THE AEROSPACE YEAR BOOK

1960

AIA

GEORGE HANNAUM

THE

AEROSPACE YEAR BOOK

1960

FORTY-FIRST ANNUAL EDITION

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

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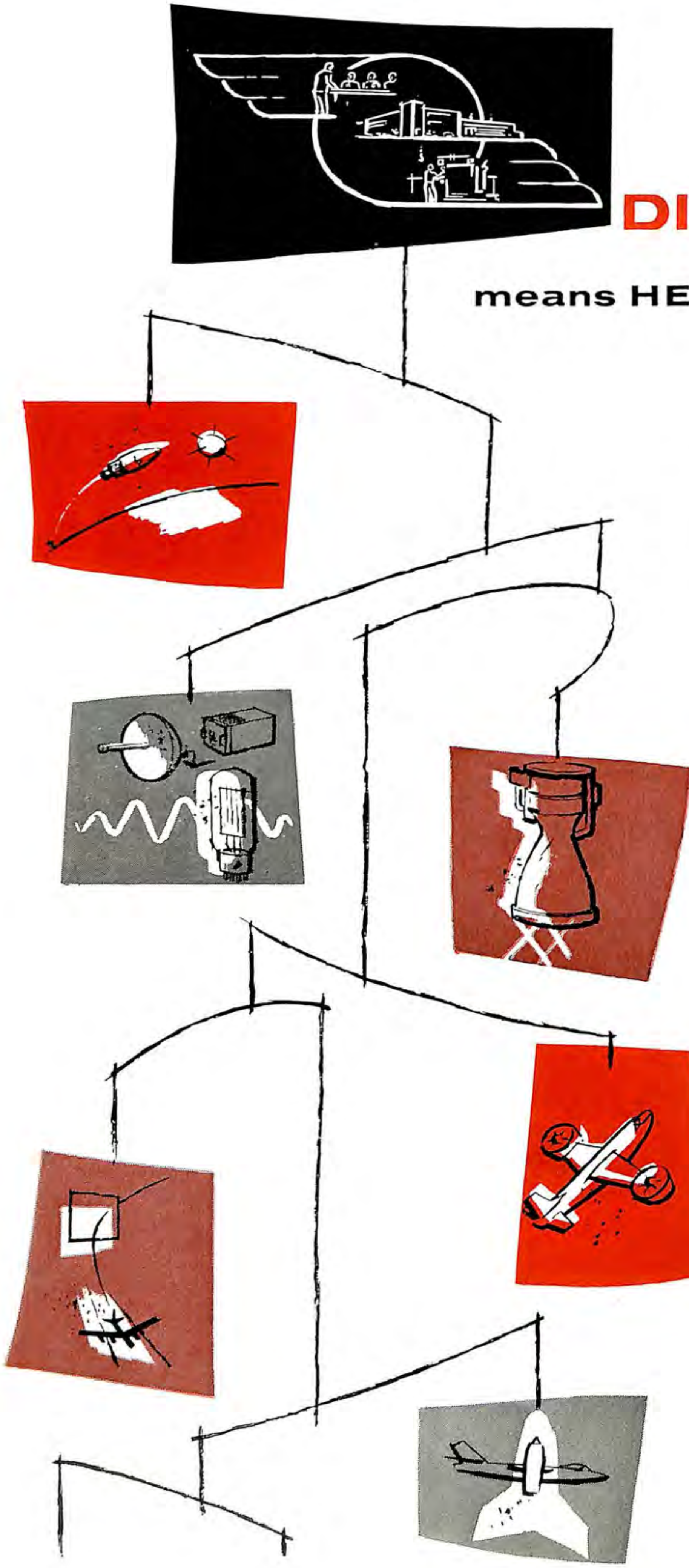


TABLE OF CONTENTS

HOT GAS SYSTEM COMPONENTS NOW AVAILABLE FROM CHANDLER EVANS

CECO
SYSTEMS CONTROLS

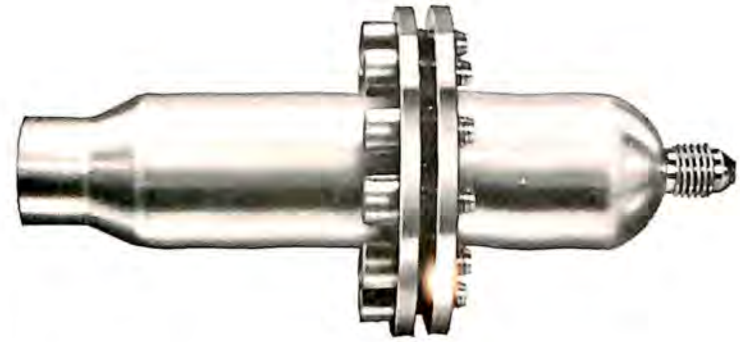
As by-products of extensive development work in the field of high-pressure pneumatics, Chandler Evans has—over the past several years—designed, developed, tested and produced a number of hot gas servo system components, some of which are presented here.

The products shown and described were developed for use with high-pressure hot gas generated from liquid or solid propellants, and are suitable to such applications as auxiliary and control power systems for guided missiles and space vehicles.

All the components shown are developed items, ready for use. However, because they have been fabricated to meet the requirements of particular applications, the specifications presented should be considered only representative. Design modifications can readily be made to adapt these devices to *your* requirements.

If you, too, are engaged in hot gas systems work and want to save considerable time and money in development, by using proven components not heretofore available, CECO will be happy to afford you its traditional cooperation.

For detailed information on these and other components, or for data on CECO's hot gas servo *systems*, contact any of the Field Engineering Offices listed at the right.

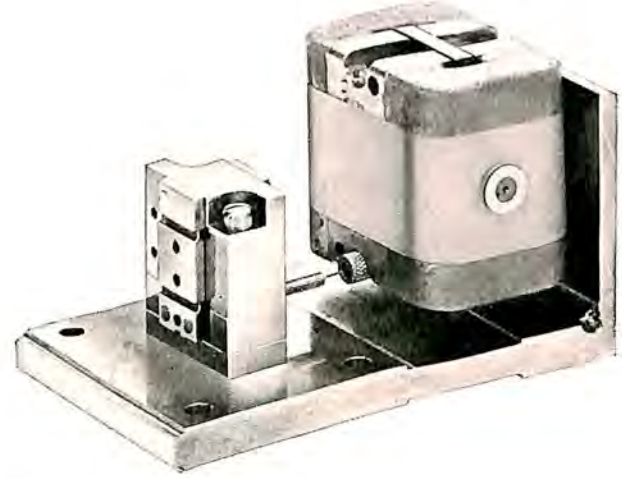


LIGHTWEIGHT HYDRAZINE REACTION CHAMBER

This reaction chamber, containing a suitable catalyst bed and injection nozzle, is used to generate hot gas. When hydrazine from a pressurized source is introduced, the catalyst immediately initiates a chemical reaction which continues until the fuel supply is exhausted.

Representative specification:

Operating temperature	to 1800°F.
Operating pressure	to 2000 psi
Flow capacity	.10 lb./sec.
Operating time	in excess of 5 hrs.
Weight (including catalyst)	1.27 lbs.
Size	1.50" O.D. x 5.00"



REED-SUSPENDED, CLOSED CENTER SERVO VALVE

Developed for use with hot gas produced by decomposition of liquid propellants, the servo valve shown here is currently available in a variety of sizes to accommodate the requirements of individual applications.

Representative specification:

Inlet gas supply pressure	to 2000 psi
Inlet gas supply temperature	to 1500°F.
Operating temperature (ambient)	to 350°F.*
Valve stroke	±.004"
Flow capacity (total gas flow)	.01 lb./sec. air @ 1500°F., 2000 psi
Overboard leakage (valve at null position)	10% of total flow
Power input (maximum)	2 watts
Natural frequency	430 cps
Weight	1.00 lb.
Size	1.75" x 2.75" x 1.75"

* *With additional torque-motor cooling, ambients to 1200°F. can be tolerated.*

PROPELLANT FLOW MODULATING AND PRESSURE REGULATING VALVE

The problem of operating hot gas generators at a specified constant pressure level led to the design, test and development of the liquid fuel regulating valve pictured here.

This valve may be described as a spring-loaded, spool-type throttling valve. Full open when the pressure at its outlet port (gas generator pressure) is low, it progressively closes off as the outlet pressure increases.

With minimum leakage an important objective, the valve shown meets the following specification:

Flow (hydrazine)	.002 to .02 lb./sec.
Upstream pressure	500 to 3000 psi
Regulated pressure	500 to 2000 psi
Temperature	0° to 200°F.
Weight	.38 lb.
Size	1.75" O.D. x 3.00"

Limited changes in regulated pressure can readily be accomplished by means of a simple adjustment screw. Broader changes in regulated pressure or in flow capacity can be accomplished through slight re-design of the spool or spring elements.

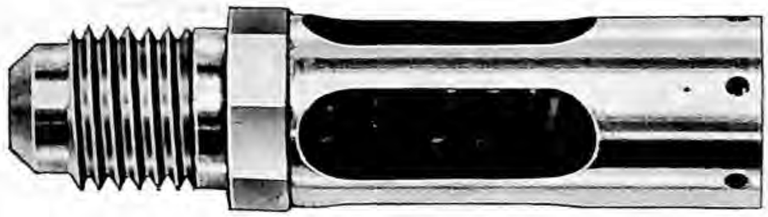
SOLID PROPELLANT HOT GAS FILTER

Since small-orifice areas of servo valves cannot tolerate contaminants produced by combustion of solid propellants, CECO found it necessary to develop the special hot gas filter shown here. Unlike those heretofore available, this filter can easily be cleaned for re-use and has amply demonstrated its ability to withstand the temperatures and pressures encountered in hot gas systems.

It operates as follows: hot gas flows into an annulus between the filter element and housing, then diffuses through to the outer surface of the element, depositing solid particles as it goes. With gas flow at .015 lb./sec., this filter operates for several minutes, with average contamination, filtering out particles as fine as 10 microns.

Representative specification:

Operating temperature	to 1800°F.
Operating pressure	to 2000 psi
Initial pressure drop at .015 lb./sec.	2 psi @ 1000 psi
Filter housing size	1.38 O.D." x 5.00"
Weight	.88 lb.



HOT GAS PRESSURE RELIEF VALVE

Typical of component hardware developed by CECO in its work with hot gas servo actuation and reaction systems is the valve pictured here. While it can easily be modified to satisfy other requirements, specification for the valve shown is as follows:

Relief pressure	1000 psi*
Reseat pressure	950 psi
Flow	.02 lb./sec. @ 1000 psi
Temperature	1800°F.
Weight	.032 lb.

* *Adjustable from 800 to 1200 psi.*

HOT GAS REACTION CHAMBER FOR LABORATORY USE

This unit is used as a "workhorse" hydrazine reaction chamber to provide clean, hot, high-pressure gas for test purposes.

Ideal for laboratory use, its flow rates range between .001 and .1 lb. sec., and may be extended in either direction by changing nozzle and load orifice sizes. Operating temperatures are between 1200°F. and 1800°F. with pressures to 2000 psi.

The chamber is preheated by an electrical coil, a feature which facilitates repetitive starting without need for disassembly between test runs to renew the catalyst.

The above picture shows CECO's generator with the pressure regulating and flow modulating valve in position. For those who require a complete, "packaged" system for providing a continuous supply of hot gas, Chandler Evans can supply a complete laboratory model hot gas generator system including the fuel storage, pressurizing, purging and pressure regulating elements in addition to the gas generator reaction chamber described above.

CECO ® SYSTEMS CONTROLS

CECO FIELD ENGINEERING OFFICES:

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MID-WEST
KENNETH L. MOAN
Room 305, Spitzer Building
Toledo 4, Ohio

EAST COAST
ROBERT M. CAMPBELL
Chandler Evans Corporation
Charter Oak Boulevard
West Hartford 1, Connecticut

Literature, including a reprint of this ad, available by request to Department 69.

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The Firebee is operational, "off-the-shelf" hardware. It is the exclusive target used in the Air Force's Project "William Tell" Weapons Meets. The Firebee is the most realistic stand-in for "enemy" aircraft ever developed to test men and weapons.

Now an even more advanced version of the Firebee is in production at Ryan. The Q-2C Firebee, already on order by the Air Force, has flown at Mach .95 speeds and 59,000-foot altitudes.

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FOREWORD

For the 40 issues of its existence, this summary of the year's activity in the field of aircraft manufacturing has been known as the AIRCRAFT YEAR BOOK.

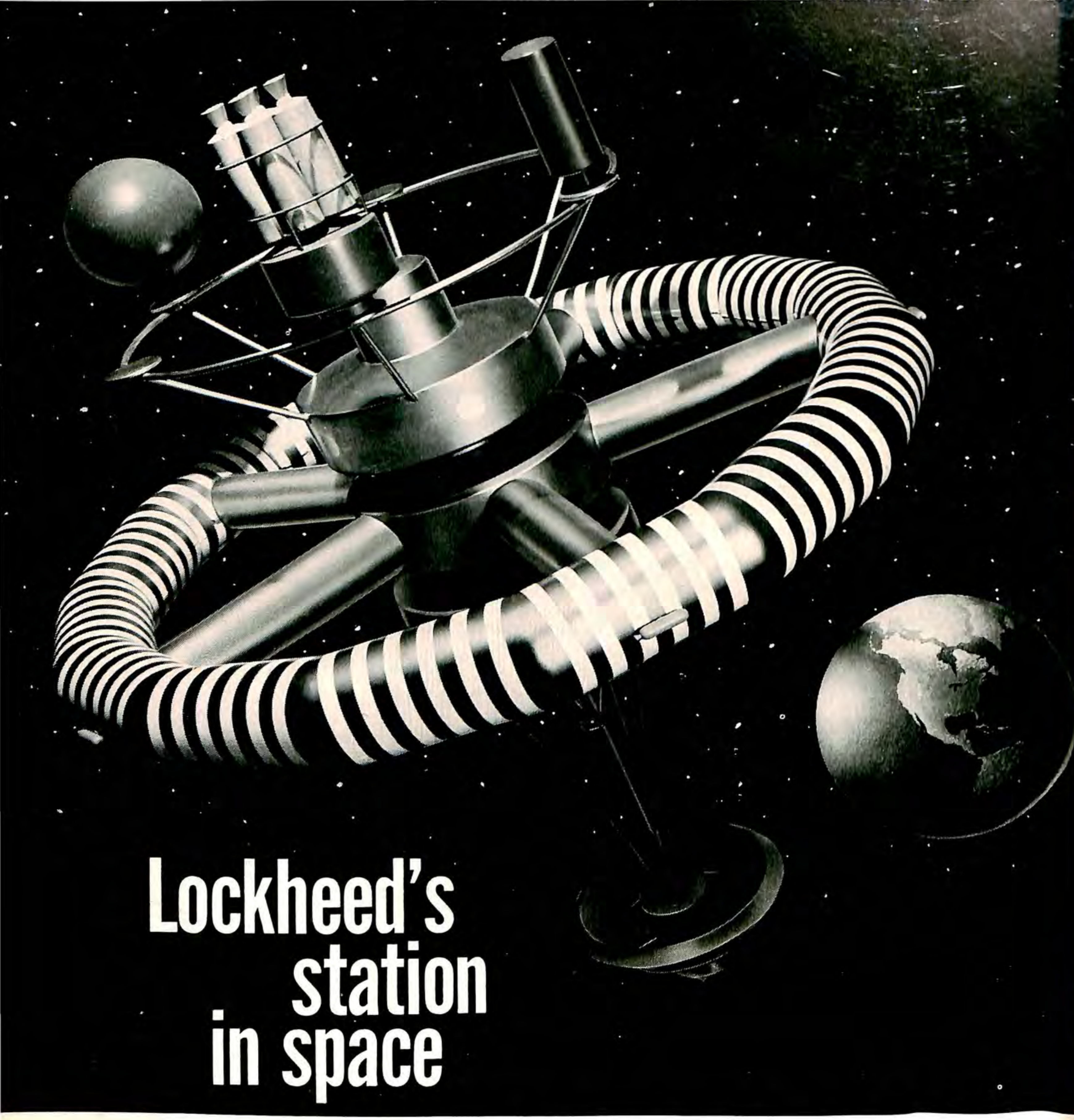
With this volume, it becomes the AEROSPACE YEAR BOOK, a title which more properly reflects the changing nature of the effort of the companies who comprise the Aerospace Industries Association. The Association similarly changed its name from Aircraft Industries Association during the year.

By definition, the term "aerospace" embraces research, development and production of manned and unmanned vehicles and their supporting equipment for movement above the Earth's surface, whether they move within the layer of atmosphere which surrounds our planet or above it. A perusal of the activities of the Association's member companies, as detailed in this volume, will demonstrate the need for the change of name.

Today, more than ever before, it is essential that the American public understand the role that the aerospace industry plays in our national welfare and security. The summary contained in this volume contributes to such an understanding.

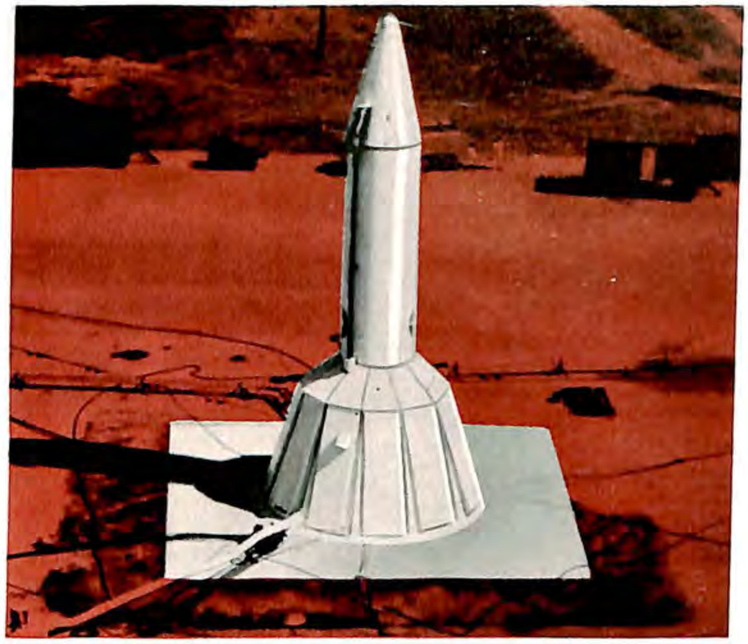
Orval R. Cook

ORVAL R. COOK
President
Aerospace Industries Association



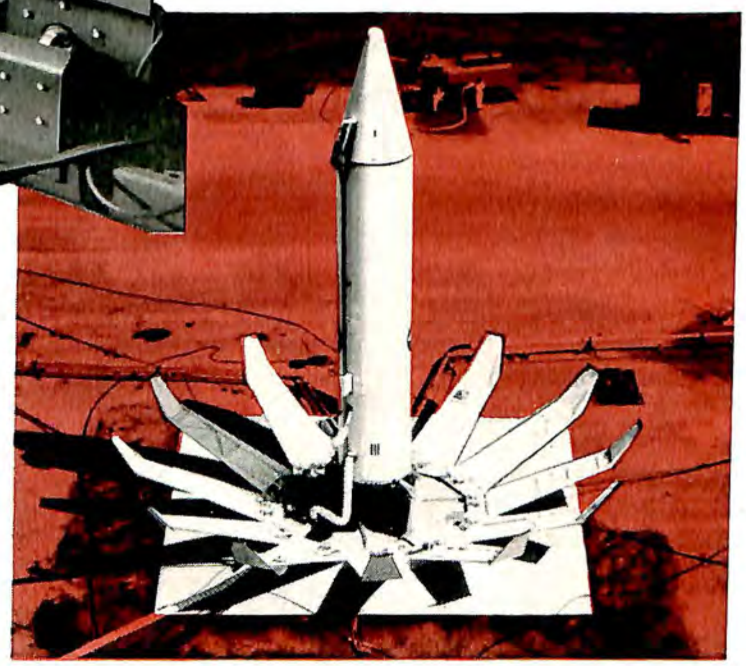
Lockheed's station in space

HURRICANE-PROOF "OVERCOAT" FOR THE JUPITER...



MISSILE SHELTER-PANELS RAISED

MISSILE SHELTER-PANELS OPEN



"buttoned up" by 24 Saginaw b/b Screws

Buttoning up the "overcoat" for the Jupiter IRBM is a cinch for the Saginaw Ball Bearing Screw! The "overcoat" is a portable prefab standby shelter designed by Barnes & Reinecke, Chicago, and U. S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va., to protect the missile's tail and personnel working on it. The shelter has 12 base sections with hinged panels raised electrically to form a weather-tight seal around the Jupiter's hull.

The Saginaw b/b Screw converts *rotary* motion into *linear* with over 90% *efficiency*. This enables the Saginaw Screws to dependably raise or lower these panels—and hold the shelter securely in place—even in the face of 76 mph hurricane winds. In fact, each Saginaw Screw is able to withstand a combined wind and weight stress of almost five tons! The Saginaw Screw also offers substantial savings in space, power and weight which make the shelter easier to transport and assemble.

