial combat, Korea.

1951, January 17—Convair RB-36D reconnaissance bomber makes 51 hr. 20 min. non-stop flight without refueling.

1951, February 2—First successful air-to-air refueling of a U.S. jet bomber is carried out by a North American RB-45C Tornado and a Boeing KB-29P tanker at Edwards AFB, Calif.

1951, April 24—Piper Super Cub, piloted by Mrs. Ana Louisa Branger, sets an international altitude record of 26,820 feet in the minus 1,103-pound category.

1951, May 15—Max Conrad sets non-stop lightplane record in Piper Pacer (125 hp Lycoming), crossing the country in 23 hr. 4 min. 31 sec.

1951, Aug. 8—Navy's Martin Viking VII sets new altitude record for single stage missiles, flying 135 miles up from White Sands Proving Ground, N.M., reaching a top speed of 4,100 mph.

1951, August 18—North American F-86A Sabrejet, piloted by Col. Keith K. Compton, flies from Edwards AFB, Calif., to Detroit, Mich., in 3 hr. 27 min. 56 sec. at an average speed of 553.761 mph.

1952, January 2—A Sikorsky H-19 helicopter completes 1,800-mile flight from Great Falls, Mont., to Ladd AFB, Fairbanks, Alaska, in five days—probably the longest flight ever made by rotary wing craft.

1952, March 18—Two Republic F-84 Thunderjets land in Neubiberg, Germany, after a 2,800-mile flight without refueling—believed to be the longest sustained jet fighter flight in history. The jets crossed seven countries, averaged 585 mph, and were in the air 4 hr. 48 min.

1952, April 30—For the first time in aviation history, air passenger-miles (10,679,281,000) in 1951 exceeded the total passenger-miles traveled in Pullman cars (10,224,714,000).

1952, May 10—Transcontinental lightplane record is set by Max Conrad in a Piper Pacer, traveling from Los Angeles to New York (2,461 mi.) non-stop in 24 hr. 54 min.

1952, August 1—Two Sikorsky H-19 helicopters complete first trans-Atlantic helicopter crossing and break non-stop distance record for rotary wing aircraft.

1952, September 17—Official world's long-distance, non-stop helicopter record established by Elton Smith in Bell Model 47D-1 flying from Fort Worth, Texas, to Wheatfield, N.Y. (Niagara Falls, N.Y., airport), a distance of 1,217.14 miles in 12 hours 57 minutes.

1952, November 19—New record set by North American F-86D (GE J-47 GE-17) Sabrejet, piloted by Capt. J. Slade Nash, flying at 699.92 mph. (Previous world speed record—670.981 mph.)

1953, January 26—Chance Vought Aircraft completes final F4U Corsair, bringing to an end the longest production record of any airplane ever built.

1953, May 18—Jacqueline Cochran Odlum flies at record speed of 652.337 mph over a 100 km. course, in a Canadair F-86 swept-wing Sabre.

1953, October 3—LCdr. James B. Verdin establishes new world speed record of 753.4 mph in Douglas XF4D-1 Skyray, Navy carrier fighter.

1953, October 20—TWA Lockheed Super Constellation completes first scheduled nonstop transcontinental passenger trip from Los Angeles to New York in 8 hr. 17 min.

1953, October 29—North American YF-100 Super Sabre establishes new world's speed record of 754.98 mph, piloted by Lt. Col. F. K. Everest.

1953, December 12—Maj. Charles E. Yeager, USAF pilot, establishes new world speed record of more than 1650 mph in the Bell X-1A.

1954, January 5—Air National Guard Col. Willard W. Millikan sets New York-Washington speed mark of 24 minutes in North American F-86F.

1954, March 1—Peak is reached in number of U. S. airports: 6,760.

1954, March 29—American Airlines DC-7 sets official Los Angeles-New York commercial speed record: 6 hrs. 10 min.

1954, May 24—Martin Viking II, single stage rocket, sets altitude record soaring 158 miles high (834,240 feet) at 4300 mph at White Sands Proving Ground, New Mexico.

1954, May 25—Goodyear ZPG-2 non-rigid airship set new record for flight without refueling, landing at Key West, Fla., after 200 hrs. 4 min. in the air.

1954, August 21—New altitude record of 90,000 feet set in rocket-powered Bell X-1A by Major Arthur Murray, USAF, at Edwards Air Force Base, Calif.

1954, August 27—Adm. DeWitt C. Ramsey, president of Aircraft Industries Association, reports that U.S. aircraft manufacturers are now building 900 to 1,000 military planes per month.

1955, February 16—Longest non-stop flight by a jet fighter-bomber—2,390 miles—made by Republic F-84-F from George AFB in California to Langley AFB, Virginia. Speed averaged 605 mph.

1955, March 9—Republic's F-84F Thunderstreak sets a new official transcontinental speed record, flying 2,445 miles non-stop from Los Angeles to New York in 3 hrs. 44 mins.

1955, May 24—A North American F-86 sets two transcontinental records: (1) as first aircraft to cross the U.S. round trip in daylight and (2) by flying east-west leg in 5 hrs., 27 mins., 37 secs., breaking previous record.

1955, August 1—White House announces that U. S. plans to launch a small unmanned satellite about the size of a basketball sometime after July, 1957. Satellite will circle earth at altitudes between 200 and 300 miles.

1955, August 17—Republic's Thunderstreak sets a new world's non-stop jet fighter distance record of 5,118 mi. from London, England to Texas.