The Saginaw Screw may be able to give *your* products that valuable Sales Appeal you're looking for. To find out, write or telephone Saginaw Steering Gear Division, General Motors Corporation, Saginaw, Michigan—*world's largest producers of b/b screws and splines.*

Give your products NEW SALES APPEAL... switch to the Saginaw ball/bearing Screw

WORLD'S MOST EFFICIENT ACTUATION DEVICE

INTRODUCTION

The activities of 1959 in the aerospace field bore a marked resemblance to those of the preceding year, for in a great many areas the year's accomplishments were extensions of trends started earlier.

The year was not, however, one lacking in achievement. Solid gains were noted in a number of categories, although in the public view the achievements were less spectacular than those of the preceding year.

The rate of change within the aerospace manufacturing industry, dictated by the rapidly advancing technology of the Space Age, continued to accelerate and with the acceleration came a new compounding of the industry's attendant problems.

Two national policy determinations were the major factors involved in the industry changes. First was the increasingly prominent role of the missile in defense, which continued to bring about a reduction in aircraft requirements. Second was the need to provide for new weapons while at the same time maintaining a strong military organization under a relatively fixed budgetary ceiling.

The changes spread across the whole canvas of aerospace manufacturing. Among the major results were these: a further shift from volume production to precision fabrication of limited quantities, bringing with it greater competition for fewer military contracts; because of the competition, a need for still more product diversification; because of the requirements for an unprecedented degree of reliability in all components, an extensive and continuing realignment of the industry's labor force with a decline in the number of production workers and an increase in engineering and technical skills; and a need for new, high-cost precision machine tools which could quickly become obsolete as technology continued to advance.

In 1959, as in 1958, the accent was on research and development rather than production, and this required further changes on the part of aircraft and missile manufacturers in their organizational structures and methods of operation in order to cover the ever broadening scope of aircraft, missiles, space vehicles, propulsion systems, guidance and related equipment.

Despite the problems, the aerospace industry could point to a successful year in the handling of its dual responsibility as aerospace producer and researcher. The industry's accomplishments are listed in detail on the pages which follow.

In space exploration, 1959 saw a number of notable achievements on the part of American researchers, although for the most part the accomplishments took the form of progress on projects which will see later fruition. On the basis of hardware sent aloft, the Soviet Union continued to enjoy the space lead it took with the launching of the first *sputnik* in 1957. A reading of the research and development section of this volume, however, might produce a more optimistic view of the space research stature of the United States.

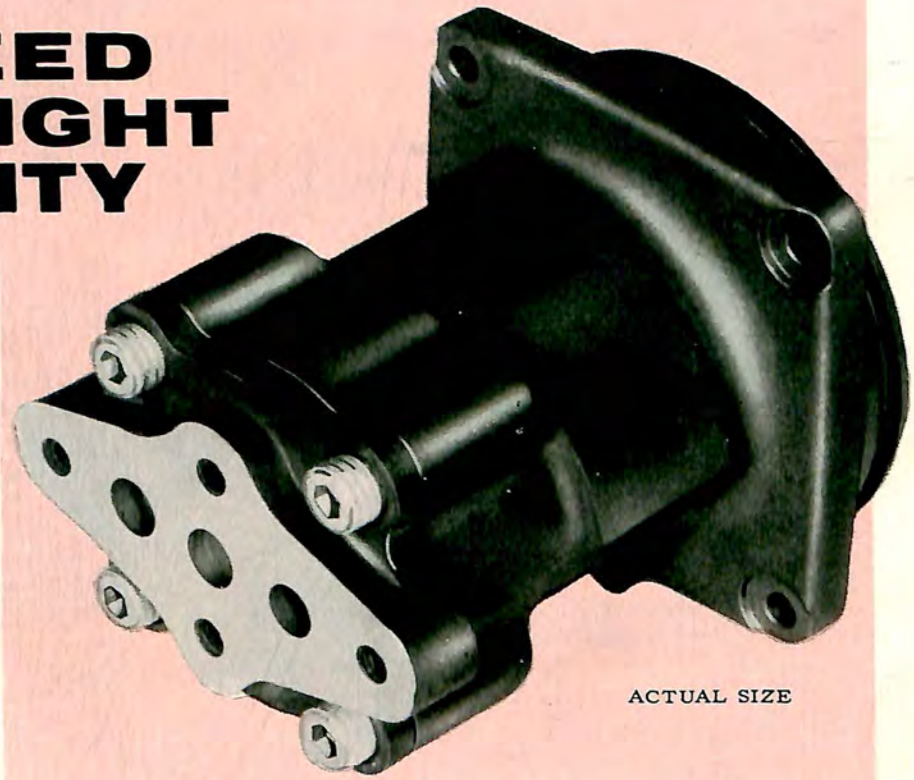
The era of turbine-powered transportation, introduced in 1958, grew out of its infancy in 1959 as a number of American and foreign airlines started operating U.S.-built turbine airliners. Jet flights, a novelty in 1958, became almost commonplace and new turboprop aircraft were making significant reductions in scheduled trip times on both trunk and local service airlines. At year-end, four of the five American-built turbine airliners were in airline use, and the fifth was preparing for its service inaugural in the spring of 1960.

For general aviation it was "more of the same," another successful year in which the ascending growth curve of this segment of aviation climbed another notch on the graph.

With Soviet might becoming more and more apparent in the light of the USSR's space accomplishments, it was a hectic year for the military services, but here too there were important advances, such as the attainment of operational status of the first American intercontinental ballistic missile and the introduction to service use of a number of other new automated weapons to replace earlier missiles rapidly becoming obsolete. On the other hand, rising costs of equipment and its research and development brought a degree of retrogression, particularly in the area of manned combat aircraft, where 1959 saw the cancellation of the Air Force's most advanced fighter aircraft and a de-emphasis on an important supersonic bomber project. The Navy neared operational status with its most important aerospace program, the Fleet Ballistic Missile, and the Army made the first firings of another significant weapon, the anti-missile missile.

The year 1959 was, in summary, a year of new progress and new problems. The accomplishments and the obstacles are detailed in this 41st annual edition of the Aerospace Year Book, the third under the aegis of American Aviation Publications.

HIGH SPEED LIGHTWEIGHT RELIABILITY



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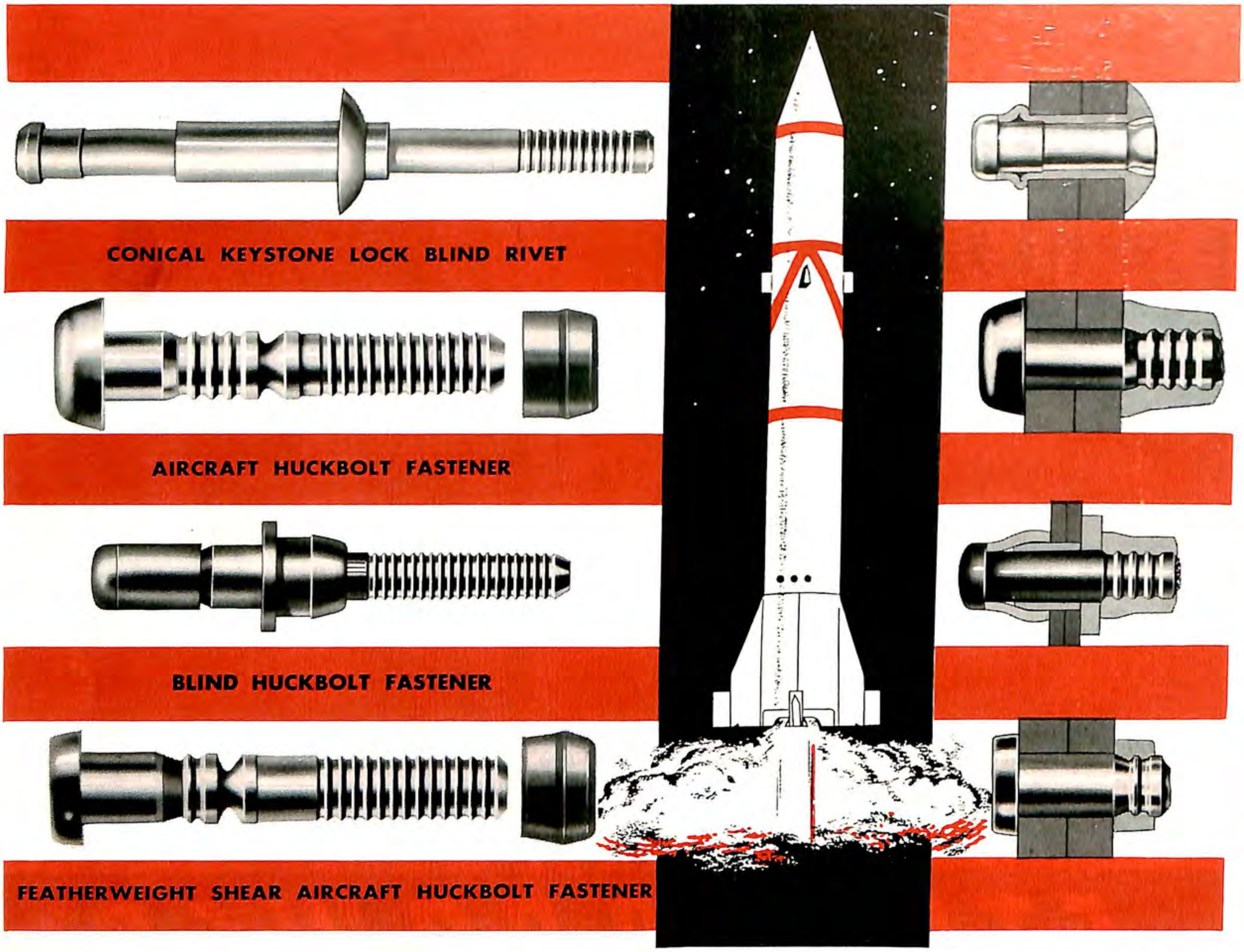

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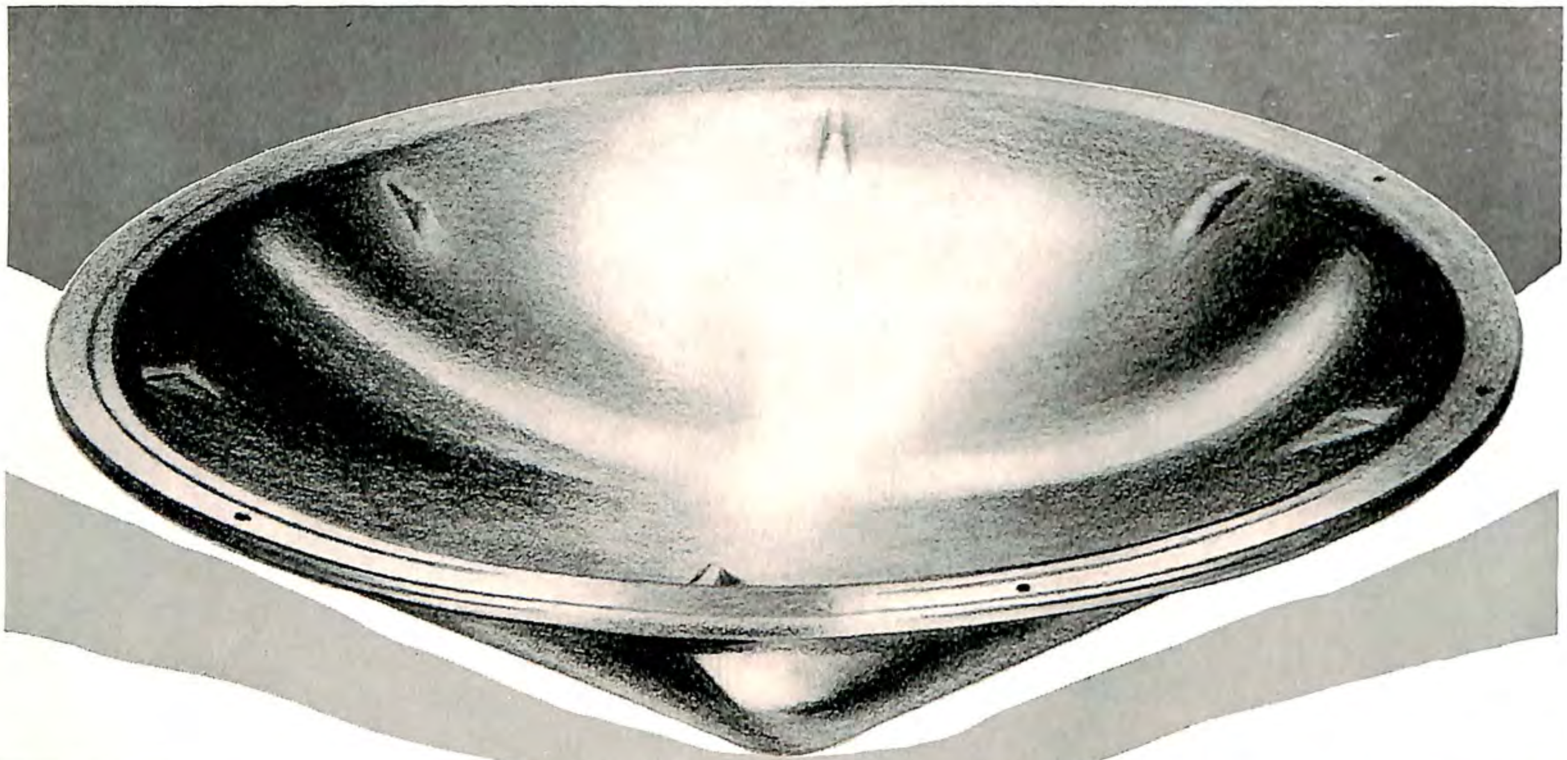

RE-ENTRY SHIELDS

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- Copper in production
- Beryllium in limited production
- Reinforced plastics in development

WYMAN-GORDON

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Ground Power Vehicle

Ground Power Trailer

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Extremely reliable and diversified, AiResearch mobile ground support equipment provides main engine starting for turbine-powered aircraft, and ground air conditioning and electrical power for both aircraft and missiles.

Heart of the lightweight ground support systems are AiResearch gas turbine compressors which provide pneumatic and/or electrical power. Electrical power is supplied when the unit is coupled with an alternator.

GROUND POWER FLYAWAY UNITS for jet engine starting are designed to meet the need for a mobile low cost pneumatic power source which is readily air portable for emergency use. These lightweight, self-contained units are mounted on a compact cart complete with instrument panel and enclosure. They can also be used for missile ground support where pneumatic power is required.

GROUND POWER VEHICLES supply both pneumatic and electrical power for jet engine starting, ground air conditioning and other ground requirements where these types of power are needed. Air and electrical connections located at the front of the vehicle allow the operator to drive frontward into position. The instrument and control panel are inside the cab, and the power unit is easily accessible through wide doors on both sides of the vehicle. Full sound attenuation reduces operating sound level below 90 decibels at a distance of 10 feet.

GROUND POWER TRAILERS provide pneumatic power for jet engine starting on ground air conditioning . . . and electrical power when equipped with an alternator. These rugged, completely self-contained units are also fully sound attenuated. Servicing is easily accomplished through ample access doors.

AiResearch ground support equipment can be designed to meet specific requirements or installed on standard vehicles. Your inquiries are invited.

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Los Angeles 45, California • Phoenix, Arizona

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AEROSPACE

EVENTS

RECORDS

New records in all categories were set by men and their aircraft during 1959.

SPEED RECORDS

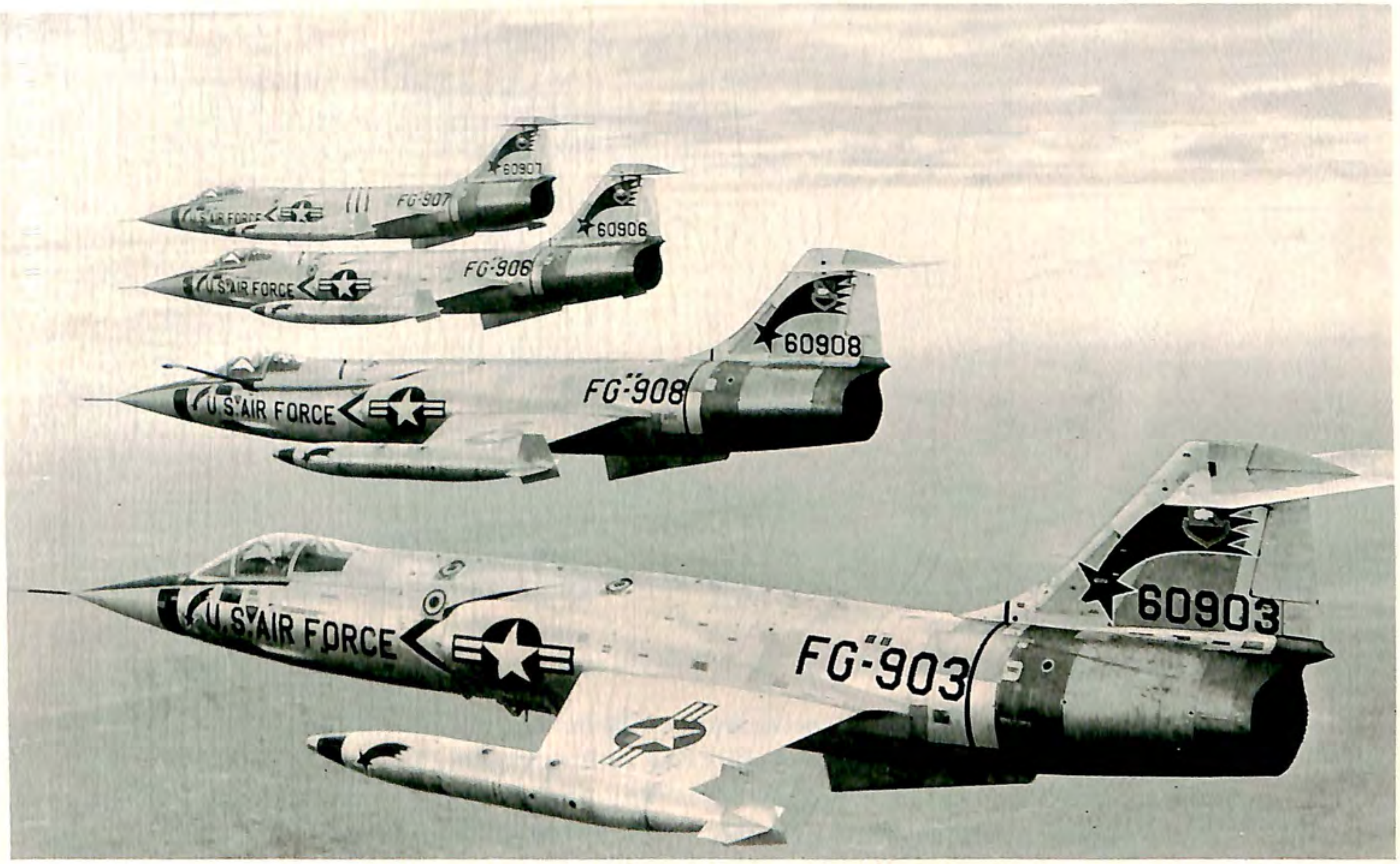
On December 11, Brigadier General Joseph Moore, USAF, flew a Republic F-105 (top) for 100 kilometers in a closed circuit for a new record of 1216 miles per hour. Four days later, Major Joseph Rogers, USAF, made a record-breaking flight at 1525.95 miles per hour in a Convair F-106 (bottom) on a straightaway course.

HELICOPTER ALTITUDE

In December, the Kaman turbine-powered H-43B, flown by Captain Walter Hodgson and Major William Davis, climbed to 30,100 feet to set a new helicopter altitude record.