1955, August 20—North American F-100C sets the first supersonic world speed record of 822.135 mph, 70 miles faster than the previous record set in 1953.

1955, October 15—Douglas A4D Skyhawk sets a new closed course world speed record of 695.163 mph.

1956, April 2—Air Force reportedly fires an air-breathing guided missile (Northrop SM-62 Snark) a distance between 1,500 and 5,000 miles from Patrick Air Force Base, Fla.

1956, July 23—Rocket-powered Bell X-2 sets new speed record of 1,900 miles an hour, flown by Lt. Col. Frank K. Everest, USAF.

1956, August 10—McDonnell XV-1 convertiplane sets unofficial speed record for helicopters of 200 mph.

1956, August 11—Vertol H-21C helicopter sets new world record for distance in a closed circuit without payload by flying 1,199.07 mi. non-stop in 11 hrs. 58 min.

1956, August 24—An Army Vertol H-21 helicopter completes first nonstop transcontinental flight over a 2,610-mile route from San Diego, Calif., to Washington, D.C., with aerial refuelings from Flight Refueling, Inc. system.

1956, September 5—Chance Vought F8U-1 captures Thompson Trophy for Navy by flying 1015.428 mph to establish new national speed record.

1956, September 7—Capt. Iven C. Kincheloe, USAF, sets new altitude record of 126,200 feet in Bell X-2.

1956, September 21—Capt. Milburn Apt sets speed record of 2180 miles per hour in Bell X-2. Plane was in subsequent crash on this flight.

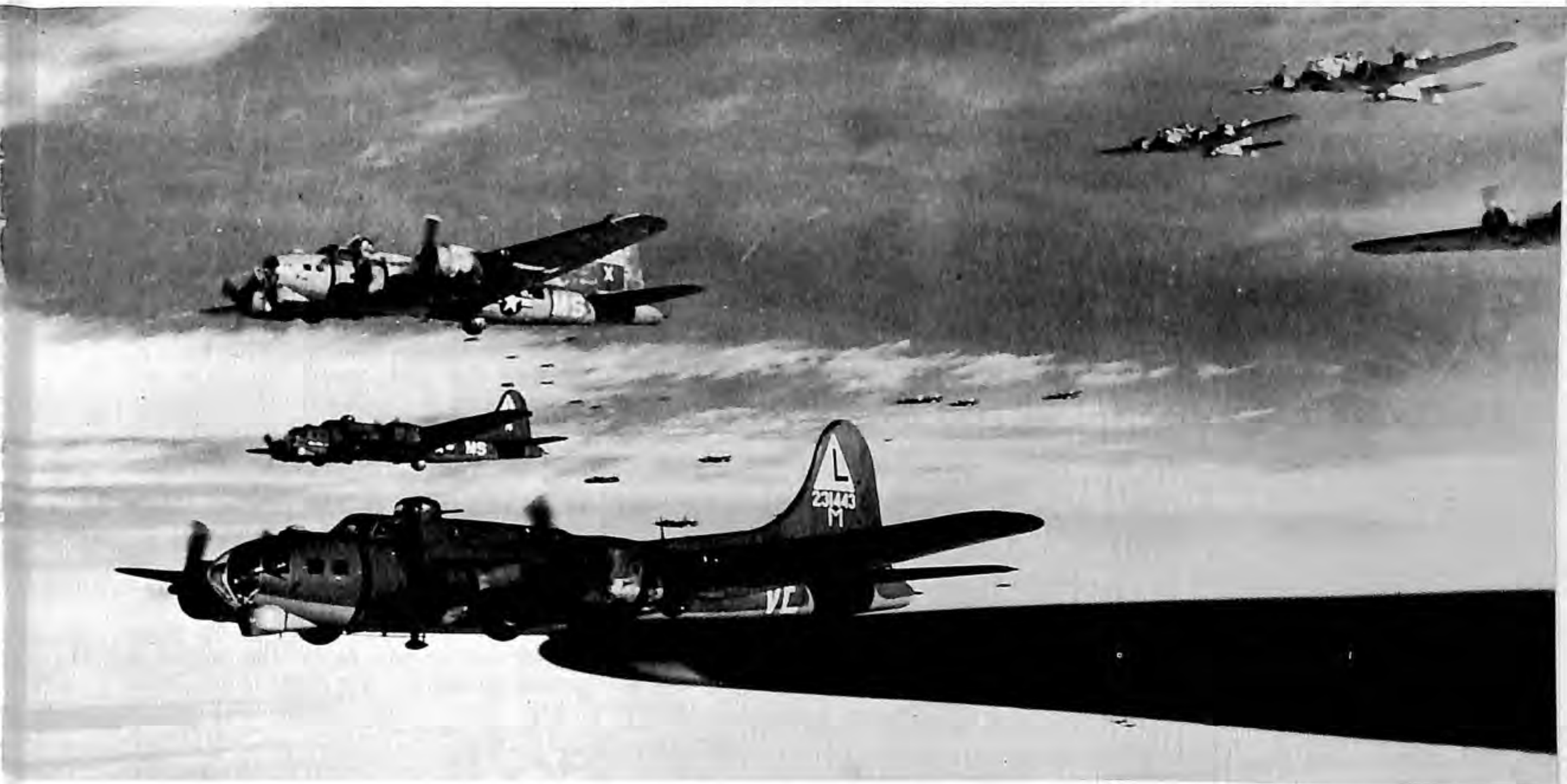
1956, October 11—NACA discloses that four-stage research rockets, fired in connection with development of the ICBM and the North American X-15, have hit speeds of 6864 mph or Mach 10.4.

1956, October 16—Bell 47J, flown by Joseph Mashman, makes first helicopter flight across Andes between Santiago, Chile and Mendoza, Argentina.

1956, November 13—North American F-107 reaches Mach 2 speed in flights at Edwards Air Force Base, Calif.

1956, November 27—Eight B-52's break the jet bomber's record by staying aloft an estimated 32½ hours, covering 17,000 miles.

1957, January 18—Three of five B-52 jet bombers land in Calif., culminating the first nonstop jet flight around the world. The 24,325-mile



Boeing B-17 "Flying Fortresses", 381st Bomb Group, Europe.

flight is accomplished in 45 hr. 20 min., slashing by one-half the previous record.

1957, January 28—Lockheed YC-121F Constellation sets new west-to-east record of 4 hr. 41 min.

1957, February 19—First hovering flight of Bell X-14 jet-powered VTOL at Niagara Falls, N.Y., airport.

1957, March 12—Boeing 707 Stratoliner, America's first jet airliner, spans continent in record-breaking flight of 3 hr. 48 min.

1957, March 15—Goodyear Aircraft Co. Navy ZPG-2 blimp sets new world records for continuous flight, 264.2 hr., 9,448 miles.

1957, March 24—Navy Douglas A3D twin jet attack bomber cracks two speed records, flying round-trip, Los Angeles-New York in 9 hr. 35 min. 48 sec. for one mark, and east-west in 5 hr. 14 min. 58 sec.

1957, June 6—Chance Vought F8U-1 Crusaders make first nonstop ocean-to-ocean flight. Pacific to the Atlantic, refueled by Flight Refueling, Inc. system.

1957, July 12—President Eisenhower, in a Bell 47J, becomes first U.S. president to fly in helicopter while in office.

1957, July 16—Chance Vought F8U-1 Crusader, piloted by Maj. John Glenn, Jr., USMC, sets new coast-to-coast record, flying from Calif. to N. Y. in 3 hr. 23 min.

1957, August 12—F3D makes first fully-automatic landing aboard an aircraft carrier, U.S.S. *Antietam,* using Bell Aircraft all-weather automatic landing system.

1957, August 20—A manned balloon sets new altitude record of 101,516 ft. during Air Force project to determine human reactions in space flight; Maj. David Simons, sealed in a pressurized capsule, stays aloft for 32 hrs.

1957, October 10—Following Russia's launching of first earth satellite (Sputnik) on Oct. 4, President Eisenhower announces that the U.S. will attempt to launch a four-pound "test" satellite in December.

1957, October 22—Air Force reports sending rocket at least 1,000 miles and perhaps 4,000 miles above the earth at Eniwetok Atoll in Operation Far Side.

1957, November 13—Boeing KC-135, piloted by Gen. Curtis LeMay, sets new distance nonstop record, flying 6,350 miles from Westover AFB, Mass., to Buenos Aires; the KC-135's return trip sets new speed record, Buenos Aires-Washington, D.C., over 5,200 miles in 11 hr. 5 min.

1957, November 27—Air Force McDonnell Voodoo jets shatter three transcontinental speed records: Los Angeles to New York and back: 6

hr. 42 min. 6 sec.; east-west, 3 hr. 34 min. 8 sec.; west-east, 3 hr. 5 min. 39.2 sec.

1957, December 12—McDonnell F-101A, piloted by Maj. Adrian Drew, captures world speed record for Air Force by flying 1207.6 mph.

1958, January 31—Army launches first U. S. satellite (Jupiter C Explorer) into space from Cape Canaveral, Fla., at 10:48 p.m.

1958, March 5—Explorer II, measuring 80 inches and weighing 32.4 pounds, is successfully placed into orbit by Army.

1958, March 13—Republic Aviation Corporation's Alouette begins jet helicopter operation in U.S.

1958, March 17—Navy's Vanguard rocket is successfully launched at Cape Canaveral, Fla.

1958, April 8—United States Air Force Boeing KC-135 stratotanker, powered by four Pratt and Whitney J57 turbojet engines, flies nonstop without refueling 10,229.3 miles from Tokyo to Lajes Air Force Base in the Azores, in 18 hours and 48 minutes.

1958, May 7—Major Howard C. Johnson, USAF, sets new world altitude record of 91,243 feet in a Lockheed F-104A Starfighter, powered by a General Electric J79 with afterburner.

1958, May 16—Air Force Lockheed F-104A, flown by Captain Walter W. Irwin, sets new official world's speed record of 1,404.09 miles per hour over a closed course at Edwards Air Force Base, Calif.

1958, July 16—Vertol Model 76 makes what is believed to be world's first successful tilt-wing conversion flight at Philadelphia International Airport.

1958, July 29—President Eisenhower signs bill creating new National Aeronautics and Space Administration.

1958, August 15—Congress passes Federal Aviation Act, creating new Federal Aviation Agency.

1958, October 26—Pan American World Airways, using Boeing 707s, begins regular daily jet transport service between New York and Paris.

1958, December 18—Air Force's 82-foot Convair Atlas intercontinental ballistic missile is launched into orbit at Cape Canaveral, Fla.