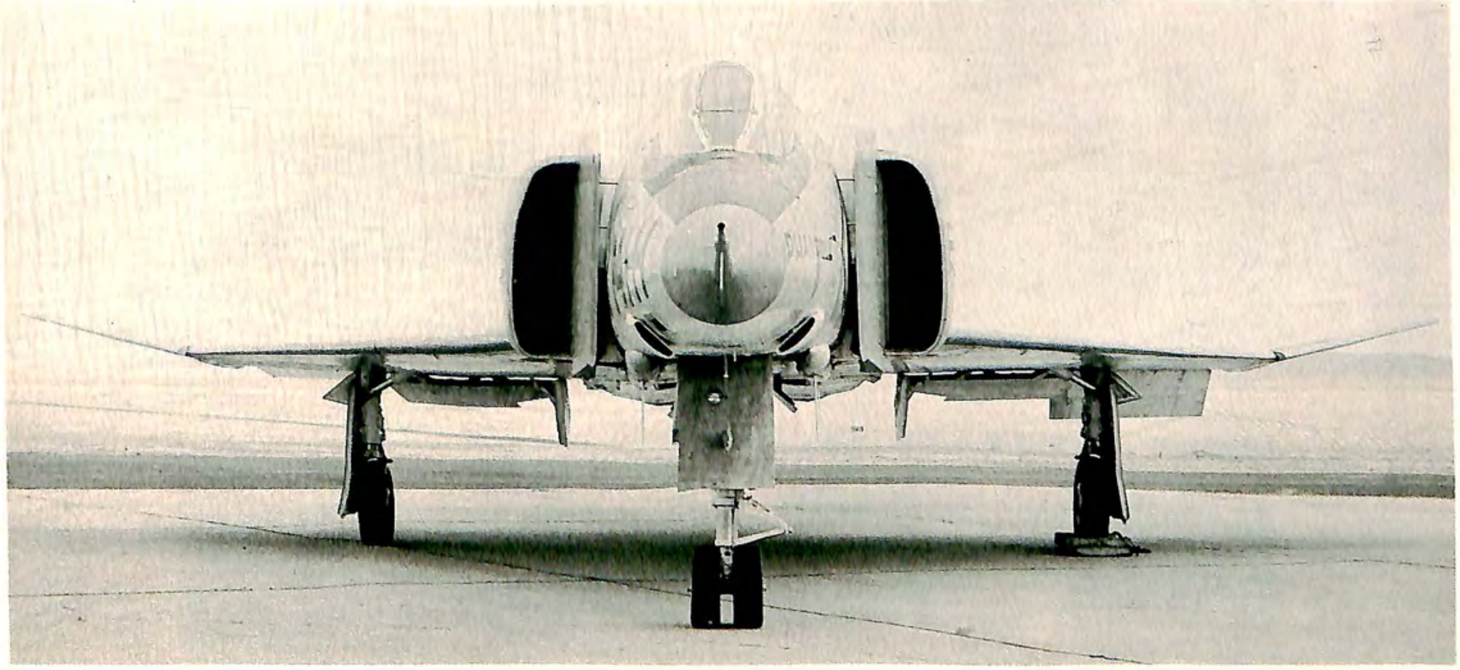
COMMERCIAL JET TRANSPORT

American Airlines' Boeing 707 powered by four Pratt & Whitney JT3C-6 turbojet engines, spanned the country, Los Angeles to New York, in four hours, three minutes, 53.8 seconds at an average speed of 609.472 miles per hour on January 25. The return trip was made in four hours, 46 minutes, 57.6 seconds.



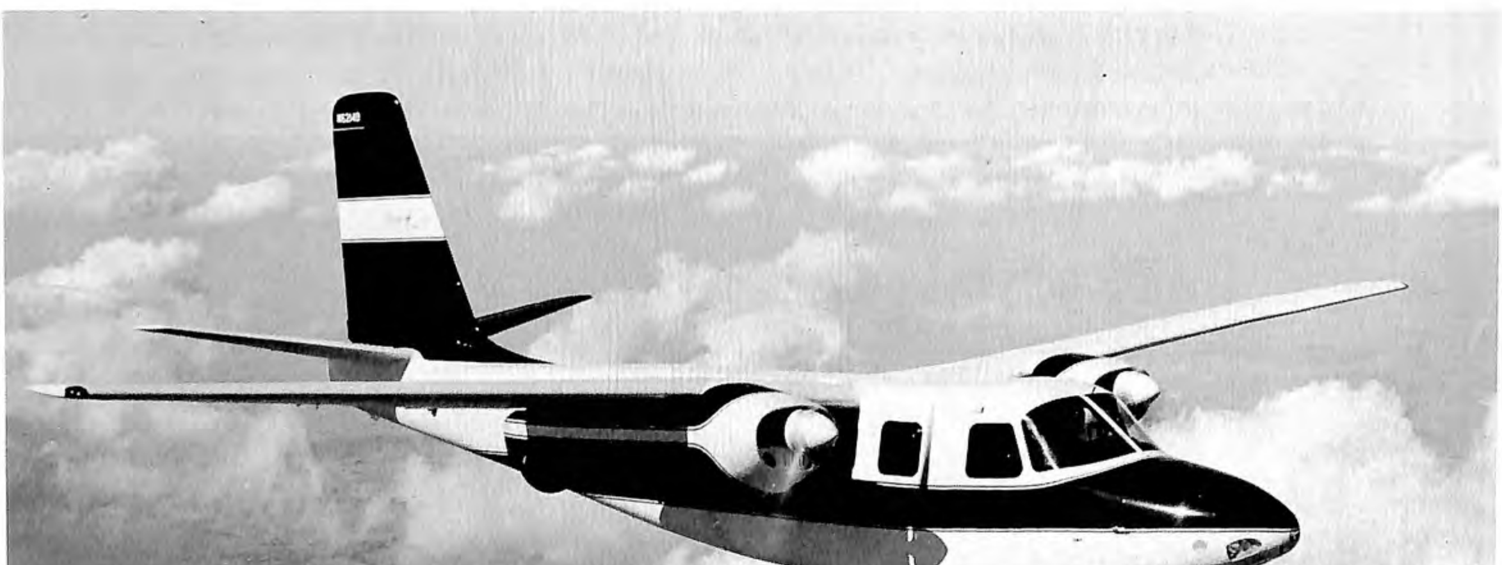
JET ALTITUDE RECORDS

Early in December, Navy set a new altitude record of 98,558.51 feet in a McDonnell F4H Phantom II jet (below) piloted by Commander Lawrence Flint. This was topped in mid-month by Air Force Captain Joe Jordan in a Lockheed F-104C (above) that climbed to 103,395.5 feet. Both planes were powered by General Electric J79 engines.



DISTANCE RECORD

Max Conrad, in a Piper Comanche, set a world distance record for light aircraft by flying nonstop from Casablanca, Morocco to Los Angeles, California, 7,668.48 miles, in 58 hours and 38 minutes on June 2 to 4. On November 26, again in a Piper Comanche, he completed another record-breaking flight, Casablanca to El Paso, Texas, 6,959 miles in 56 hours and 26 minutes.



LIGHT AIRCRAFT SPEED

An Aero Commander 680-E, piloted by Miss Jerrie Cobb, flew at 226.972 miles per hour over an official 2,000 kilometer course on April 13 to set a new world record for light aircraft.

LOS ANGELES-WASHINGTON RECORD

On January 20, a Douglas RB-66A, powered by two General Electric CJ805 turbojet engines, flew from Los Angeles, California, to Washington, D. C. in three hours, 35 minutes, 59.1 seconds. The same plane made the return trip in four hours 58 minutes, 15.9 seconds on January 22.

SPEED IN A CLOSED CIRCUIT

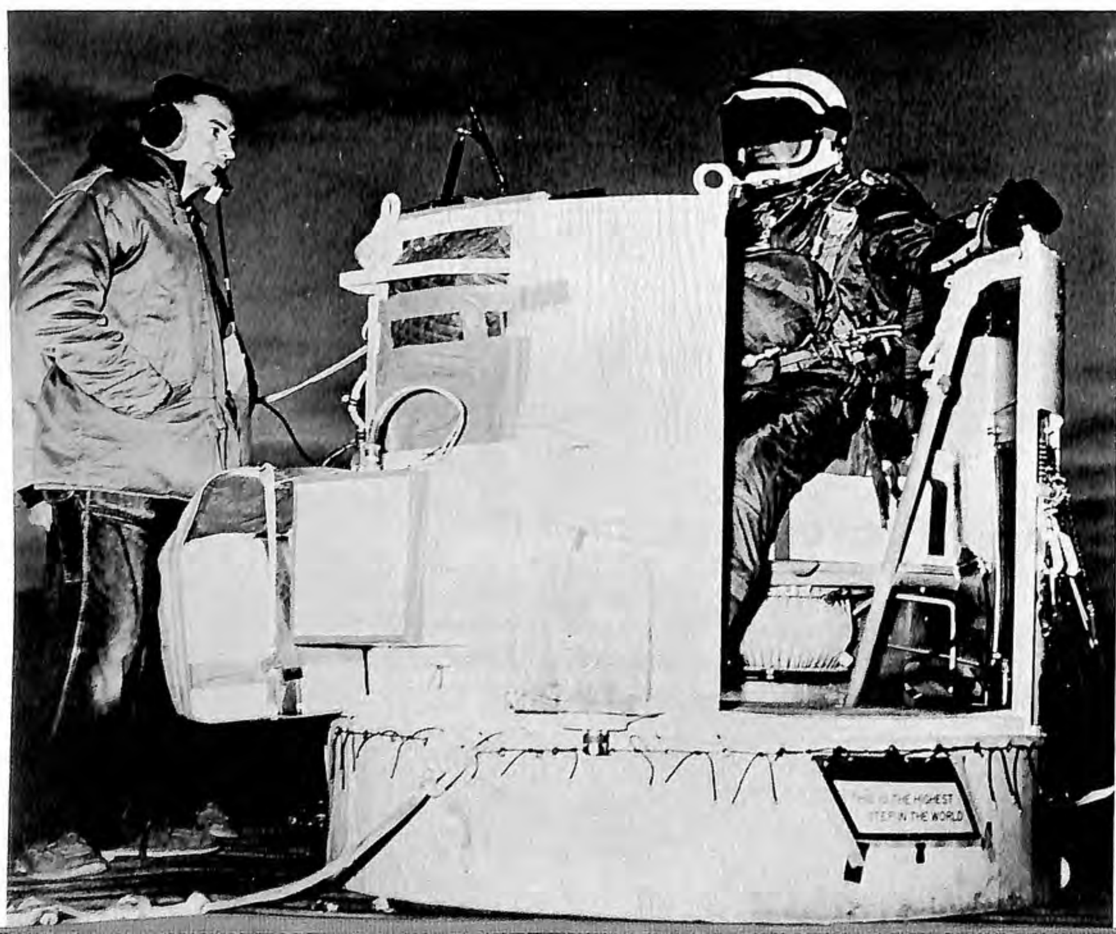
On April 8, the McDonnell RF-101C, powered by two Pratt & Whitney J57 engines, flew 1,000 kilometers in a closed circuit at 700.047 miles per hour to set a new record. A week later, the RF-101C made another record-breaking flight, flying 500 kilometers at 816.3 miles per hour.

ENDURANCE FLYING

Flying a standard Cessna 172, Pilots Robert Timm and John Cook set a world nonstop endurance flying record, staying in the air 64 days, 22 hours and 19 minutes.

HIGHEST JUMP

The longest parachute jump in history was made from an open balloon gondola at an altitude of 76,400 feet on November 16 by Air Force Captain Joseph W. Kittinger, Jr. Shown here, Captain Kittinger waits in the open gondola prior to the big lift.



AWARDS

Although it is impossible to include all who were honored for their achievements during the year, some of the major award-winners are pictured on these pages.

COLLIER TROPHY

Awarded annually for the greatest achievement in aviation in the United States, the value of which has been demonstrated in actual use during the preceding year, the Collier Trophy for 1959 was presented by Vice President Richard Nixon to the designers and fliers of the Lockheed F-104. Pictured here left to right are Air Force officers Major Walter W. Irwin and Lieutenant Colonel Howard C. Johnson, who set altitude and speed records in the plane, Vice President Nixon, Neil Burgess and Gerhard Neumann of General Electric's Flight Propulsion Division, who developed the J79 turbojet engine, and Clarence L. Johnson of Lockheed Aircraft Corporation, who designed the airframe.

AWARDS TO USAF PILOTS

Distinguished Flying Crosses were awarded to the five Air Force pilots who broke four aviation records within seven days. Shown here left to right are Secretary of the Air Force Dudley C. Sharp; Brigadier General Joseph H. Moore who set a new closed course speed record and was also winner of the *BENDIX AWARD;* Captain Joe E. Jordan, winner of the *GENERAL ELECTRIC TROPHY,* who established a new altitude record; Captain Walter J. Hodgson who set a new helicopter altitude record; his flight co-pilot, Major William J. Davis; and Major Joseph W. Rogers who flew to a new straight-away speed record and won the *THOMPSON TROPHY.*

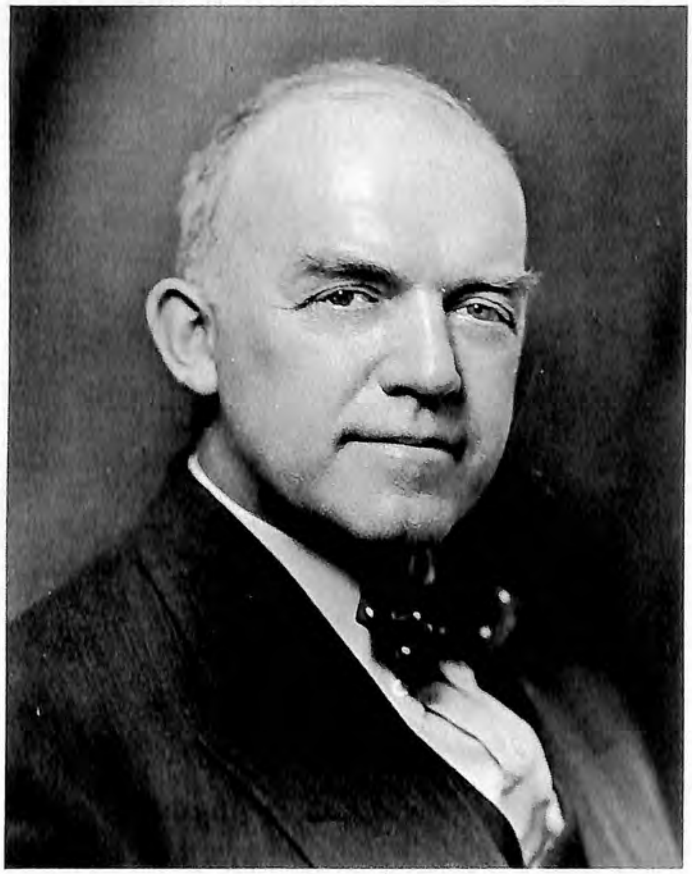
FRANK G. BREWER TROPHY

Dr. Paul Garber, Head Curator, National Air Museum, was named winner of the National Aeronautic Association's Brewer Trophy, awarded each year "to any individual or organization which contributes most to the development of air youth in the field of education and training."

OCTAVE CHANUTE AWARD

This award was presented by the Institute of the Aeronautical Sciences to John P. Reeder, NASA Langley Research Center "for extended and significant contributions to aircraft flight research, with particular reference to the safe operation of helicopters during the landing approach under adverse weather conditions."

WRIGHT BROTHERS MEMORIAL TROPHY



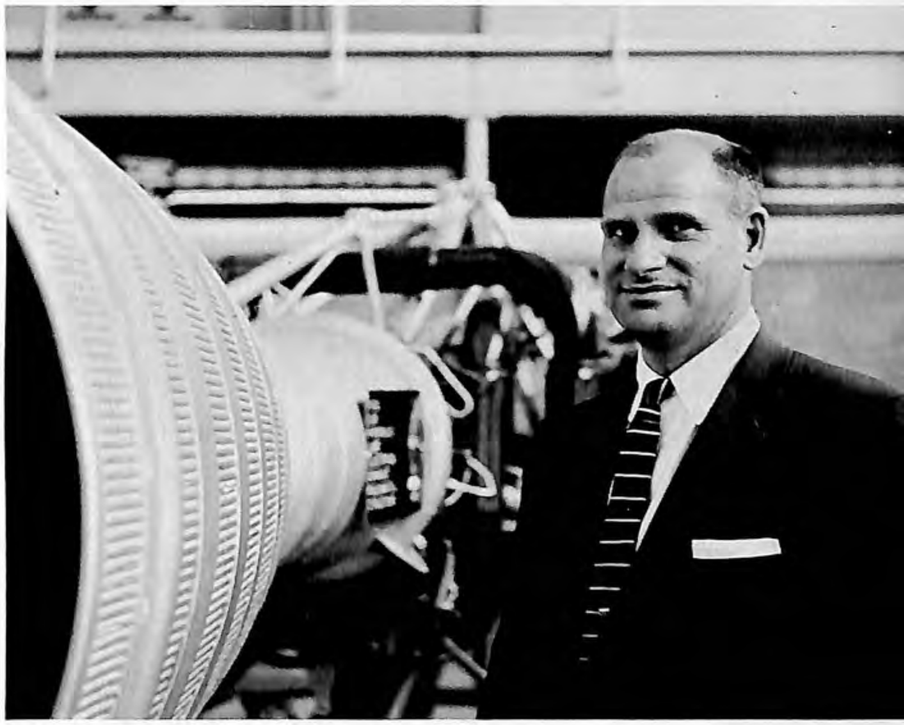
William P. MacCracken, Jr., Attorney at Law and an Elder Statesman of Aviation, was selected to receive the Wright Trophy for "significant service of enduring value to aviation in the United States."

AVIATION MAN OF THE YEAR

SAC Commander General Thomas S. Power, named "Aviation Man of the Year," received the H. H. Arnold Trophy at the annual Air Force Association convention in September.

GENERAL WILLIAM E. MITCHELL AWARD

James H. "Dutch" Kindelberger (left), chairman of the board of North American Aviation, Inc. is shown here accepting the Mitchell Award from Lieutenant General Clarence S. Irvine. Mr. Kindelberger was honored as "the United States citizen making the outstanding individual contribution to aviation."



ROBERT H. GODDARD MEMORIAL DINNER AWARDS

S. K. Hoffman (left), Vice President, North American Aviation, Inc. and General Manager of the Rocketdyne Division, received the Dr. Robert H. Goddard Memorial Trophy, presented by Missiles and Rockets magazine "for his leadership in developing the high-thrust rocket engines which in 1958 launched the first American satellite and the first long-range ballistic missile." Later in the year, Mr. Hoffman was again honored when he won the American Rocket Society's Robert H. Goddard Memorial Award.

Thomas F. Dixon (right), Chief Engineer, Rocketdyne, a division of North American Aviation, Inc. accepted on behalf of Rocketdyne, the Rocket Industries Achievement Award presented by the Borg-Warner Corporation "to the company which during the preceding year contributed most to the advancement of the art of missiles and astronautics."

AMERICAN HELICOPTER SOCIETY AWARDS

The Dr. Alexander Klemin Award, the Society's highest honor, was presented to Robert H. Lichten (left), Bell Helicopter Corporation, for development of the Army XV-3. Presenting the award is Don Berlin, Awards Chairman.

The Society's Kossler Award for the "most outstanding practical application of the helicopter," was presented to New York Airways. Robert L. Cummings (left), President of NYA, accepts the award from Don Berlin.

Leston P. Faneuf (right), Bell Aircraft Corporation, presents the Grover E. Bell Award to Lee Douglas representing the Vertol Aircraft Company engineering staff, for the design, development and successful test flight of the Vertol 76, first tilt wing aircraft to perform successful conversion.

AWARDS TO TAC

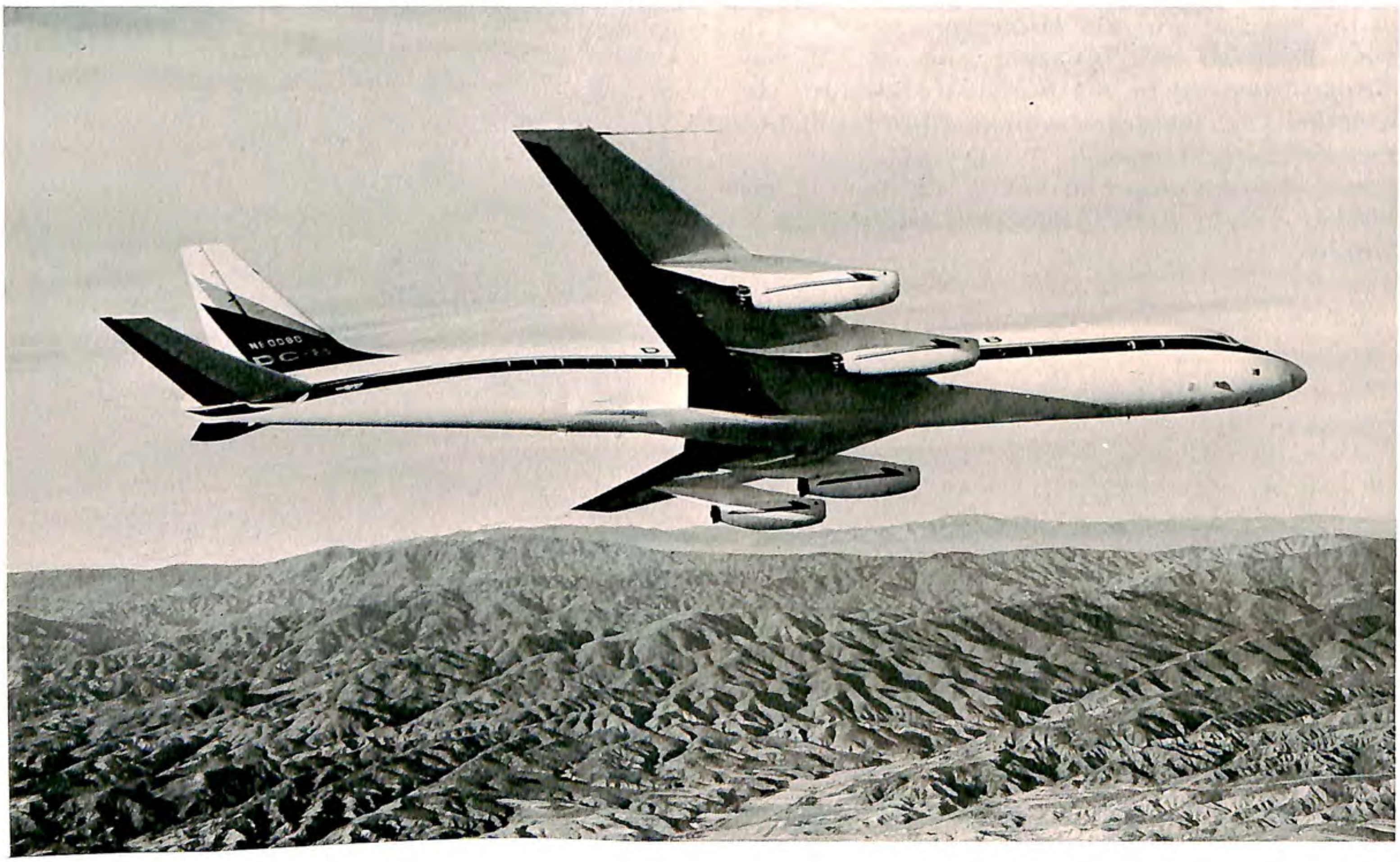
The Tactical Air Command won three Air Force awards during 1959: the Order of Daedalian Trophy for "the major air command having the most effective aircraft accident prevention program during 1958;" the Schilling Trophy in recognition of the fast and powerful Strike Force responses in both Formosa and Lebanon; and the Mackay Trophy, awarded by the National Aeronautic Association "for the year's most meritorious flight." Pictured here, General O. P. Weyland (right), recently retired Commander of TAC, received the Mackay Trophy from Lieutenant General Dean S. Strother.

LAWRENCE SPERRY AWARD

Robert G. Loewy, chief technical engineer of Vertol Aricraft Corporation, was presented the Lawrence Sperry Award by the Institute of Aeronautical Sciences "for his theoretical and experimental contributions to structural dynamics, aeroelasticity and unsteady aero-dynamics in rotary wing aircraft design."

NEW PLANES

American-built turbine-powered transports entered domestic and international passenger service during the year.



DOUGLAS DC-8

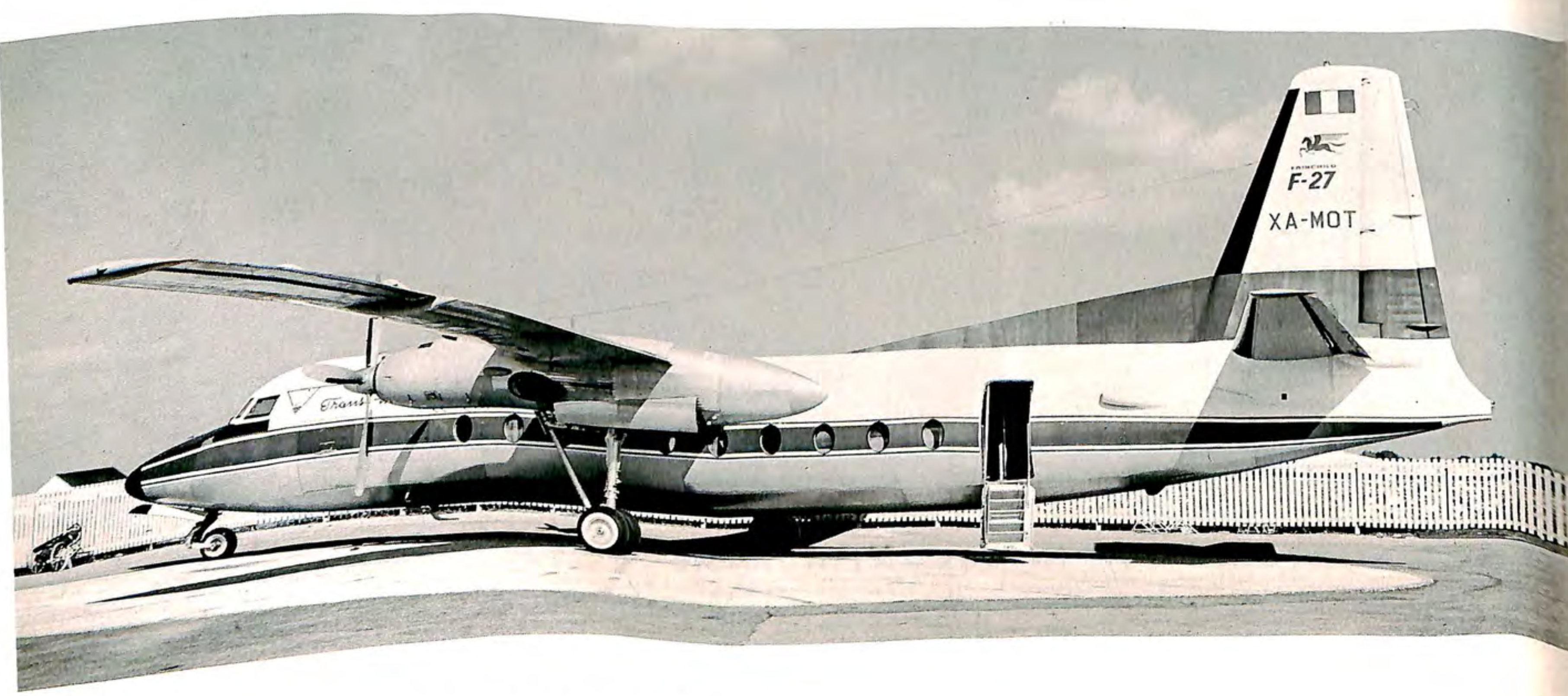
The Douglas DC-8 transport carried its first paying passengers in September with inaugural flights by Delta Air Lines and United Airlines.

BOEING 707 INTERCONTINENTAL

The Boeing 707-320 entered intercontinental service with Pan American and Trans World Airlines during the year. Also, late in November, the 720 medium range jet transport made its first flight.

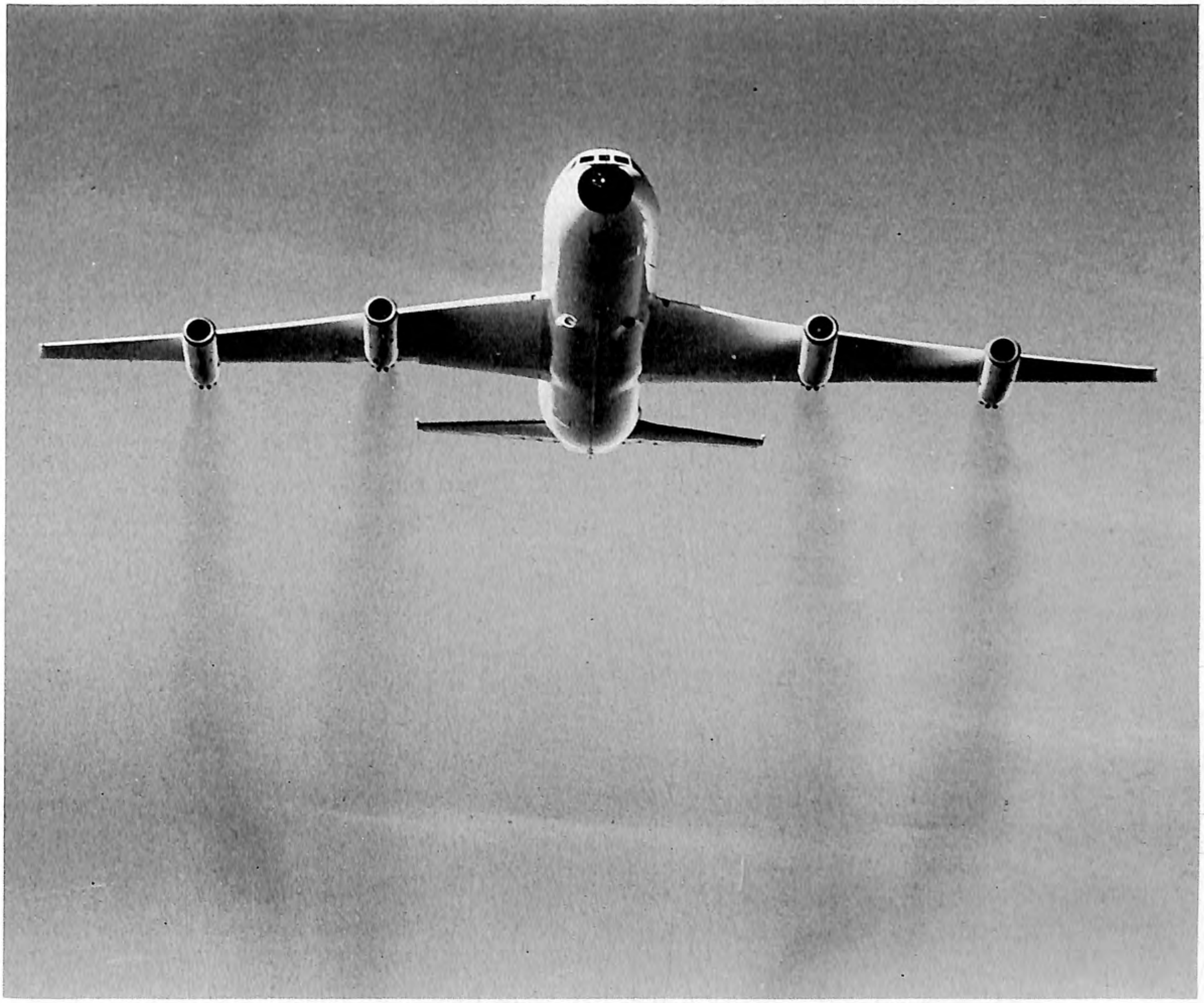
LOCKHEED ELECTRA

Over one hundred propjet Electra transports were delivered to foreign and domestic airline customers during the year.



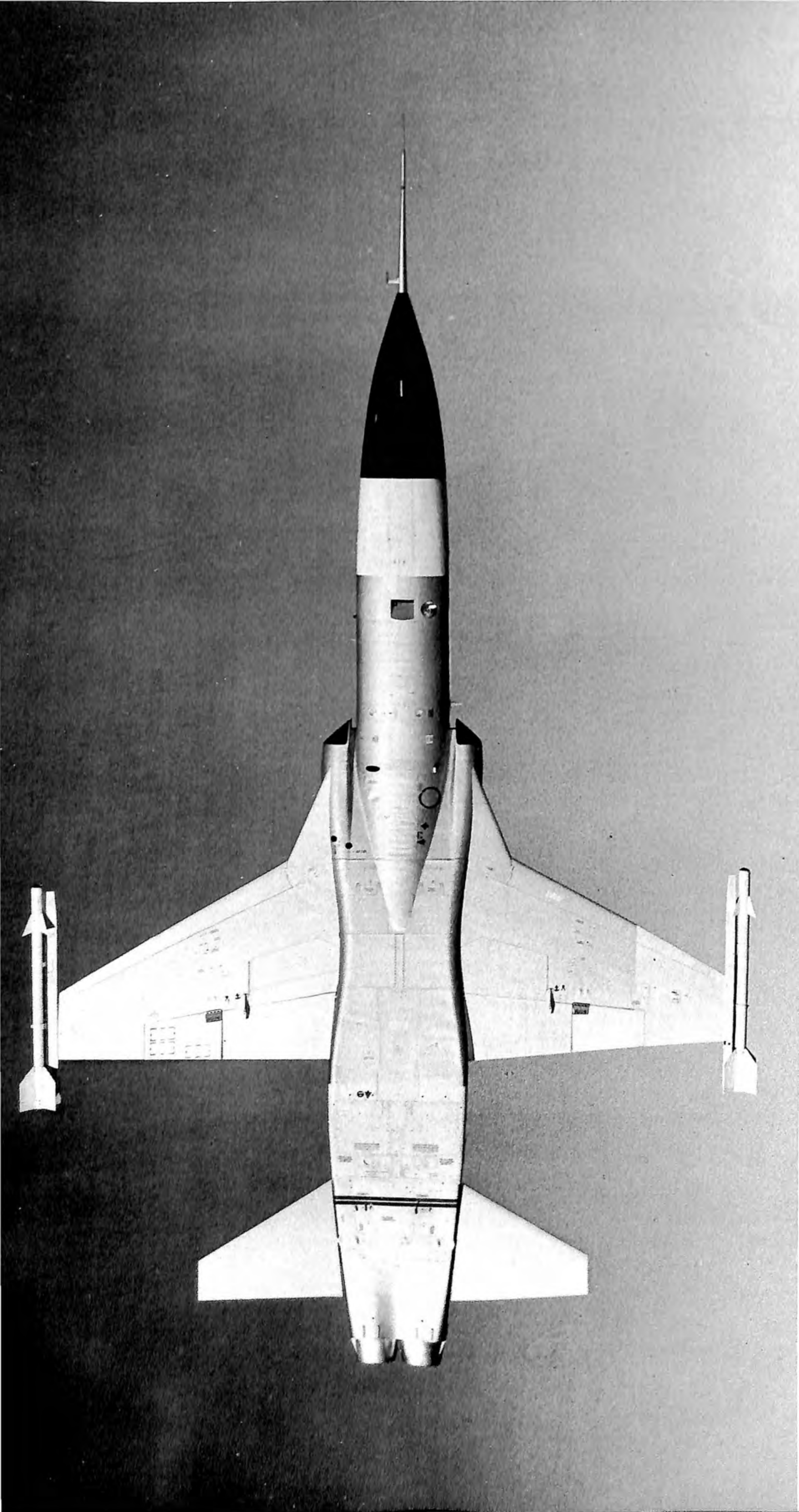
FAIRCHILD F-27

The F-27 was placed in service late in 1958. By the end of 1959, the aircraft were being produced at the rate of five per month.



CONVAIR 880

At year-end, the Convair 880 was undergoing certification flight testing and was to be delivered to airline users early in 1960.



NORTHROP N-156F

The Freedom Fighter, under development for use by allied nations, made its first flight in June. Its sister ship, the T-38 Talon, flew for the first time in April and was scheduled to become operational in the Air Training Command.

McDONNELL 119

This new four-engine utility jet trainer and transport, began test flights early in the year.

GRUMMAN MOHAWK

The Mohawk, designed for combat surveillance and target acquisition, and capable of speeds in excess of 300 miles per hour, flew for the first time in April.

LOCKHEED P3V-1

First production order for the P3V-1 anti-submarine aircraft came from the Navy in September.

GOODYEAR MAYFLOWER II

This new non-rigid airship was the first commercial version to be built by Goodyear in more than twenty years.

PIPER AZTEC

The Aztec, newest, largest and fastest plane in the Piper fleet of business aircraft, was introduced late in the year.

PIPER PAWNEE

Deliveries of the new Pawnee, designed specifically for aerial application of agricultural chemicals, began in the summer of 1959.

BEECHCRAFT DEBONAIR

First flight of the Model 33 Debonair, a four-place, single-engine business airplane, occurred in September.

CESSNA 407

Cessna entered the military utility market in October by introducing a mock-up of a four-plane jet, designed to fulfill military needs for a multi-mission, low-cost jet.

CESSNA 210

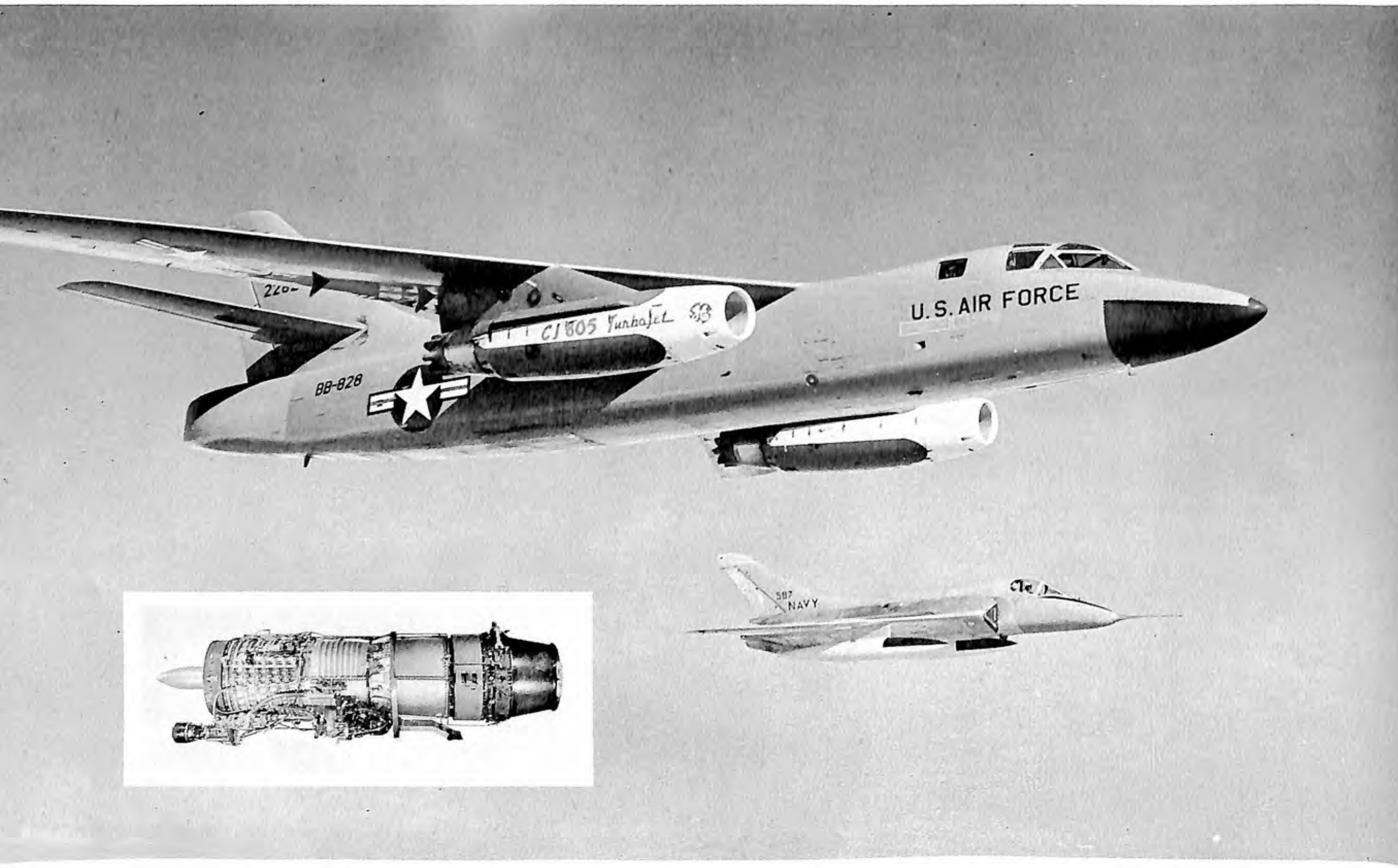
Unveiled in 1959 was Cessna Aircraft Company's new Model 210, single-engine plane with high-wing design and retractable landing gear.

BEECHCRAFT QUEEN AIR

In October, Beech introduced a new six-place executive transport at the 12th annual meeting of the National Business Aircraft Association.

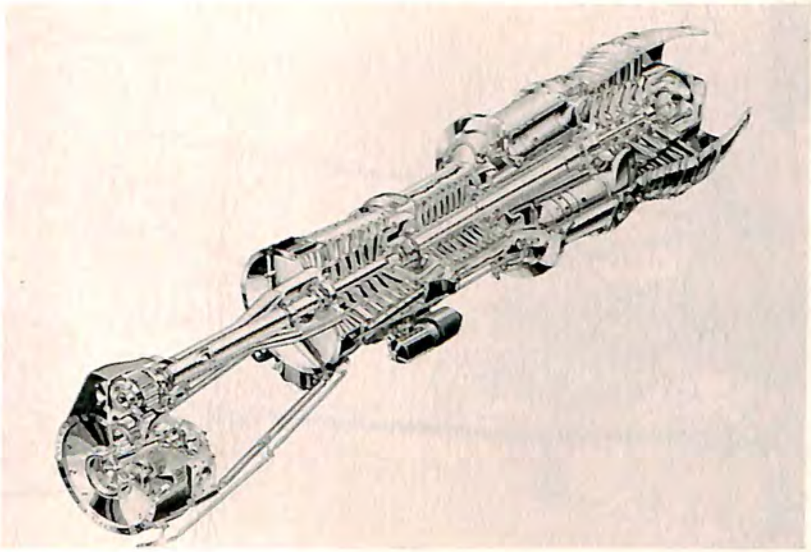
NEW ENGINES

New engines in various stages of test or development were announced during the year. Representative types are pictured here.



GENERAL ELECTRIC CJ-805-3

In the commercial transport area, the GE CJ-805-3 (inset) underwent a vigorous flight-test program, most of the time being accumulated in the Navy XF4D and Air Force RB-66A pictured above. Four of these turbojets power the Convair 880. The CJ-805-23, also announced during the year, will power the Convair 600.