1959, January 13—McDonnell Aircraft Corporation wins National Aeronautics and Space Administration's first space capsule competition; work is expected to take about two years and cost about $15 million.

1959, January 25—In launching first jet service across the United States, American Airline's 707 flagship sets two official records: eastbound, Los Angeles to New York, 4 hours, 3 minutes, 53.8 seconds; westbound, 4 hours, 46 minutes, 57.6 seconds.

1959, April 9—National Aeronautics and Space Administration announces names of seven astronauts who will be this country's first pioneers in space.

1959, June 8—Mail is carried by missile for first time as 3,000 letters are delivered in a Regulus I from the submarine Barbero to the Mayport Fla. naval auxiliary air station.

1959, September 14—Russia's Lunik II, 860-pound missile containing instruments and the Soviet coat of arms, hits the moon.

1959, September 17—North American's rocket-powered X-15 makes first powered flight at 1400 miles per hour at Edward AFB, Calif., with pilot Scott Crossfield at the controls.

1959, September 18—Vanguard III, the nation's eleventh earth satellite, is catapulted into orbit expected to last 30 years.

1959, November 16—Captain Joseph Kittinger, Jr. makes record parachute jump from open Gondola at an altitude of 76,400 feet.

1959, November 20—Discoverer VIII, the nation's 15th satellite, is launched into orbit from Cape Canaveral, Fla.

1959, December 8—Navy announces new altitude record of 98,558 feet set by McDonnell F4H Phantom II powered by two General Electric J79 engines, at Edwards AFB, Calif.

1959, December 9—Kaman H-34B establishes new helicopter altitude record of 30,100 feet.

1959, December 11—Republic F-105 sets 100-kilometer closed circuit speed record, flying at 1216.48 miles per hour.

1959, December 14—Lockheed F-104C climbs to 103,395.5 feet to set new world record. Convair F-106 makes record-breaking flight at 1525.95 miles per hour over straightaway course.

1960, January 3—American Airlines 707 sets new Los Angeles-Baltimore record of 3 hrs. 39 min. and Los Angeles-Boston record of 4 hrs. 24 min.; TWA 707 sets Los Angeles-New York mark of 3 hrs. 57 min.; Eastern Air Lines sets DC-8 Long Beach-Miami record of 3 hrs. 58 min.

United Air Lines inaugurates daily jet service between Washington/Baltimore and Chicago and San Francisco in DC-8s.

1960, February 24—Titan ICBM is launched from Cape Canaveral and fired 5000 miles in its longest flight to date.

1960, February 29—First North American X-15 is accepted by the Air Force and turned over to NASA Research Center, Edwards AFB, Calif., for research flight test program.

1960, May 20—An Atlas ICBM is successfully fired over 9000 miles, the greatest distance ever covered by a ballistic missile.

1960, May 21—Hiller 12E sets new aviation altitude records in rescue of two mountain climbers from Mount McKinley with six landings and takeoffs being made at 18,000-ft. level, several thousand feet higher than has been attempted previously.

1960, August 16—Air Force Capt. Joseph W. Kittinger makes record parachute jump from a balloon approximately 102,800 feet over the New Mexico desert.

1960, September 7—Sikorsky Aircraft delivers first turbine-powered helicopter, the S-62, to Los Angeles Airways for use in scheduled airline service.

1960, September 25—Navy claims new world speed record when McDonnell F4H-1 Phantom II fighter, powered by two General Electric J-79 engines and piloted by Comdr. John F. Davis flies at 1390.21 miles per hour over a 100-kilometer closed circuit course.

1960, November 14—Air Force successfully snares capsule of Discoverer XVII satellite that had circled the earth 31 times covering nearly one million miles.

1960, November 24—Convair rolls out first 990 jet transport (previously designated the 600) which is powered by GE CJ805-23 engines and cruises at 640 mph.

1960, December 13—Navy claims new world altitude record for jet aircraft carrying a 1000 kilogram payload in North American A3J flight to 91,450.8 feet.

1960, December 20—The Martin Company delivers its last aircraft—a Navy P5M-2 Marlin flying boat—as the company completes transition to production of Missiles, electronics and space exploration.

1961, February 28—Thompson Trophy is awarded to Strategic Air Command B-58 crew for setting new world record of 1284.73 miles per hour for a 1000 kilometer closed course.

1961, March 8—Max Conrad sets new lightplane round-the-world record of 8 days, 18 hours, 40 minutes, in Piper Aztec. The Flight was 25,527 miles and was begun February 27.

1961, May 5—Astronaut Alan B. Shepard completes first U. S. successful suborbital ballistic flight in Mercury spacecraft.

1961, May 12—Air Force reports that a Convair B-58 Hustler held a sustained speed of 1302 miles per hour for 30 minutes and 45 seconds over a 669.4-mile distance to set a new closed-course speed record.

1961, May 19—Navy twin-turbine Sikorsky HSS-2 helicopter claims new world helicopter speed record of 192.9 miles per hour.

1961, June 4—Aerojet-General fires the most rocket power (500,000 pounds thrust) ever produced by a solid-fuel rocket motor. It used more than 50 tons of solid propellant.

1961, July 21—Capt. Virgil Grissom successfully completes 118-mile high suborbital flight in Mercury capsule.

1961, August 21—Douglas Aircraft Company reports that its DC-8 exceeded mach 1 in a test flight, claiming it to be the first transport aircraft to accomplish this feat.