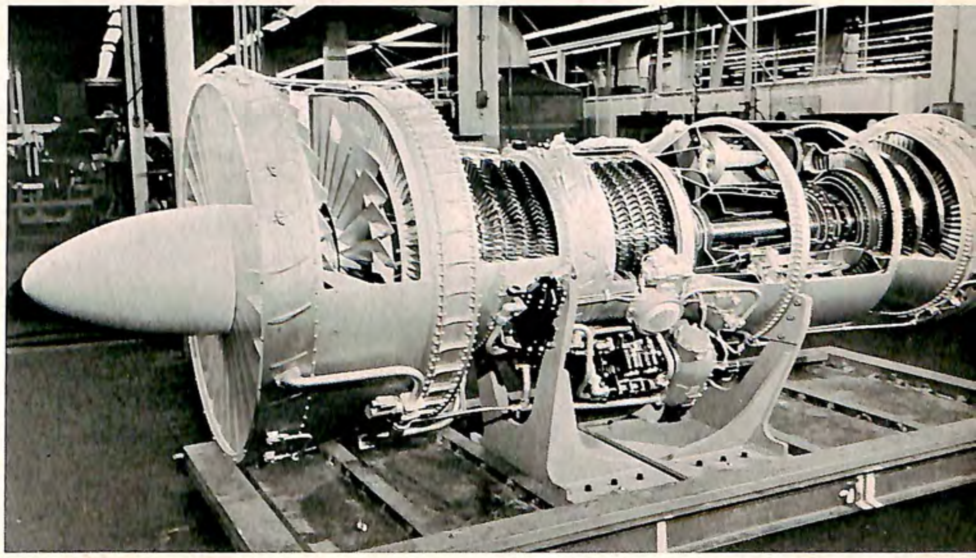


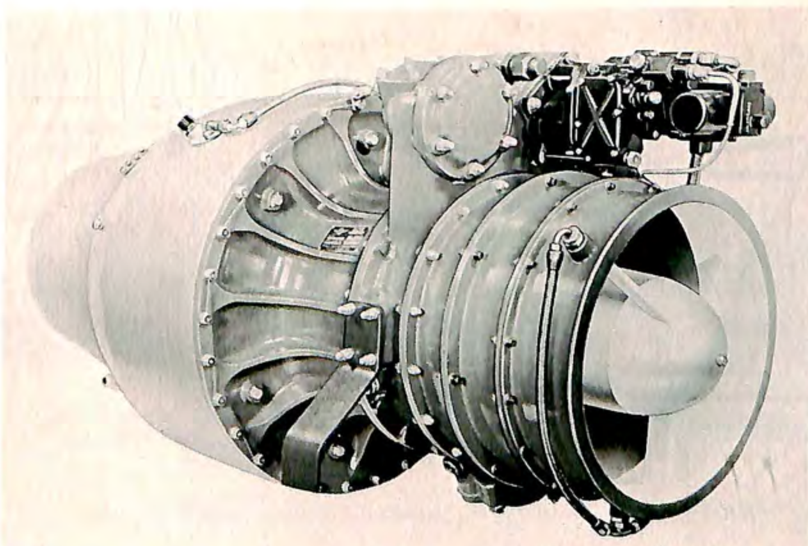
ALLISON T61

Newest member of the Allison gas turbine engine family was the 6500-horsepower powerplant, shown above in a cutaway drawing. Air Force cancelled the contract for its development at year-end.

PRATT & WHITNEY JT3D

Pictured here is a cutaway view of the JT3D turbofan, rated at 17,000 pounds of thrust. The engine was flight tested during 1959 for delivery in mid-1960.





CONTINENTAL J69-T-29

This Continental engine, a 1700-pound thrust turbojet for target missiles, was in production during 1959.

VERTICAL FLIGHT

In September, 1959, the helicopter industry celebrated its twentieth birthday.

THEN.....

The VS-300 helicopter lifts off the ground in September, 1939, with inventor Igor I. Sikorsky at the controls.

.....AND NOW

The HSS-2, developed for the Navy by Sikorsky Aircraft, is shown during one of its first flights in 1959.

FLYING CRANE

Capable of lifting a six-ton load, the Sikorsky S-60 lifts a weighted dummy of the Honest John missile.

TURBINE-POWERED HELICOPTERS

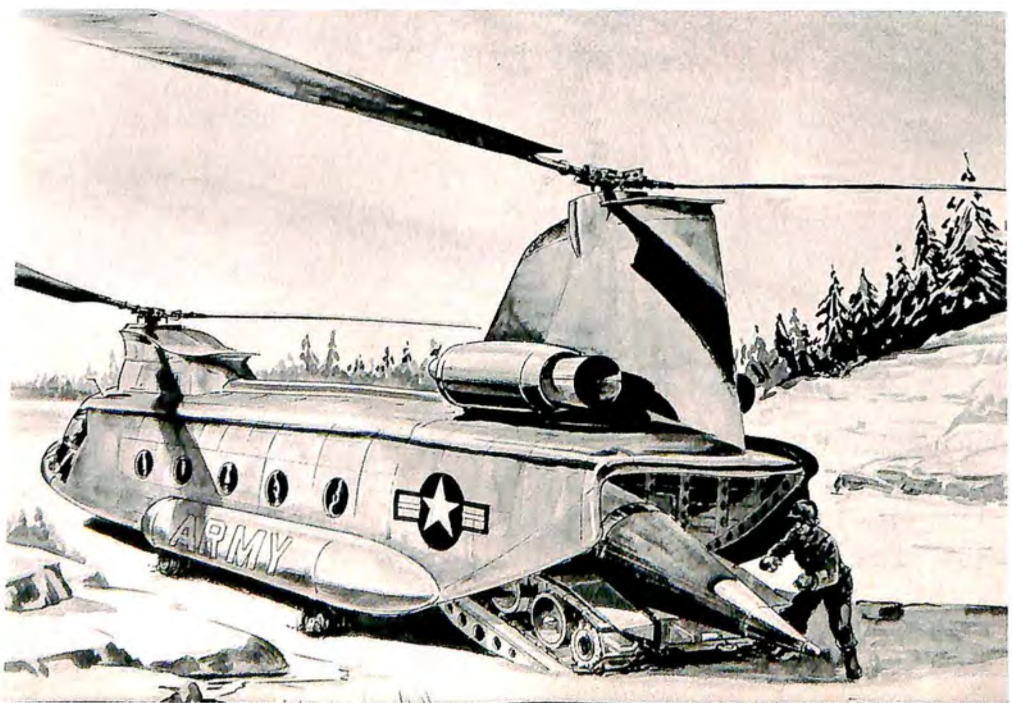
Kaman Aircraft Corporation offered two new turbine-powered helicopters during the year: the H-43B (left) for the Air Force and the HU2K (right) for the Navy.

CESSNA CH-1C

A new helicopter, embodying stability characteristics comparable t fixed wing aircraft, was announced by Cessna Aircraft Company.

YRON-1 ROTORCYCLE

Gyrodyne's one-man carrying rotary wing aircraft was being evaluated by the Marines for many tactical uses.



ARMY TRANSPORT HELICOPTER

Here is an artist's concept of the YHC-1B Chinook for which Vertol Aircraft Corporation received a military letter contract in mid-year.

BELL XV-3

The XV-3 convertiplane, being developed by Bell for the Army, underwent NASA tests during the year.

FAIRCHILD M-224

Fairchild's Aircraft and Missiles Division continued development of this VTOL craft for the Army during 1959.

NEW VERTICAL-LIFT AIRCRAFT

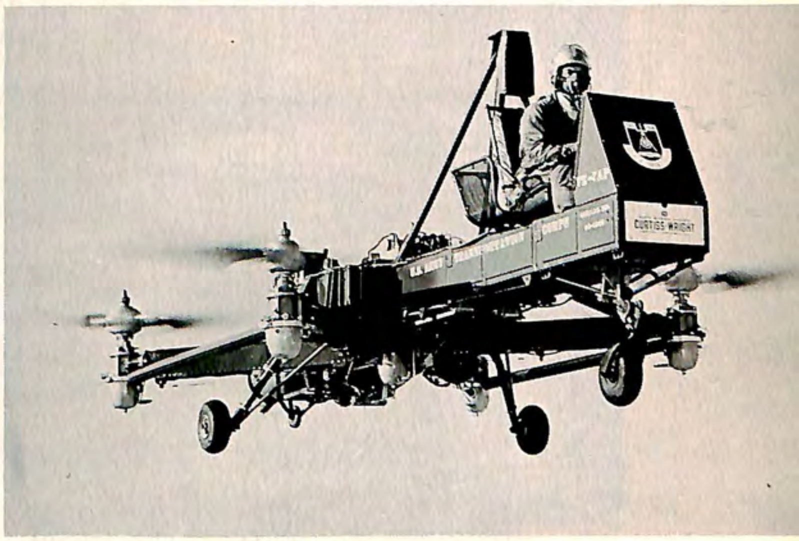
In experimental test stage was this new type vertical lift aircraft, being built by Vanguard Air and Marine Corporation. In each wing and in the tail assembly, otherwise conventional in appearance, are shrouded propellers.

RYAN VERTIPLANE

The Vertiplane, utilizing the deflected slipstream principle to accomplish vertical take-off and landing, is pictured as it completed its first conventional flight tests.

X-18 TILT WING

Developed by Hiller Aircraft Corporation, the X-18 completed its first flight as a conventional airplane on November 24 when it flew to an altitude of 4,000 feet and stayed aloft for twenty minutes.



AERIAL PLATFORM

The Curtiss-Wright VZ-7AP combines the characteristics of a jeep and a helicopter. It is being developed for the Army Transportation Research and Engineering Command.

PEOPLE

The year 1959 saw new leaders in many areas of aviation.

Malcolm A. MacIntyre
President
Eastern Air Lines

Harvey Gaylord
President
Bell Aircraft Corporation

Lieutenant General Donald Putt
President
Institute of Aeronautical Sciences

Thomas V. Jones
President
Northrop Corporation

William B. Bergen
President
The Martin Company

NEW SYSTEMS

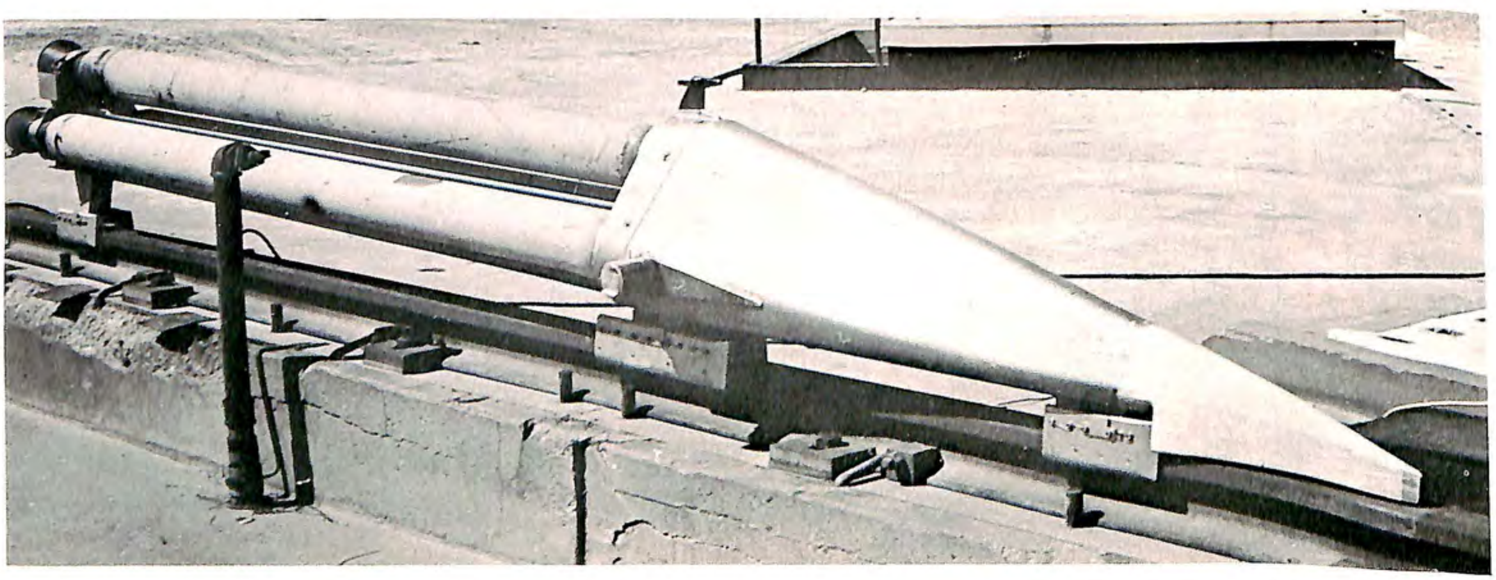
Space limitations prevent including all of the important developments in the field of systems and components. Those reviewed are representative of the entire industry.

HIGH ALTITUDE PHOTOGRAPHY

Using a technique perfected by General Electric's Missile and Space Vehicle Department, this photograph was taken at an altitude of 200 miles. The main stage of the Atlas can be seen falling away, just after separation from the nose cone.

RYAN NAVIGATOR

In the photograph above, a RYANAV model 120B Doppler automatic navigation system and hovering device is being installed on one of the Army's newest Sikorsky H-34 cargo-type helicopters.

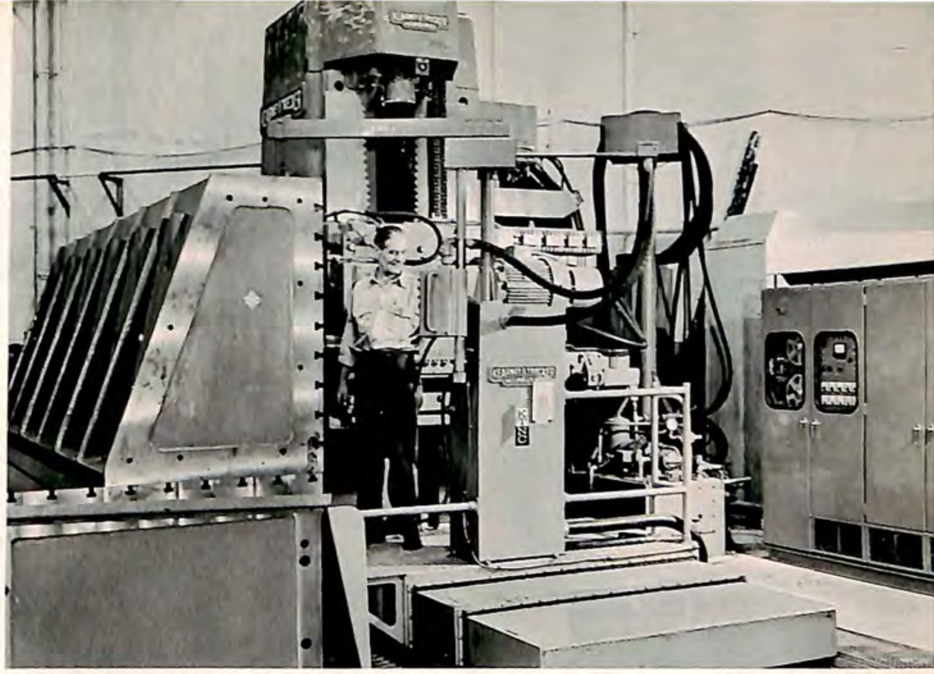


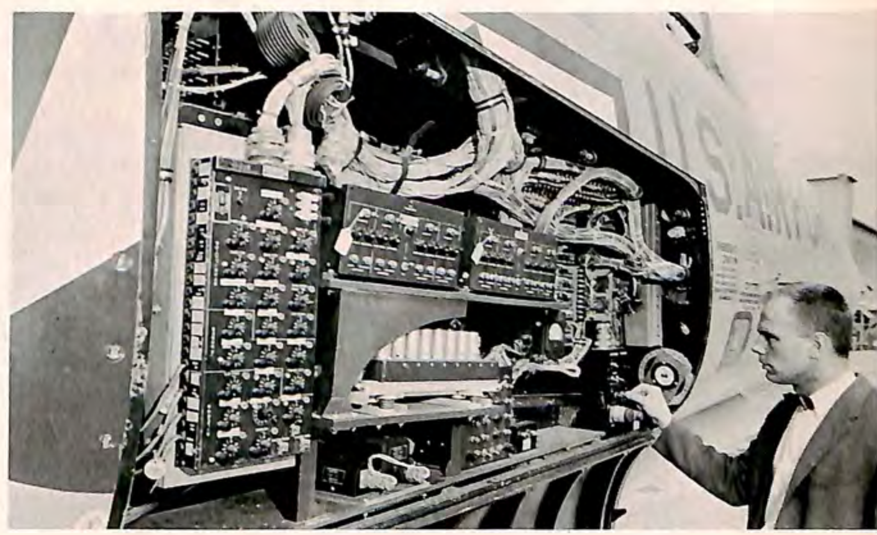
MONORAIL SLED

Capable of reaching a velocity of Mach 5, the Cook Research Laboratories' Monorail Sled is shown here prior to a test at Holloman Air Force Base, New Mexico.

NUMERICAL CONTROL CENTER

An automatically controlled machine tool battery, one of the largest such installations on the east coast, contributed substantially to the completion of Republic Aviation Corporation's F-105D ahead of schedule.





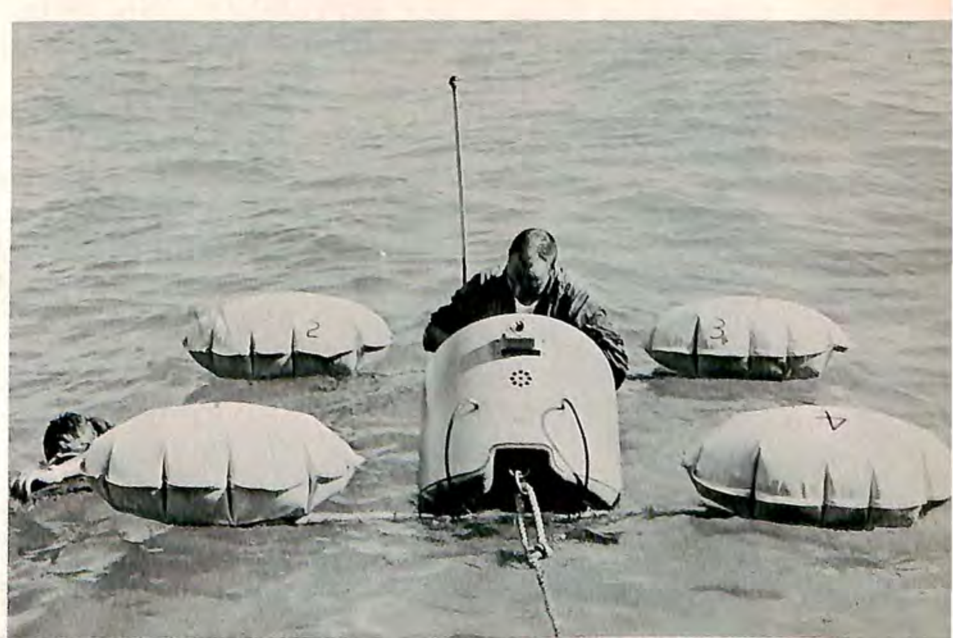
FLIGHT CONTROL SYSTEMS

Developed by Minneapolis-Honeywell, this space age auto pilot (right) has its own electronic "intelligence" and can learn to adapt itself to its own environment. It was installed on a McDonnell F-101 for testing.

Designed expressly for jet airliners, the Sperry SP-30 (left) made inaugural flights during 1959 on the new Douglas DC-8s.

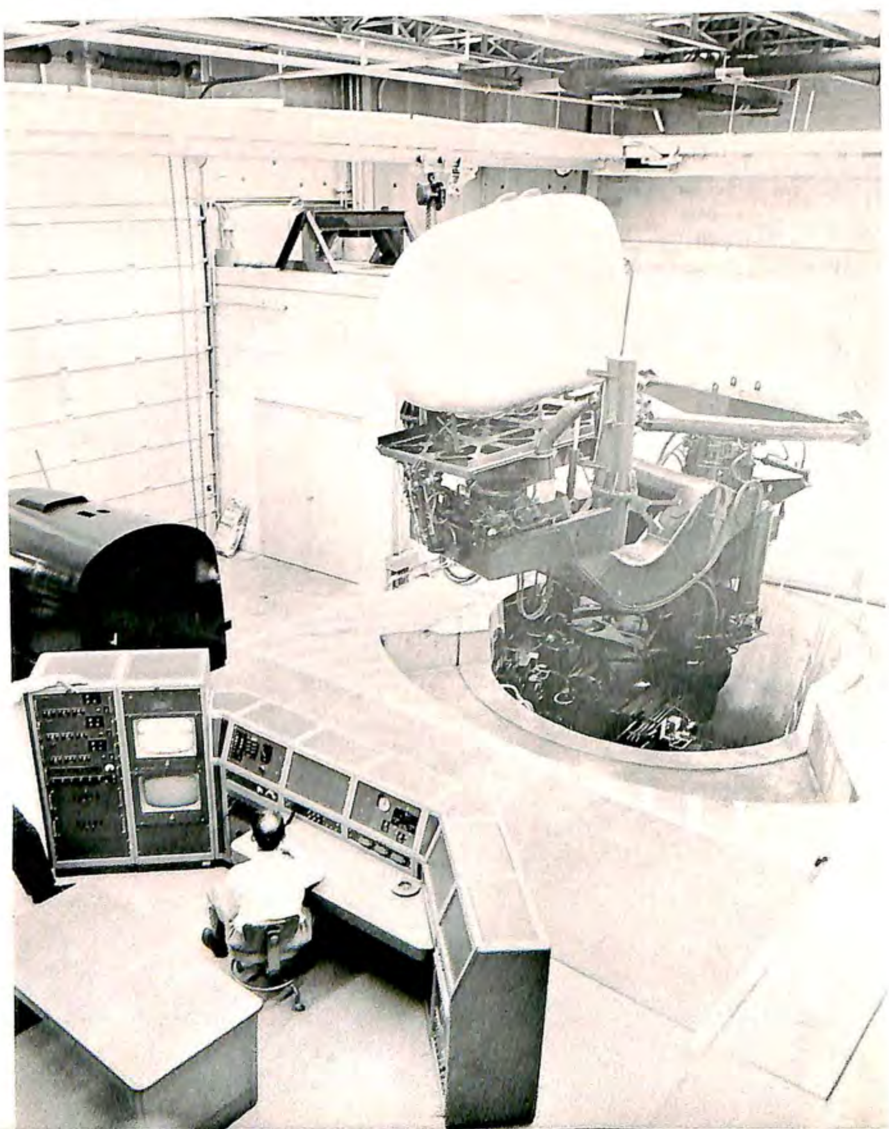
ESCAPE CAPSULE

This capsule, designed and built by Goodyear Aircraft Corporation was successfully tested for comfort, survivability, mobility and arrangement of survival equipment.