1961, October 17—NASA Pilot Joe Walker flies the X-15 to altitude of 217,000 feet over Edwards Air Force Base.

1961, November 29—NASA successfully recovers chimpanzee and capsule which had orbited the globe two times as part of Mercury program.

1961, December 1—Navy claims three world speed records for its Sikorsky HSS-2 helicopters. The twin-turbine craft set marks of 182.8 mph for 100 kilometers, 179.5 mph for 500 kilometers and 175.3 mph for 1000 kilometers.

1961, December 5—A Navy F4H Phantom II, piloted by Commander George W. Ellis, set a new world altitude record of 66,443 feet for sustained horizontal flight.

1961, December 28—American Airlines became the first airline ever to carry 100 million passengers and held ceremonies with Lt. General James H. Doolittle serving as national symbol of the event.


Astronaut Grissom in gondola of human centrifuge.

Air Force launch of Blue Scout 1, first vehicle to contain a guidance system, is pronounced a success.

1961 DAY BY DAY CHRONOLOGY

JANUARY

- ***January 3***
New Polaris submarine, Patrick Henry, puts to sea carrying 16 missiles, increasing the number operationally deployed to 32.
- ***January 5***
Boeing B-52H rolled out at Wichita plant carrying four aerodynamically configured Sky Bolt test mockups below its wings.
- ***January 7***
Air Force launch of Blue Scout I, first vehicle to contain a guidance system, is pronounced a success.
- ***January 17***
Expenditures planned for nation's defense in FY 1962 total $42.9 billion—$1.4 billion more than fiscal 1961.
- ***January 19***
Najeeb E. Halaby named new Federal Aviation Agency Administrator.

FEBRUARY

- ***February 1***
Launching of first free-flight test of Air Force Minuteman ICBM called "unqualified success" by technical officers at Cape Canaveral.
- ***February 2***
Samos II, Air Force observer satellite, circles earth in near perfect orbit, after launch from Point Arguello on January 31.
- ***February 7***
Alan S. Boyd named by President Kennedy to head Civil Aeronautics Board.
- ***February 15***
Static test of prototype thrust chamber of NASA F-1 liquid propellant rocket engine achieves 1,550,000 pounds thrust.
- ***February 20***
Class rate system of calculating subsidy for local service carriers is put into effect by the Civil Aeronautics Board.
Wildcat strike of flight engineers hits airlines.
- ***February 28***
Thompson Trophy is awarded to Strategic Air Command B-58 crew for setting new world record of 1284.73 miles per hour for a 1000 kilometer closed course.

MARCH

- ***March 3***
Cessna Aircraft Company announces first flight of its "push-pull" light twin Skymaster.
- ***March 6***
Boeing B-52H equipped with turbofan engines makes first flight at Wichita.
- ***March 8***
Max Conrad sets new lightplane round-the-world record of 8 days, 18 hours, 40 minutes, in Piper Aztec. The flight was 25,527 miles and was begun February 27.
- ***March 13***
Lockheed Aircraft Corporation's Georgia division is selected to build the optimum jet cargo aircraft for the Air Force.
- ***March 14***
National Airlines and Delta Air Lines get major routes in CAB's decision in Southern Transcontinental Service case.
- ***March 15***
Riddle Airlines reports commercial distance record with a DC-7F flight of 6307 statute miles nonstop between Tokyo and Chicago.
- ***March 30***
North American X-15, piloted by Joseph A. Walker, reaches altitude of 169,600 feet above California-Nevada border.

APRIL

- ***April 4***
CAB approves the merger of Capital Airlines into United Air Lines, permitting the combined airline to publish merged schedules as of June 1.

- *April 7*
Douglas DC-8F Jet Trader, combination passenger-cargo aircraft, announced and scheduled for flight in August 1962.
- *April 12*
Soviet Union successfully launches (Maj. Yuri Gagarin) man into orbit.
- *April 13*
Net profit of domestic trunklines hit 10-year low in 1960, Air Transport Association reports.
- *April 14*
F-1 liquid propellant rocket engine reaches thrust level of 1,640,000 pounds in first "long" run of 13 seconds.
- *April 17*
Beech Aircraft Corporation unveils new 200 mile-per-hour Model B-95A Travel Air.
- *April 26*
Lightweight Doppler navigator set, applicable to all types of aircraft, is unveiled by Ryan Electronics.

MAY

- *May 3*
First Convair 990 completes initial landing tests.
First Army YHC-1B Chinook turbine-powered helicopter is completed and rolled out at Boeing-Vertol division plant.
- *May 4*
Aero Commander Incorporated unveils its six-place executive jet Model 1121 Jet Commander, powered by General Electric CJ-610-1 engines.
- *May 5*
Astronaut Alan B. Shepard completes first U.S. successful suborbital ballistic flight in Mercury spacecraft.
- *May 9*
Cessna Aircraft Company introduces new five-passenger twin-engine Skynight.
- *May 12*
Air Force reports that a Convair B-58 Hustler held a sustained speed of 1302 miles per hour for 30 minutes and 45 seconds over a 669.4-mile distance to set a new closed-course speed record.
- *May 19*
Navy twin-turbine Sikorsky HSS-2 helicopter claims new world helicopter speed record of 192.9 miles per hour.
- *May 22*
Bell Helicopter Company and Hiller Aircraft Corporation win design competition for the Army's light observation helicopter.
General Curtis LeMay is named Air Force Chief of Staff, to succeed General Thomas White on July 1.

JUNE

- *June 4*
Aerojet-General fires the most rocket power (500,000 pounds thrust) ever produced by a solid-fuel rocket motor. It used more than 50 tons of solid propellant.
- *June 9*
Domestic trunkline traffic dips in first third of year 3.5 percent below 1960 levels; coach traffic gains with first-class traffic down.

JULY

- *July 11*
August Esenwein is elected as president of Aerospace Industries Association to replace General Orval R. Cook on December 31, 1961.
- *July 12*
First static firings of the F-1 rocket engine are begun by NASA.
- *July 13*
Lockheed-Georgia Company is contracted to build a jet-powered VTOL research aircraft for Army.
- *July 21*
Capt. Virgil Grissom successfully completes 118-mile high suborbital flight in Mercury capsule.
- *July 24*
Eastern Air Lines' Electra is hijacked enroute from Miami to Tampa and flown to Havana.
- *July 26*
President Kennedy proposes new short and long-term measures to increase the nation's non-nuclear war capability.

AUGUST

- *August 7*
Russia orbits Cosmonaut Maj. Gherman Titov 17 times around the earth.
- *August 16*
Ling-Temco Electronics Incorporated and Chance Vought Corporation merge.
- *August 24*
Air Transport Association report shows that U.S. trunklines had a net loss of $13.5 million on their domestic operations for the first half of 1961 as compared with a $5.3 million loss in 1960.
- *August 21*
Douglas Aircraft Company reports that its DC-8 exceeded mach 1 in a test flight, claiming it to be the first transport aircraft to accomplish this feat.
- *August 29*
Department of Defense chooses the team of Chance Vought-Hiller-Ryan to build five prototype VTOL transports under Air Force supervision.
CAB rules to revoke minimum airfreight rates effective October 1.

SEPTEMBER

- *September 2*
Navy and Air Force agree on specifications for an air superiority fighter aircraft (TFX), a single plane to be built to fulfill the requirements of both services.
- *September 10*
Project Horizon report on aviation goals for 1961-70 decade is issued by the White House.
- *September 28*
Trunk airline presidents and CAB members meet in historic face-to-face meeting to discuss mutual problems.

OCTOBER

- *October 4*
Flight studies of sonic boom problem to begin.
- *October 6*
Vice President Lyndon Johnson tours NASA space facilities around the nation.
- *October 17*
NASA Pilot Joe Walker flies the X-15 to altitude of 217,000 feet over Edwards Air Force Base.
- *October 19*
Chairman Robert S. Kerr of the Senate Space Committee estimates U.S. investment in accelerated space program will probably total $30 billion over the next 10 years.

NOVEMBER

- *November 3*
CAB Chairman Alan Boyd warns trunklines to merge or face consequences.
- *November 14*
Eastern Air Lines proposes five-point plan for basic revision of existing tariff structure.
- *November 22*
Navy claims world speed record for McDonnell F4H Phantom II flying at 1606.342 miles per hour at Edwards Air Force Base.
- *November 29*
NASA successfully recovers chimpanzee and capsule which had orbited the globe two times as part of Mercury program.

DECEMBER

- *December 1*
Navy claims three world speed records for its Sikorsky HSS-2 helicopters. The twin-turbine craft set marks of 182.8 mph for 100 kilometers, 179.5 mph for 500 kilometers and 175.3 mph for 1000 kilometers.
- *December 5*
A Navy F4H Phantom II, piloted by Commander George W. Ellis, set a new world altitude record of 66,443 feet for sustained horizontal flight.
- *December 28*
American Airlines became the first airline ever to carry 100 million passengers and held ceremonies with Lt. General James H. Doolittle serving as national symbol of the event.

OFFICIAL RECORDS

The National Aeronautic Association (NAA), being one of the 51 member nations of the Federation Aeronautique Internationale (FAI), must sanction, certify and register all record attempts within the United States in order that they be "Officially" recognized world wide.

Any and all competitors must conform to the rules and regulations as set forth by the FAI in its "Sporting Code." This remarkably complete Code is kept up to date by comprehensive studies of the International Sporting Committee who then present their recommendations for changes and/or additions to the Annual General Conference for approval.

The 54th General Conference was held in Monte Carlo, Monaco, from the 12th to the 22nd of October 1961.