ENVIRONMENTAL CONTROL

During the summer, Garrett Corporation's AiResearch Manufacturing Company received a contract from McDonnell for an environmental control system which would enable an astronaut to live comfortably beyond the protection of the Earth's atmosphere. Pictured here under test is a heat exchanger similar to the one which will air condition the capsule and suit.



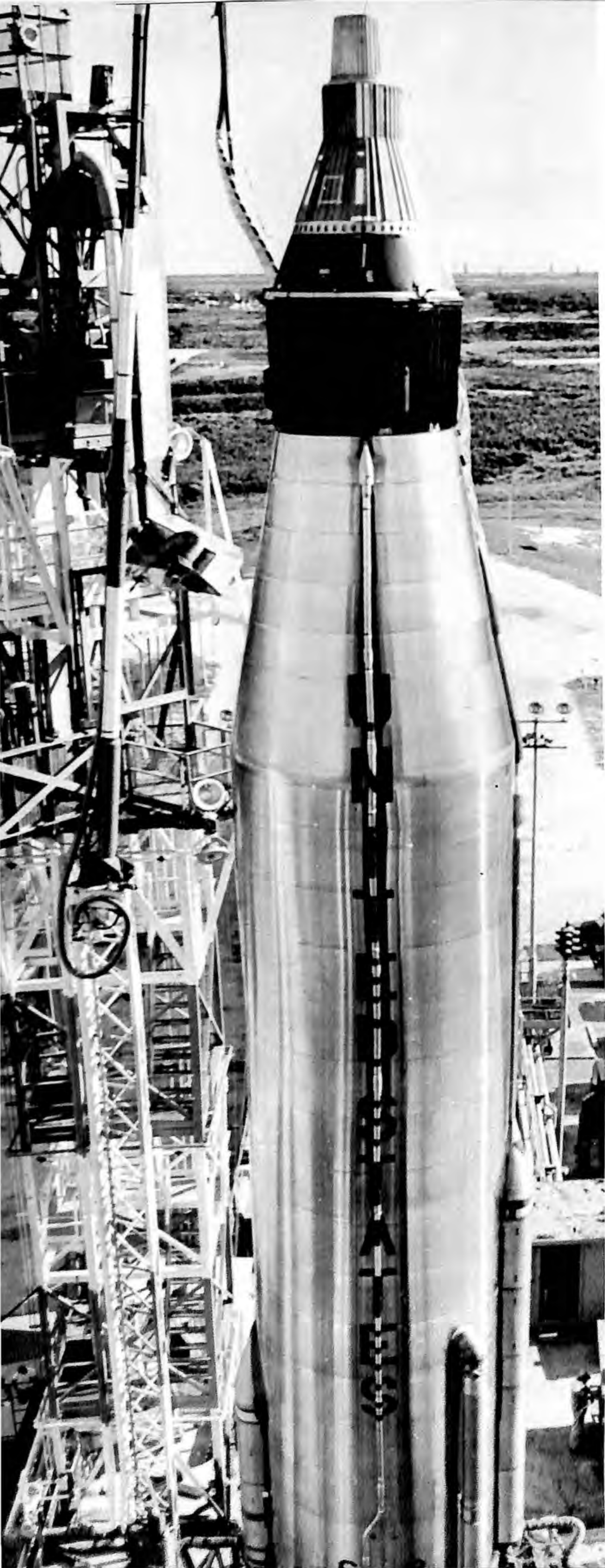
FLIGHT SIMULATOR

Built by Bell Helicopter for human engineering studies of the Army-Navy Instrumentation Program, this flight simulator can reproduce the motion, sound, vibration and general cockpit arrangement of most existing helicopters.

ASTRONAUTICS

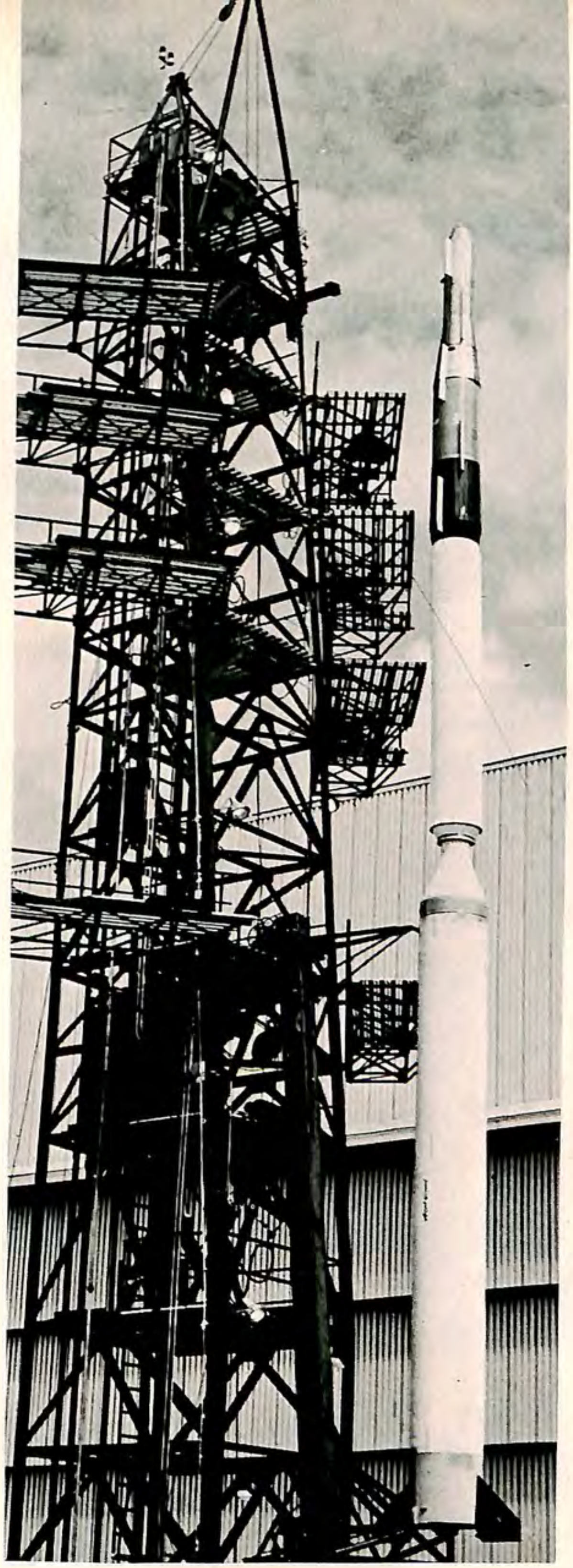
X-15

Progress was made during 1959 on the NASA-Air Force X-15 program, designed to carry man to the threshold of space. The research plane, built by North American Aviation, was completed during the year and glide tests started in the summer. Later, using an interim rocket powerplant, the X-15 made three successful powered flights. The X-15 was expected to make its high performance runs in 1960. From a design standpoint, it is capable of reaching altitudes of more than 100 miles and speeds of close to 4,500 miles per hour.



PROJECT MERCURY

The efforts of the National Aeronautics and Space Administration to put man into orbit under Project Mercury gained momentum during the year. McDonnell Aircraft Corporation received a contract to build the capsule (below) which will contain the astronaut and completed mock-ups. North American Aviation built a Little Joe booster rocket, with which capsule mock-ups were fired to altitude, separated from the booster, lowered by parachute and recovered. The third such Little Joe test was made on November 17. On September 9, a capsule re-entry test was made using a modified Atlas missile known as Big Joe (left) for the booster. Meanwhile, the seven astronauts selected by NASA from the ranks of military pilots, were undergoing training.

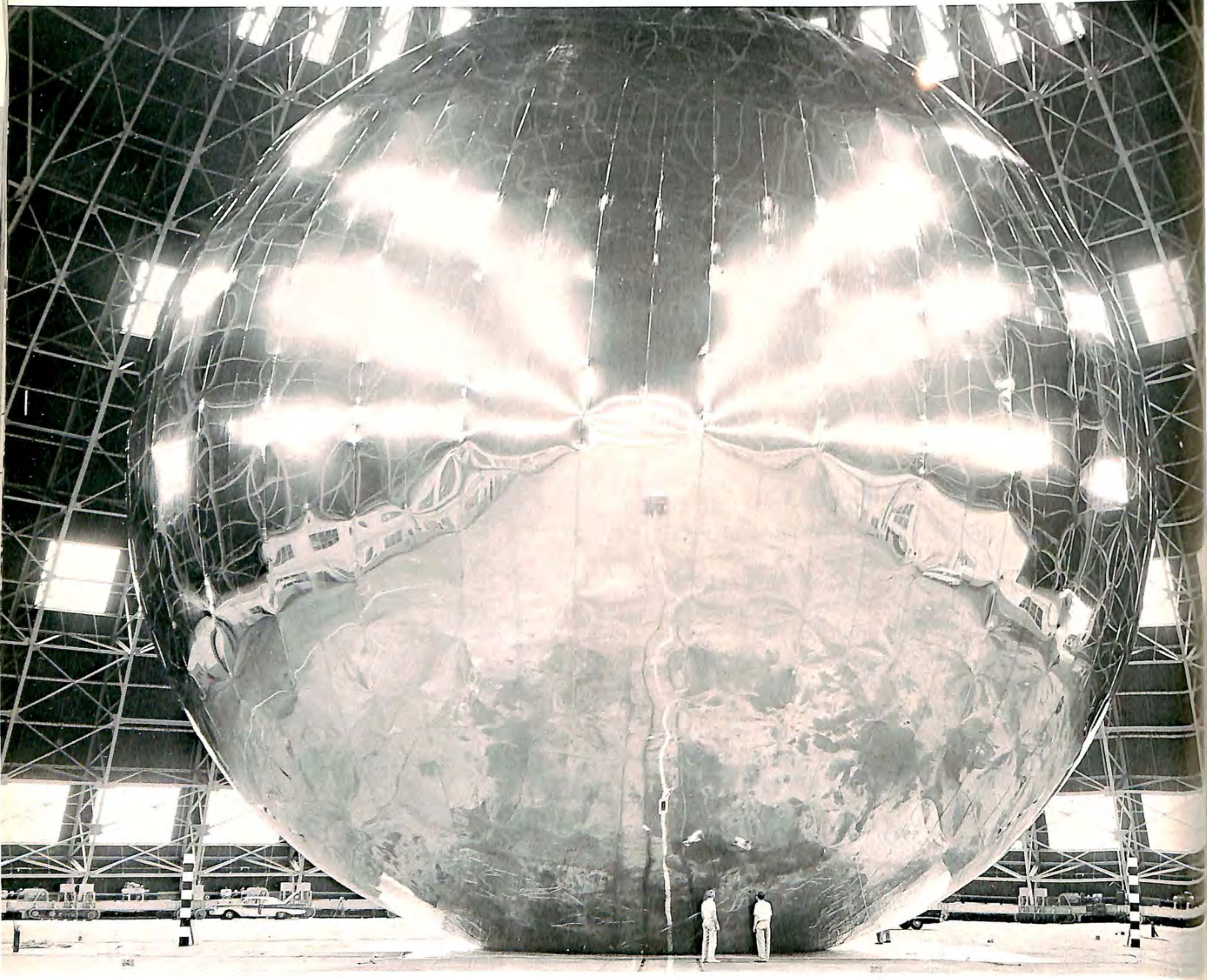


SPACE VEHICLES

Looking to the future, NASA started work in 1959 on a series of space vehicles. First of these was Scout (right), a four-stage solid-propelled vehicle designed to boost a 150-pound research payload into a 300-mile orbit. First Scout tests were to be made in mid-1960. A larger four-stage vehicle, using an Atlas booster as the initial stage, is Centaur, to be available by 1962. Centaur will be capable of firing a four-ton payload into a 300-mile orbit or carrying a 730-pound payload to the Moon. Development was started on still more advanced boosters, Saturn and F1. Saturn will consist of a cluster of eight Rocketdyne H1 rocket engines (above), each producing 150,000 pounds thrust, or a total of 1.2 million pounds. F1, also known as Nova, will have six 1.5 million-pound thrust Rocketdyne engines for a total thrust of nine million pounds.

DYNA-SOAR

A major step toward development of a manned military space vehicle was taken in 1959 when the Air Force awarded contracts for Dyna-Soar, a boost-glide bomber project initiated in 1958, Teams headed by Boeing Airplane Company and The Martin Company had worked for more than a year on two separate designs for the complicated space vehicle. In November, the USAF announced a compromise decision under which Boeing would assume responsibility for development of the frame and Martin would provide the propulsion, with a system based on its Titan ICBM booster.

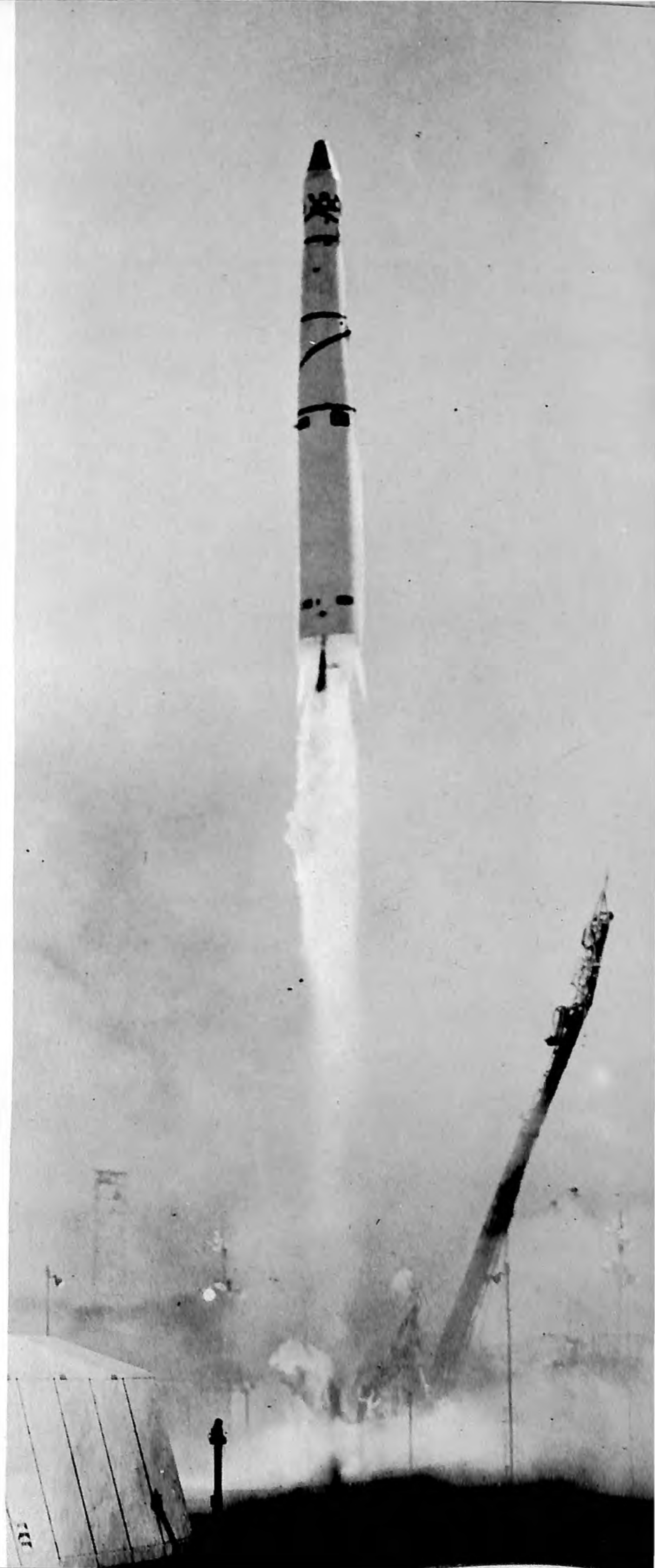


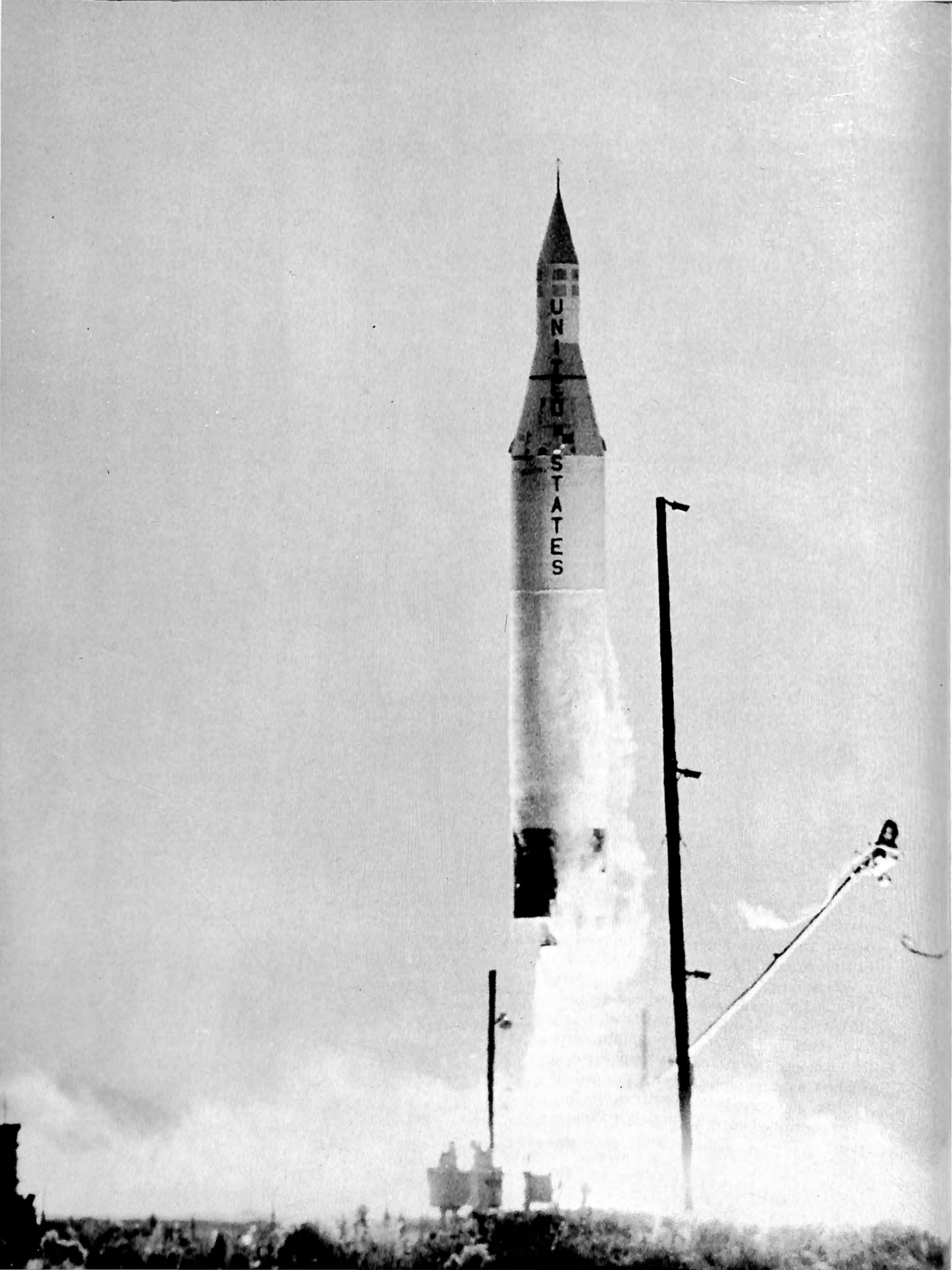
ECHO

An experiment in the use of satellites for global communications, Echo was launched by the National Aeronautics and Space Administration on October 28. The satellite is a 100-foot diameter balloon, launched by a rocket booster and inflated at high altitude. As a satellite, the balloon can be used to reflect radio and radar signals for investigation of forward scattering techniques of communications and propagation. It can also be used as a lunar probe, its size and aluminum coating permitting tracking visual throughout a lunar flight with existing astronomical equipment. The balloon can be folded into a 30 inch metal container and inflated at high altitude by only a few pounds of gas.