CLASS	DATE	AIRCRAFT	PILOT	RECORD DESCRIPTION	RECORD
ABSOLUTE	**WORLD**				
AIRCRAFT	11/22/61	McDonnell F4-H	Lt. Col. Robinson, USMC	Speed Over a Straight Course	1,606.324 MPH
ROCKETS	5/5/61	Mercury	Cdr. Shepard, USN	Greatest Altitude Without Orbit	615,300 Feet
ROCKETS	5/5/61	Mercury	Cdr. Shepard, USN	Greatest Mass Lifted Without Orbit	4,040 Lbs.
BALLOONS					
A-4	7/19/61	Balloon "Golden Bear"	Don Piccard	Altitude	34,462 Feet
A-5	7/19/61	Balloon "Golden Bear"	Don Piccard	Altitude	34,462 Feet
A-6	7/19/61	Balloon "Golden Bear"	Don Piccard	Altitude	34,462 Feet
A-7	7/19/61	Balloon "Golden Bear"	Don Piccard	Altitude	34,462 Feet
A-8	7/19/61	Balloon "Golden Bear"	Don Piccard	Altitude	34,462 Feet
A-10	5/4/61	Winzen Balloon	Commander Ross, USN	Altitude	113,739.9 Feet
JET FIXED	**WING LA**	**ND (Heavy)**			
C-1, I	10/12/61	Northrop T-38	Jacqueline Cochran	Altitude, Horizontal Sustained	55,300.95 Feet
C-1, I	12/5/61	McDonnell F4-H	Cdr. George Ellis, USN	Altitude, Horizontal Sustained	66,443.8 Feet
C-1, I	8/29/61	McDonnell F4-H	Lt. Hardisty, USN	3 Km. Speed	902.7 MPH
C-1, I	1/14/61	Convair B-58	Major Confer	1,000 Km. Speed (Closed Circuit)	1,284.7 MPH
C-1, I	1/14/61	Convair B-58	Major Confer	1,000 Km. Speed with 1000 Kgs.	1,284.7 MPH
C-1, I	1/14/61	Convair B-58	Major Confer	1,000 Km. Speed with 2000 Kgs.	1,284.7 MPH
C-1, I	1/12/61	Convair B-58	Major Deutchendorf	2,000 Km. Speed (Closed Circuit)	1,061.8 MPH
C-1, I	1/12/61	Convair B-58	Major Deutchendorf	2,000 Km. Speed with 1000 Kgs.	1,061.8 MPH
C-1, I	1/12/61	Convair B-58	Major Deutchendorf	2,000 Km. Speed with 2000 Kgs.	1,061.8 MPH

CLASS	DATE	AIRCRAFT	PILOT	RECORD DESCRIPTION	RECORD
C-1, I	5/24/61	McDonnell F4-H	Lt. Gordon, USN	FAI Course LA/NY	869.7 MPH
C-1, I	5/26/61	Convair B-58	Major Payne	FAI Course Wash., DC/Paris	1,048.6 MPH
C-1, I	5/26/61	Convair B-58	Major Payne	FAI Course NY/Paris	1,089.3 MPH
PROP FIXED WING LAND (Heavy)					
C-1, II	3/8/61	Piper "Aztec"	Max Conrad	Speed Around the World	123.2 MPH
PROP FIXED WING LAND (Light)					
C-1.c, II	12/8/61	Piper Comanche	Sterling Kennedy	FAI Course Wash., DC/Chicago	158.3 MPH
C-1.d, II	3/8/61	Piper "Aztec"	Max Conrad	Speed Around the World	123.2 MPH
HELICOPTERS (Heavy)					
E-1	5/17/61	Sikorsky HSS-2	Commander Sullivan, USN	3 Km. Speed	192.9 PMPH
E-1	5/24/61	Sikorsky HSS-2	Commander Sullivan, USN	100 Km. Speed (Closed Circuit)	174.8 MPH
E-1	12/1/61	Sikorsky HSS-2	Captain Lloyd, USN	100 Km. Speed (Closed Circuit)	182.8 MPH
E-1	12/1/61	Sikorsky HSS-2	Captain Lloyd, USN	500 Km. Speed (Closed Circuit)	179.5 MPH
E-1	12/1/61	Sikorsky HSS-2	Captain Lloyd, USN	1,000 Km. Speed (Closed Circuit)	175.3 MPH
E-1	5/25/61	Kaman H43-B	Captain McMeen	Altitude with 1,000 Kgs.	25,814 Feet
E-1	10/24/61	Kaman H43-B	Lt. Col. Carney, USMC	3,000 Meters—Time to Climb	2 min. 44.5 secs.
E-1	10/24/61	Kaman H43-B	Lt. Col. Carney, USMC	6,000 Meters—Time to Climb	6 min. 42.3 secs.
E-1	10/24/61	Kaman H43-B	Lt. Col. Carney, USMC	9,000 Meters—Time to Climb	14 min. 11.5 secs.
HELICOPTERS (Light)					
E-1.b	2/2/61	Bell 47-G	L. W. Hartwig	Closed Circuit Distance	631.4 Miles
E-1.b	2/8/61	Bell 47-G	A. P. Averill	Straight Line Distance	728.9 Miles
E-1.b	1/31/61	Bell 47J-2	L. W. Hartwig	100 Km. Speed (Closed Circuit)	104.6 MPH
E-1.b	2/2/61	Bell 47-G	L. W. Hartwig	500 Km. Speed (Closed Circuit)	73.9 MPH
E-1.b	2/2/61	Bell 47-G	L. W. Hartwig	1,000 Km. Speed (Closed Circuit)	73.6 MPH
E-1.c	1/31/61	Bell 47-2	A. P. Averill	100 Km. Speed (Closed Circuit)	107 MPH
E-1.d	10/18/61	Kaman H43-B	Lt. Col. Carney, USMC	Altitude	32,279 Feet
GLIDERS (Single Place)					
D-1	2/25/61	Schweizer SGS	Paul Bikle	Altitude Gained	42,303 Feet
D-1	2/25/61	Schweizer SGS	Paul Bikle	Altitude Above Sea Level	46,267 Feet
FEMININE RECORDS:					
BALLOON					
A-6	11/20-21/61	Balloon	Connie Wolf	Altitude	13,597 Feet
A-6	11/20-21/61	Balloon	Connie Wolf	Duration	40 hours, 13 minutes
A-6	11/20-21/61	Balloon	Connie Wolf	Distance	363.99 Miles
A-7	11/20-21/61	Balloon	Connie Wolf	Altitude	13,597 Feet
A-7	11/20-21/61	Balloon	Connie Wolf	Duration	40 hours, 13 minutes
A-7	11/20-21/61	Balloon	Connie Wolf	Distance	363.99 Miles
A-8	11/20-21/61	Balloon	Connie Wolf	Altitude	13,597 Feet
A-8	11/20-21/61	Balloon	Connie Wolf	Duration	40 hours, 13 minutes
A-8	11/20-21/61	Balloon	Connie Wolf	Distance	363.99 Miles

CLASS	DATE	AIRCRAFT	PILOT	RECORD DESCRIPTION	RECORD
A-9	11/20-21/61	Balloon	Connie Wolf	Altitude	13,597 Feet
A-9	11/20-21/61	Balloon	Connie Wolf	Duration	40 hours, 13 minutes
A-9	11/20-21/61	Balloon	Connie Wolf	Distance	363.99 Miles
A-10	11/20-21/61	Balloon	Connie Wolf	Altitude	13,597 Feet
A-10	11/20-21/61	Balloon	Connie Wolf	Duration	40 hours, 13 minutes
A-10	11/20-21/61	Balloon	Connie Wolf	Distance	363.99 Miles
FIXED WING LAND					
C-1, I	9/18/61	Northrop T-38	Jacqueline Cochran	Straight Line Distance	1,492.394 Miles
C-1, I	9/15/61	Northrop T-38	Jacqueline Cochran	Closed Circuit Distance	1,346.366 Miles
C-1, I	10/12/61	Northrop T-38	Jacqueline Cochran	Altitude	56,072.8 Feet
C-1, I	10/12/61	Northrop T-38	Jacqueline Cochran	Altitude—Horizontal Sustained	55,253 Feet
C-1, I	8/24/61	Northrop T-38	Jacqueline Cochran	15/25 Km. Speed	842.6 MPH
C-1, I	10/6/61	Northrop T-38	Jacqueline Cochran	100 Km. Speed (Closed Circuit)	784.285 MPH
C-1, I	8/31/61	Northrop T-38	Jacqueline Cochran	500 Km. Speed (Closed Circuit)	659.6 MPH
C-1, I	9/8/61	Northrop T-38	Jacqueline Cochran	1,000 Km. Speed (Closed Circuit)	639.38 MPH
HELICOPTERS					
E-1	2/10/61	Bell 47-G	Dora Dougherty	Straight Line Distance	404.3 Miles
E-1	2/8/61	Bell 47-G	Dora Dougherty	Altitude	19,406 Feet
SPECIAL CATEGORIES					
Bleriot	5/10/61	Convair B-58	Major Murphy	2,000 Km. Speed for ½ Hour (Closed)	1,302 MPH
COMMERCIAL	6/1/61	Delta DC-8	Captain G. T. Wood	Air Route Speed Atlanta/LA	464.7 MPH
COMMERCIAL	6/1/61	Delta DC-8	Captain V. O. Johnson	Air Route Speed LA/New Orelans	484.5 MPH
COMMERCIAL	6/3/61	Delta DC-8	Captain S. W. Hopkins	Air Route Speed LA/Atlanta	556.9 MPH
COMMERCIAL	11/8/61	American 707	Captain M. Althaus	Air Route Speed Cincinnati/New York	556.2 MPH
COMMERCIAL	12/7/61	American 707	Captain F. Illston	Air Route Speed Dallas/New York	679.2 MPH
COMMERCIAL	12/7/61	American 707	Captain S. Smith	Air Route Speed LA/Baltimore	655.9 MPH
COMMERCIAL	12/8/61	American 707	Captain H. Schmidt	Air Route Speed LA/Baltimore	660.2 MPH
COMMERCIAL	12/8/61	American 707	Captain W. Miller	Air Route Speed LA/NY	636.8 MPH
COMMERCIAL	12/7/61	American 707	Captain R. Lewis	Air Route Speed LA/NY	663.1 MPH
COMMERCIAL	8/18/61	American 707	Captain C. Jordan	Air Route Speed NY/Chicago	548.4 MPH
COMMERCIAL	8/18/61	American 707	Captain D. W. Ledbetter	Air Route Speed NY/San Francisco	554.8 MPH
COMMERCIAL	10/15/61	American 707	Captain C. A. Ryan	Air Route Speed NY/Phoenix	537.1 MPH
COMMERCIAL	10/15/61	American 707	Captain M. Rummer	Air Route Speed Phoenix/NY	573.4 MPH
COMMERCIAL	11/17/61	American 707	Captain H. G. Robinson	Air Route Speed Phoenix/NY	647.6 MPH
COMMERCIAL	10/25/61	American 707	Captain R. Hoyt	Air Route Speed San Francisco/Chicago	597.6 MPH
COMMERCIAL	10/25/61	American 707	Captain H. L. Clark	Air Route Speed San Francisco/NY	576.6 MPH
COMMERCIAL	12/5/61	American 707	Captain W. R. Swain	Air Route Speed San Francisco/NY	622.8 MPH
COMMERCIAL	12/8/61	American 707	Captain T. E. Jonson	Air Route Speed San Francisco/NY	658.1 MPH
COMMERCIAL	12/7/61	American 707	Captain C. Lippincott	Air Route Speed San Francisco/NY	670.3 MPH
COMMERCIAL	12/13/61	American 707	Captain J. Adams	Air Route Speed El Paso/Dallas	476.4 MPH

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