DISCOVERER

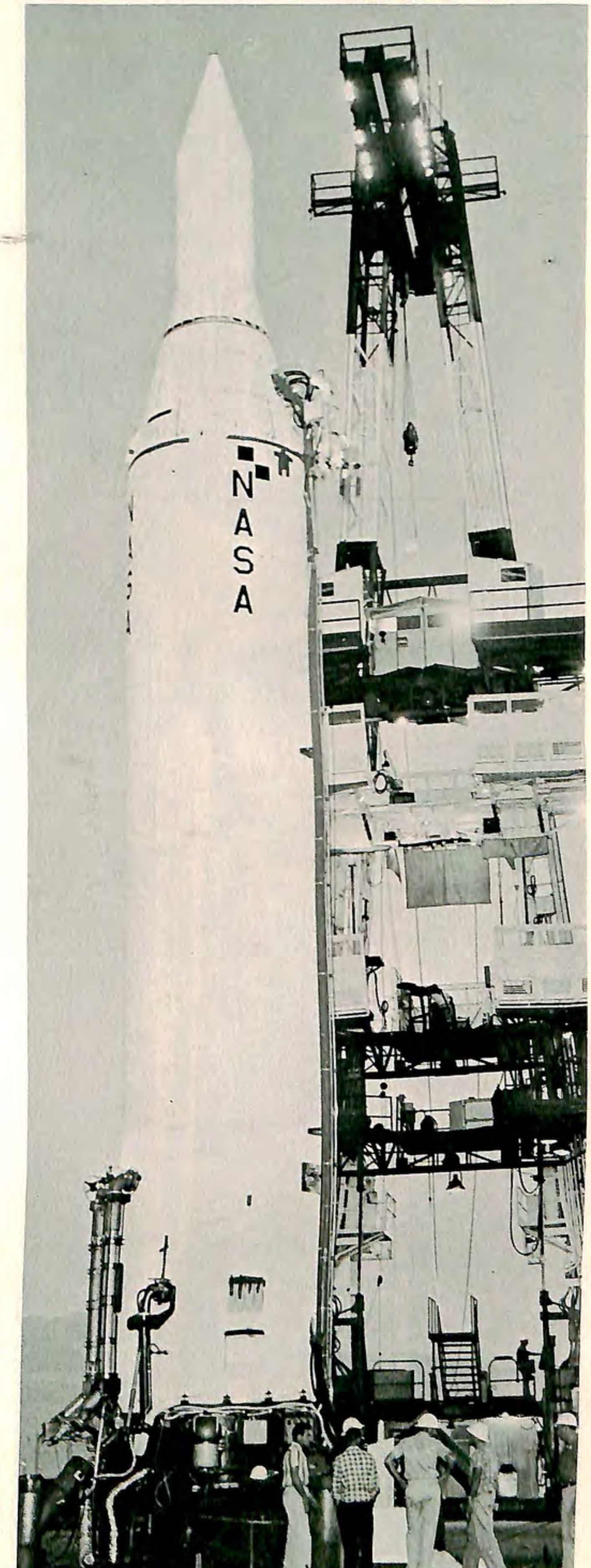
The Air Force and the Advanced Research Projects Agency successfully lanunched six satellites as part of the Discoverer program during 1959. The tests were designed to achieve orbits, including polar orbits, of large, heavy satellites, and to eject and recover space capsules. Discoverer I was placed in orbit on February 28, and Discoverers 11, V, VI, VII and VIII achieved orbits later in the year, each carrying a Lockheed-built 1,700 pound Agena satellite. The capsules ejected successfully several times but efforts to recapture them failed. Among Discoverer's accomplishments were: first to carry an American payload of more than 300 pounds, first polar orbit, first satellite controlled in orbit and first capsule ejection.




UNITED STATES

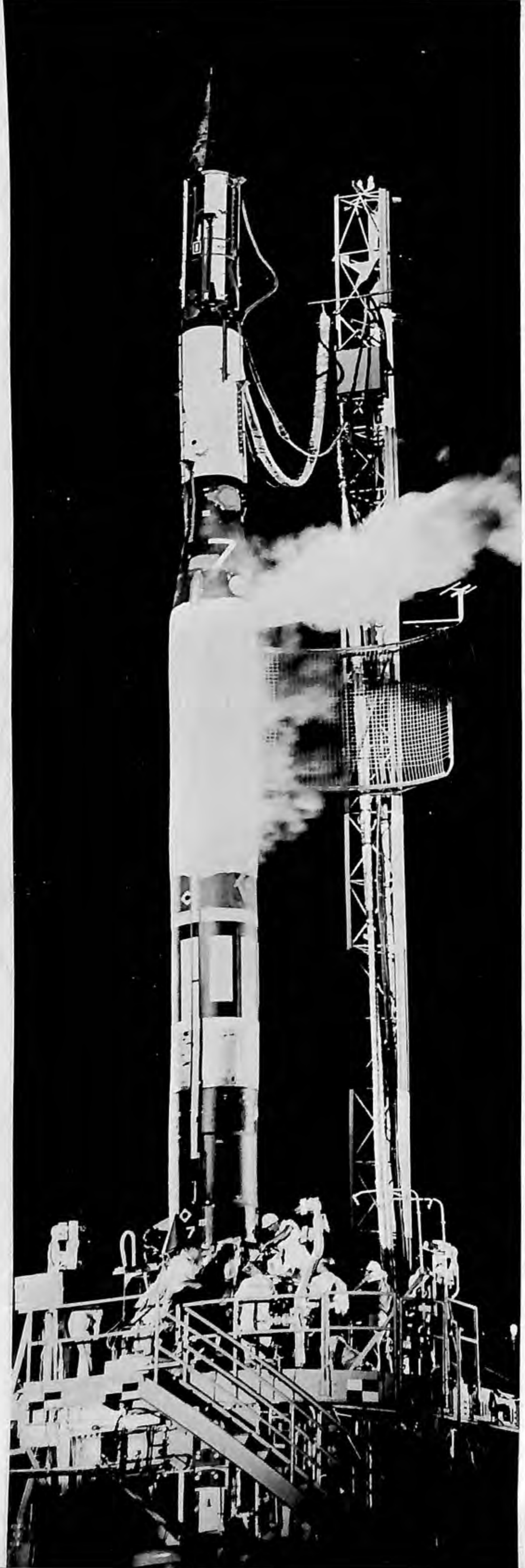
PIONEER

Launched on March 3, Pioneer IV (right), a scientific space probe, achieved an Earth-Moon trajectory. It passed within 37,000 miles of the Moon and went into a permanent orbit around the Sun. The satellite was tracked 407,000 miles into space, and in addition to providing an advanced tracking exercise for NASA scientists, it also transmitted excellent radiation data.



EXPLORER

Two satellites of the Explorer series went into orbit during the year. Explorer VI, a combination meteorological and scientific satellite, was launched August 7. Because of its four paddleshaped vanes, studded with solar cells for battery recharging, it was called the "Paddlewheel Satellite." Explorer VII (left), designed to measure Earth's radiation balance, was launched October 13. It carried 91.5 pounds of instruments and went into its predicted orbit. The Explorer program was initiated by the Army and transferred during 1959 to NASA.



VANGUARD

The Vanguard program came to a conclusion in 1959 with the launching of Vanguard III on September 18 from the Atlantic Missile Range. Vanguard III became the eleventh U.S. satellite to enter orbit. It carried a 50-pound payload and was expected to have an orbital life of from 30 to 40 years. Earlier in the year, February, Vanguard II, with a 21-pound payload, went into orbit. Vanguard I had been placed in orbit on March 17, 1958. The Vanguard program was a joint effort of the Navy, the National Aeronautics and Space Administration and The Martin Company, which built the vehicles.

MISSILES

ATLAS

In development and test status for several years, Atlas achieved a high degree of reliability during 1959 and was declared operational when the first service missiles were delivered to Vandenberg Air Force Base, California. Twenty of the Convair-built intercontinental ballistic missiles were launched during the year, including long range tests to check guidance and re-entry characteristics and short range tests for sub-assembly evaluation.

MINUTEMAN

Work progressed on the Air Force's second generation ICBM, the solid-propelled Minuteman, for which Boeing Airplane Company is system manager. On September 15, at Edwards Air Force Base, California, the USAF started tests with a full-scale silo test vehicle, in which a model of the missile was fired from an underground silo in captive flight, restrained by nylon ropes. Three such tests, all successful, were made during 1959.

NIKE-ZEUS

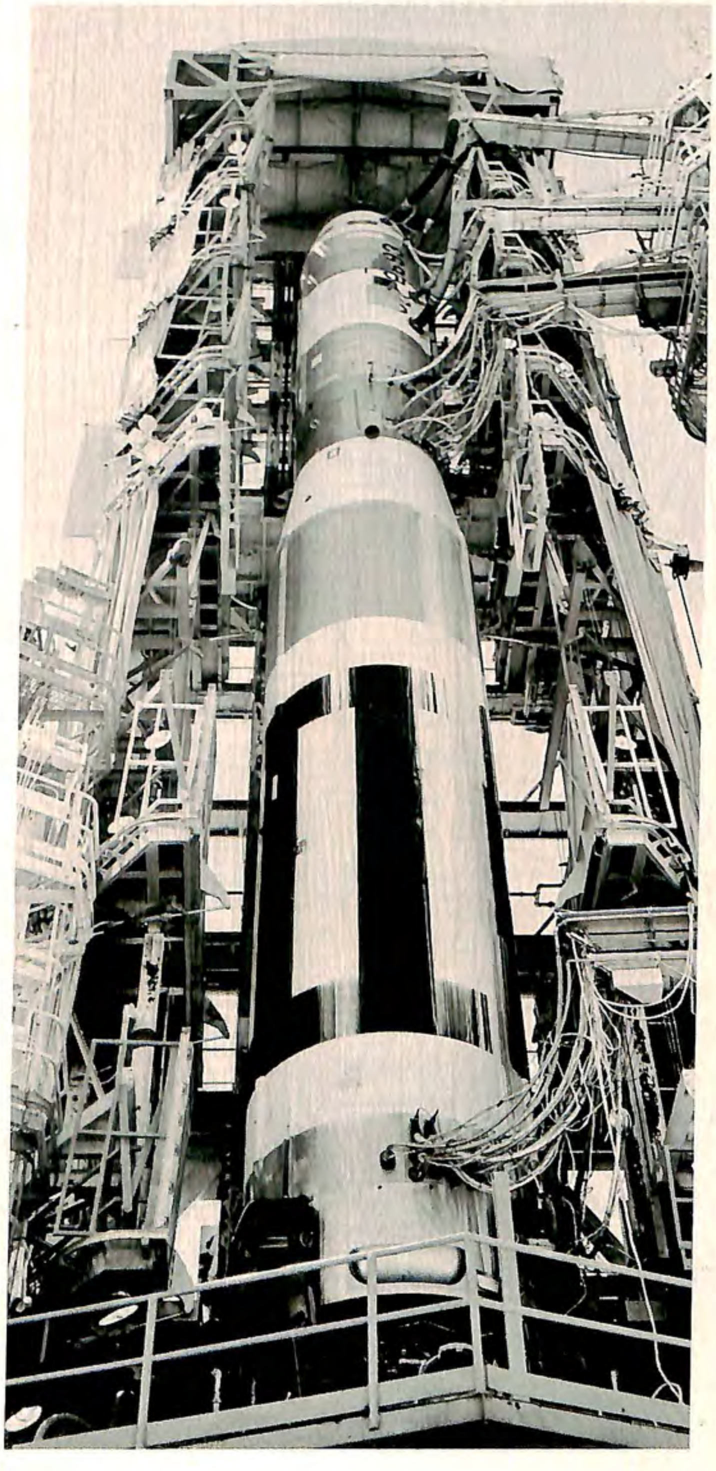
First firings of the Army's Nike-Zeus, a missile system designed for defense against enemy ballistic missiles, took place during 1959. An important adjunct to the air defense system, Zeus is solid propelled, command guided and equipped with a nuclear warhead. Its mission of destroying invading missiles a safe distance from the intended target is aided by a ground system composed of several types of radar, a number of computers and a high speed communications network. It is being built by the team which turned out its predecessors, Nike-Ajax and Nike-Hercules: Western Electric, Douglas Aircraft Company, and Bell Telephone Laboratories.

ALBM

The concept of launching medium range ballistic missiles from aircraft, providing a mobile aerial platform difficult to destroy, was furthered during 1959. The new development program is known as ALBM, for Air Launched Ballistic Missile. In 1959, a research version of such a missile, the Martin-built 199B (shown here), was successfully launched from a Boeing B-47. Later, the Air Force awarded an advanced development contract to Douglas Aircraft for an ALBM designated the GAM-87A Sky Bolt.

POLARIS

The intermediate range Fleet Ballistic Missile Polaris (right) reached advanced flight test stage during the year. Built by Lockheed, the 28-foot solid-fueled missile has an initial range capability of 1,200 nautical miles, which will be extended through further development. In 1959, successful flights were made from a surface vessel and from a ship's motion simulator, and underwater testing of the launch system was ahead of schedule.



TITAN

Second of the Air Force's intercontinental ballistic missiles, Titan (left) started its flight test program during 1959. Also known as SM-68, the Martin-built Titan made its first flight on February 6 and was launched successfully four other times during the year. Titan, a complement, rather than a duplicate of Atlas, is launched by a 300,000-pound thrust booster.

REDEYE

The World War II "bazooka" made a new appearance in 1959, this time as a missile launching device. The new Army and Marine Corps weapon is Redeye, a missile designed to provide ground troops with a defense against low-flying attacking aircraft. The four-foot missile is fired from its own shipping container. Development contracts were awarded during the year to Convair Division of General Dynamics Corporation, prime contractor, and Philco Corporation, guidance manufacturer.

EAGLE

Development was started during 1959 on a new type of air-to-air missile in which the high performance is built into the missile rather than the launching aircraft, permitting use of relatively slow planes as launchers. First of this family is Eagle, for which Bendix Aviation Corporation was named prime contractor and manufacturer of flight control, guidance and support equipment. Grumman Aircraft Engineering Corporation will build the airframe. The Navy is sponsoring this new developmental program.

CORVUS

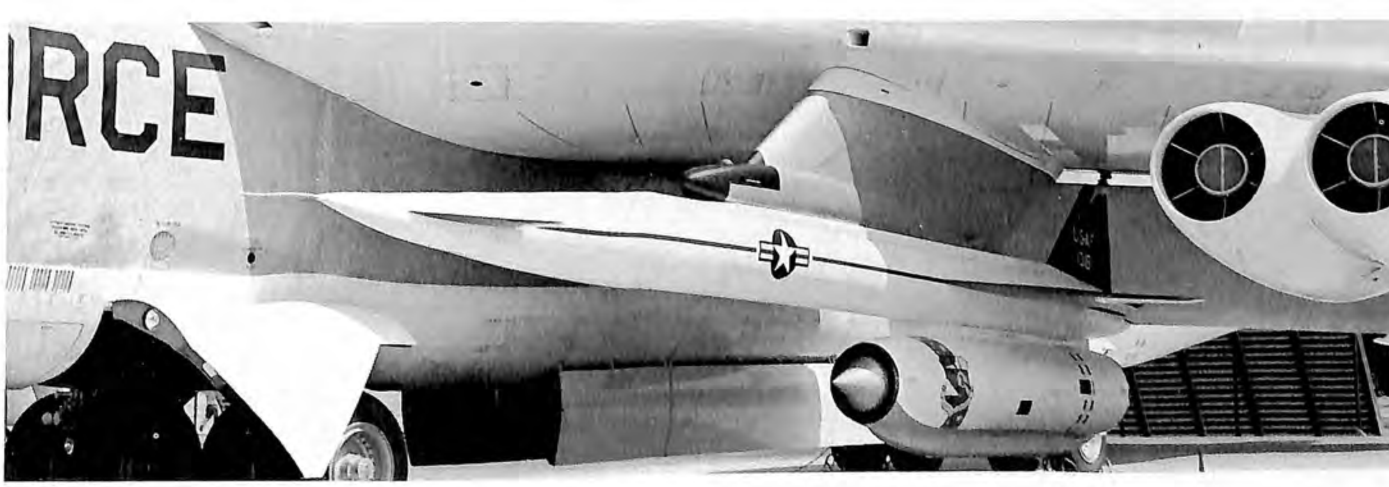
A test version of Corvus was successfully flown at the Pacific Missile Range on July 18. Corvus, built by Temco Aircraft Corporation, is a supersonic air-to-surface missile designed to enable Navy carrier-based aircraft to penetrate heavily defended areas.

SHILLELAGH

Development contracts were awarded during 1959 for a new missile designed to provide increased firepower for support of Army ground troops. The new missile, known as Shillelagh, is a lightweight system for use against enemy troops, armor and fortifications. Aeronutronics Division of Ford Motor Company was named prime contractor.

HOUND DOG

North American Aviation's GAM-77 Hound Dog made its first test flight on April 23. Hound Dog is an air-to-surface weapon which can deliver a nuclear warhead several hundred miles after release from a Boeing B-52. In advanced development status, it was to be delivered to Strategic Air Command in 1960.



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All Operated From a Single Compact Control Panel

Here is an integrated COM/NAV system with the extra advantage of ARC's higher performance standards. All matched units designed and produced by one manufacturer, all units centrally controlled from a single compact panel. It includes dual omni, two independent communications systems, ADF, marker beacon, glide slope, audio controls and cabin speaker amplifier. Accessibility . . . greater flexibility for adapting to special needs. Many combinations available. Deserving of complete confidence, this system will expand the utility of your business aircraft. All basic COM/NAV units certified to Category A of applicable FAA TSOs or CAATC.

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Aircraft Radio Corporation BOONTON, N. J.

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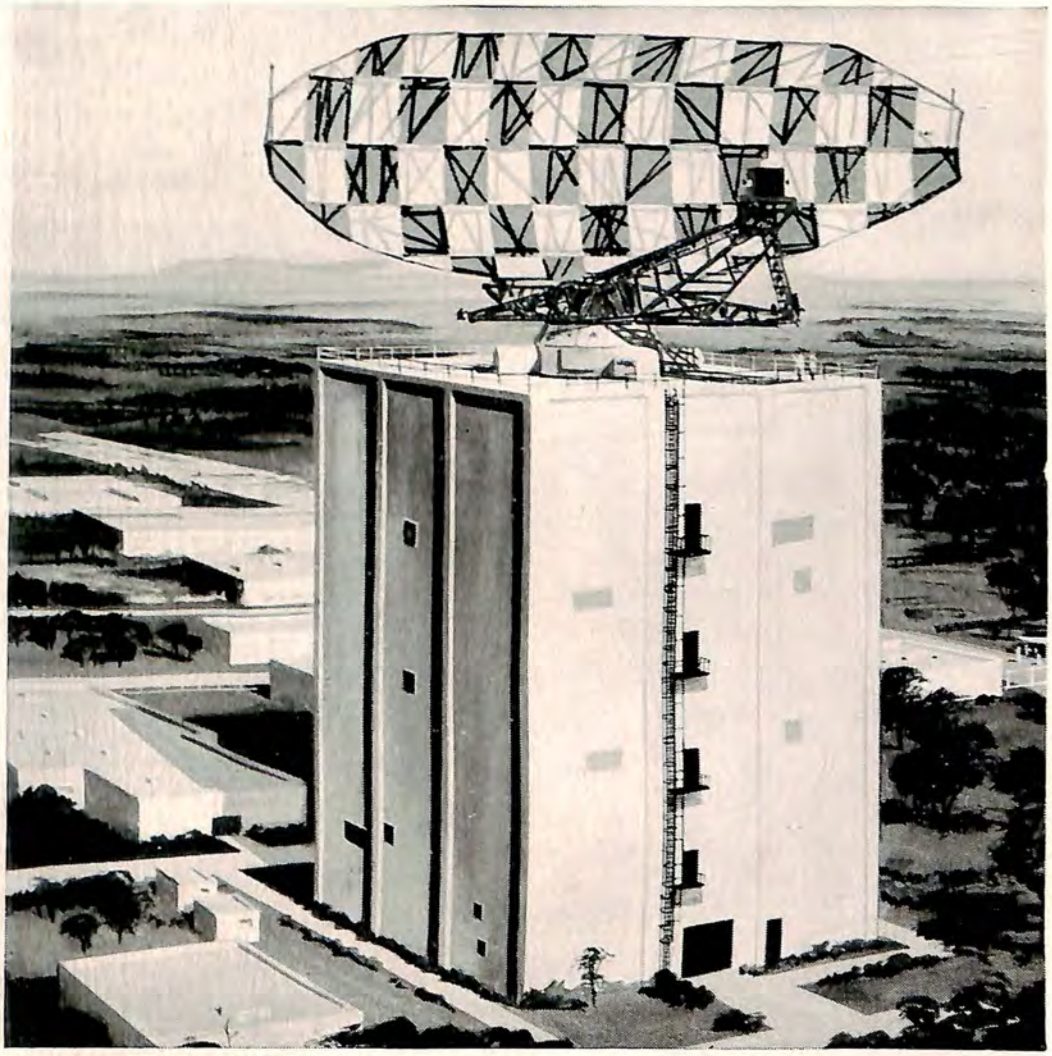
In 1936—air defense by **SPERRY**

Before the invention of radar, Sound Locators aided the human ear in sensing the approach of aircraft.

HIGH SPEED COMPUTERS housed in tower calculate target information from radar and provide intercept-destroy data.

CENTER OF OPERATIONS for FPS-35 installation is MAJAC—Monitor, Anti-Jam and Control Console.



TOWER OF STRENGTH in U. S. defenses, area search radars by Sperry will be spotted strategically throughout main Air Force defense networks.

Giant Sperry Search Radar To Strengthen U. S. Air Defenses

First fortress-like radar is "on the air" only 19 months after contract

New, high-powered area defense search radars housed in giant concrete "fortress" towers—are taking their place in America's vast chain of air defense systems. The first such tower was constructed at Thomasville Aircraft Control and Warning Station in Alabama.

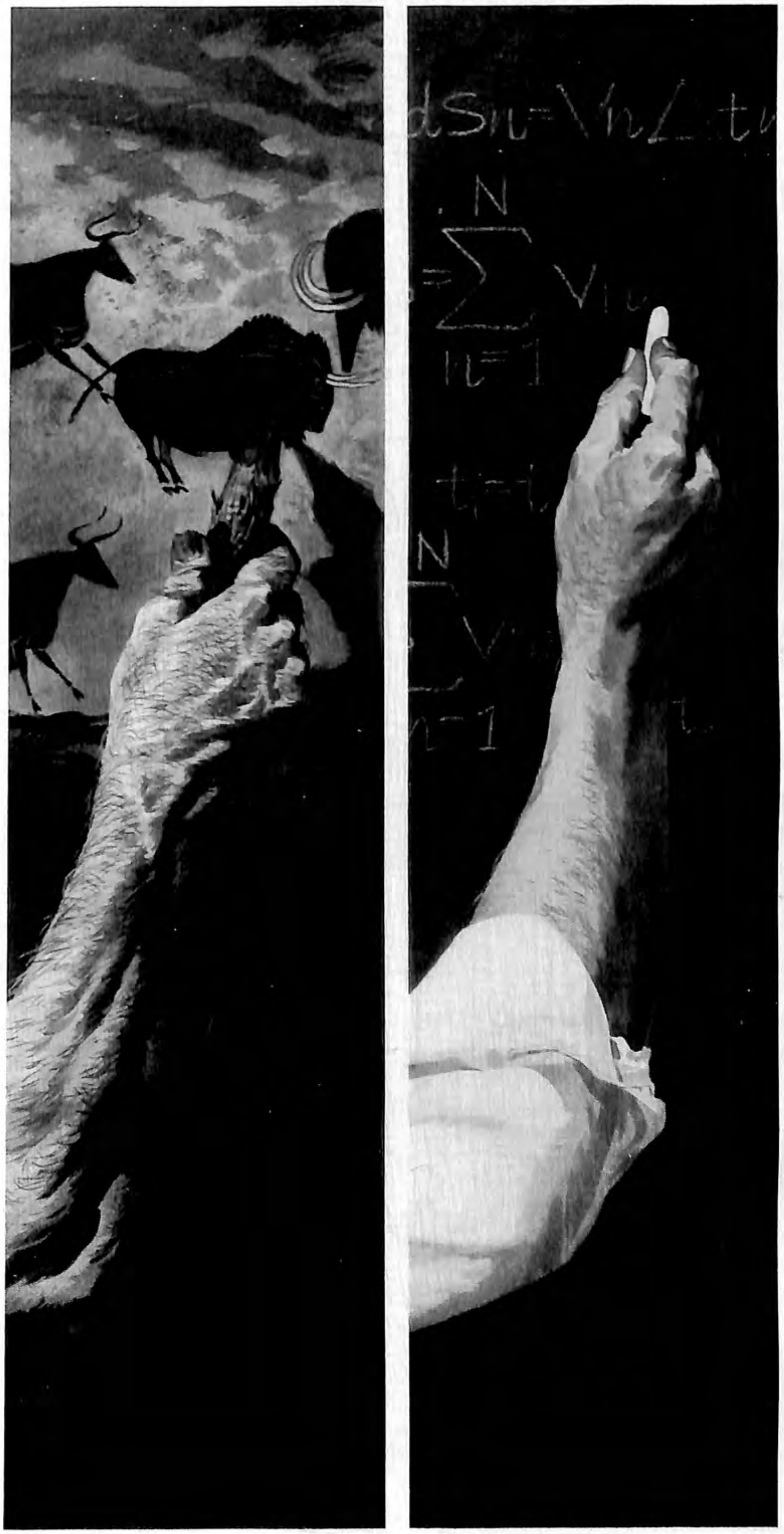
These radars (AN-FPS-35), developed by Sperry's Surface Armament Division in close cooperation with USAF's Rome Air Development Center, will become part of the Continental Aircraft Control and Warning System which searches out cruise-type missiles and aircraft.

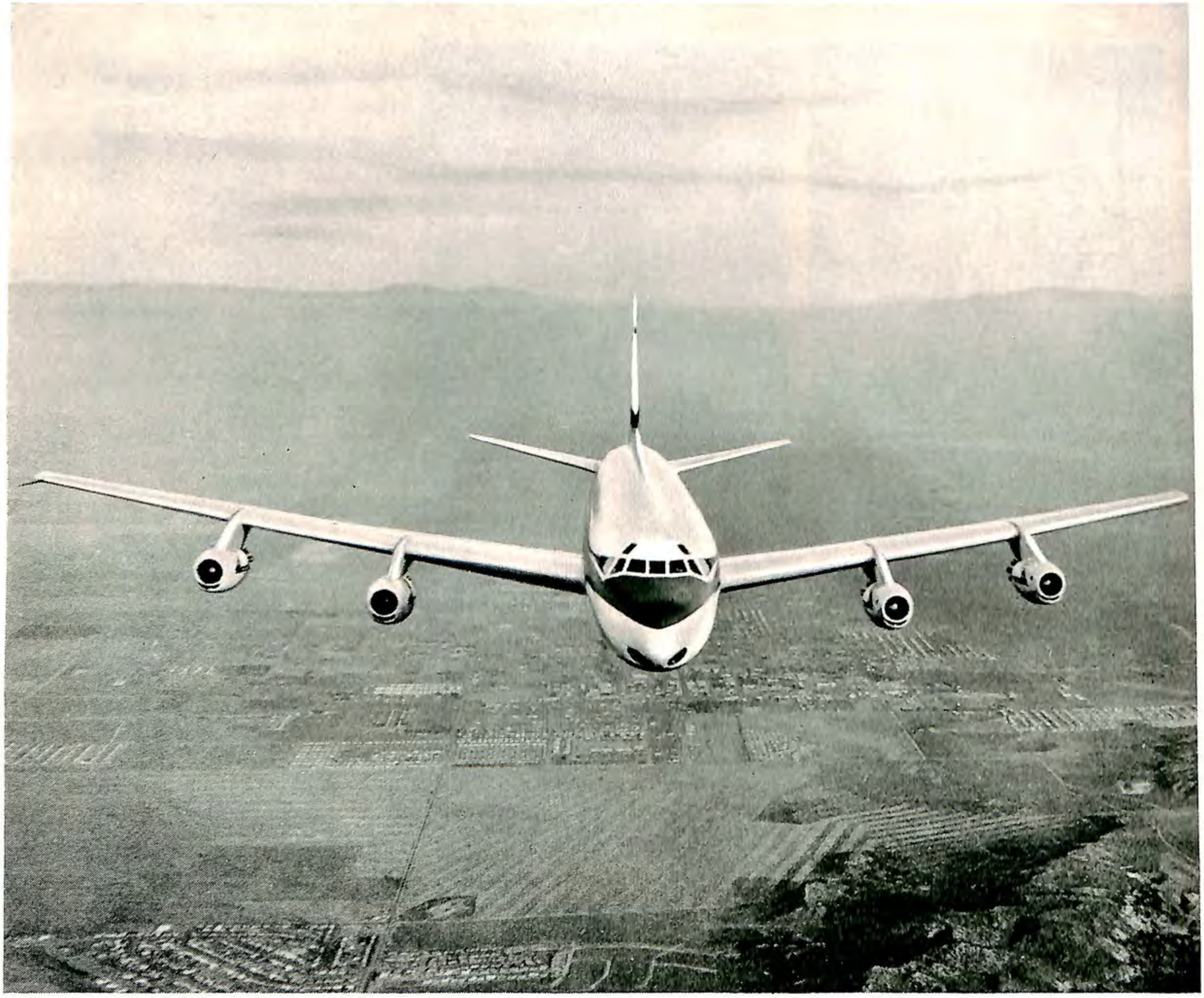
The giant antenna assembly, weighing nearly 70 tons, is situated on a concrete tower 85 feet high and 60 feet square. The radar feeds target position information into high speed computers, which in turn work out involved calculations for interception and destruction of the target by missile weapon systems. The tower houses the full complement of men and equipment necessary to sustain continuous operation. Strategic sites in the U. S. defense network have already been selected for location of additional search radar systems.

This "tower of strength" in U. S. defenses underlines Sperry's advanced capabilities in radar—the result of experience dating back to radar's earliest beginnings and highlighted by many significant Sperry contributions to the science.

SPERRY

SURFACE ARMAMENT DIVISION, *SPERRY GYROSCOPE COMPANY, DIVISION OF SPERRY RAND CORPORATION, GREAT NECK, NEW YORK*





WORLD'S MOST MODERN JETLINER

COMING YOUR WAY—THE DC-8 BUILT BY DOUGLAS

As the giant but graceful shape of the DC-8 crosses your sky, the three and one-half *million* man-hours of testing that went into its development can't be seen. But when you're borne aloft in this luxurious jetliner, you have the security of knowing that it has passed structural fatigue tests equivalent to *100 years of airline service* . . . that its giant windows are triple paned with an excess strength factor of almost 1,000 percent . . . that its comfort evaluation and testing were undertaken from the start with luxury commercial operation the only objective. Nothing has been spared in money, time and human effort to make the DC-8 the unrivaled "Queen of the jet age." Only Douglas experience could build it—experience gained from the famous family of "DC" aircraft. Make the DC-8 your way to travel.

MORE AIRLINES HAVE CHOSEN THE DC-8 THAN ANY OTHER JETLINER


Official U. S. Naval Observatory Photo
At $00^h\,00^m\,01^s$ GMT
January 1, 1960
Martin logged its
390,660,000th mile
of space flight

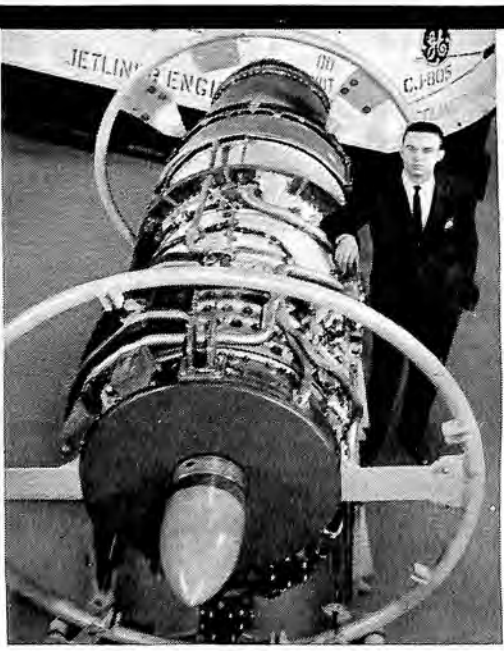
From General Electric, a growing spectrum of . . .

POWER FOR THE TURBINE AGE

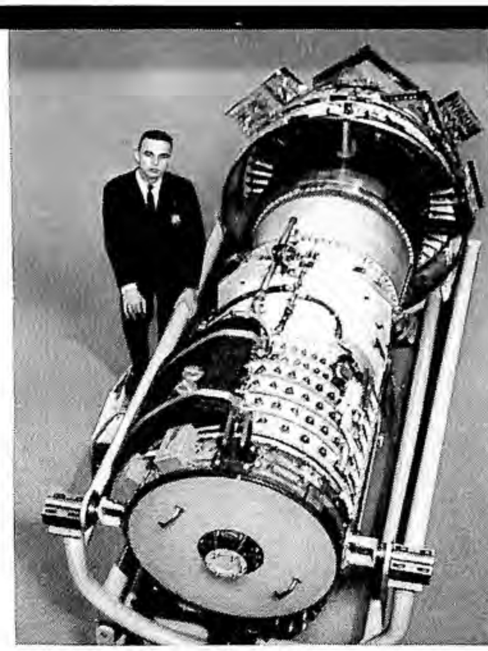
T58 G.E.'s T58, now in production for military and commercial use, delivers more power per pound of engine, consumes less fuel per hp-hr than any other turboshaft flying today. Guaranteed at 1050 shp, 0.64 SFC, this 271-pound powerplant has proved itself during flight and environmental testing. Now in development is the 1250 shp first-step growth version.

T64 G.E.'s T64 is a turboprop/turboshaft direct-drive engine in the 2600 horsepower class. A compact, versatile power package, it can be used in either fixed-wing or rotary-wing aircraft, or as a power source for advanced aircraft applications. Basic configurations of the T64 are on test and confirming their exceptional performance characteristics.

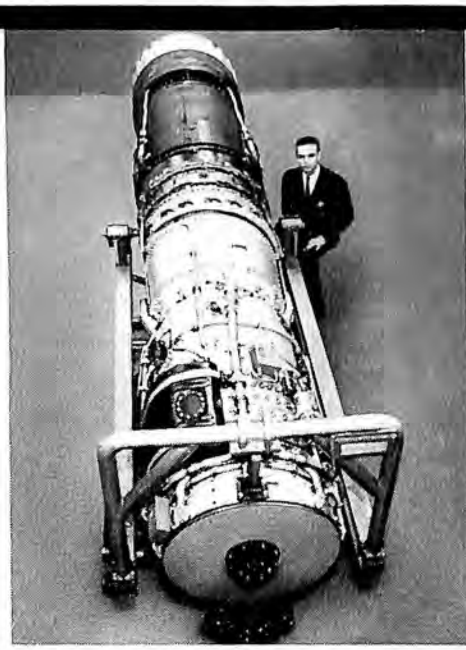
J85 The powerful (2500/3800-lb-thrust class), lightweight J85 turbojet introduces new levels of power and performance. Designed to power missiles, drones, small and medium sized aircraft, the J85 is being flight tested in McDonnells' "Quail" decoy missile, and Northrop's N-156F "Freedom Fighter," and T-38 supersonic trainer.



CJ-805-3 G.E.'s commercial counterpart of the J79. Rated in the 10,000-lb-thrust class, it has a 4:1 thrust-to-weight ratio. Now being proved in extensive flight and factory test programs, the -3 will power the Convair 880 jetliners. G-E built reverser-suppressors produce optimum results with minimum losses.



TF35 and CJ-805-23 Designed for near-sonic transport aircraft, the TF35 combines the J79 gas generator with an aft-fan for higher thrust at lower SFC. Commercially designated the CJ-805-23, it will power the Convair 600 luxury jetliner.

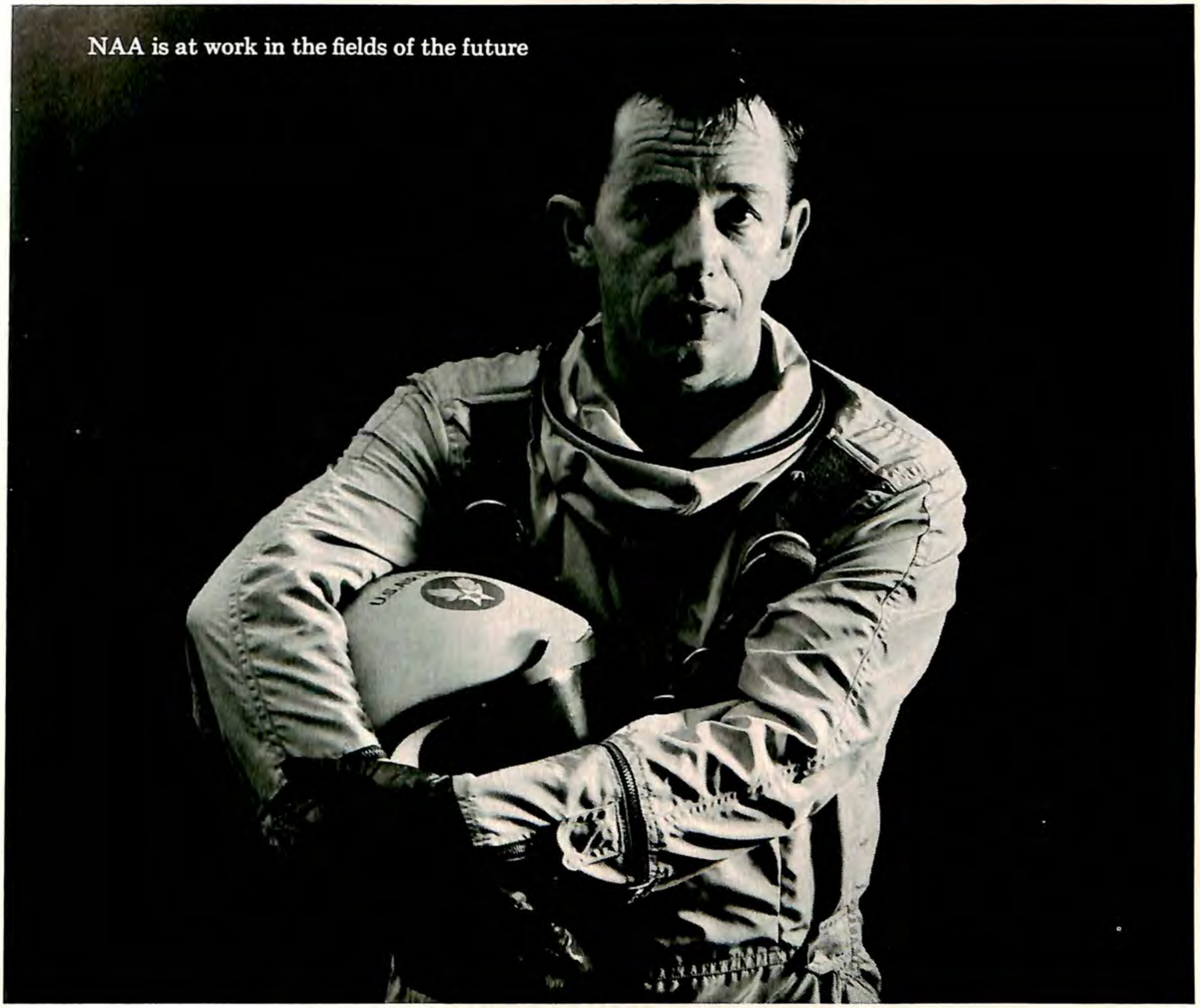


J79 Powerplant of the F-104 Starfighter, holder of world's speed and time-to-climb records, the rugged J79 has accummulated more than 90% of U.S. Mach 2 flight time. This 15,000-lb-thrust class turbojet also powers five other Mach 2 air weapons: F11F-1F, F4H, B-58, A3J and Regulus II.

235-39

Progress Is Our Most Important Product

GENERAL ELECTRIC



Creed for a Test Pilot:

"prove all things; hold fast that which is good"

This generation has a rendezvous with Space. The man who will take the first all-important step toward that rendezvous is the test pilot. His challenge is to try the things that haven't been done before. The supreme risk is his... but the benefits belong to us all.

The vehicles he tests are the result of America's most advanced scientific knowledge and newest industrial skills. One such vehicle is the X-15, designed to carry the first American to the fringes of Space. This is an experimental rocket-powered plane to probe 100 miles into the sky at the speed of 3600 miles per hour.

The X-15 was designed, developed, and built by North American Aviation, the company that has built more airplanes and has more supersonic experience than any other company in the world.

Famous NAA airplanes that were ready when America needed them include the T-6 Texan trainer, P-51 Mustang, B-25 Mitchell, B-45 Tornado, F-86 Sabre, and the F-100 Super Sabre.

Now North American is applying its vast experience in the development of a revolutionary new aircraft designed to fly three times the speed of sound—the B-70 Valkyrie multi-purpose bomber for the Strategic Air Command.

NORTH AMERICAN AVIATION, INC.

SERVING THE NATION'S INTEREST FIRST—THROUGH THESE DIVISIONS

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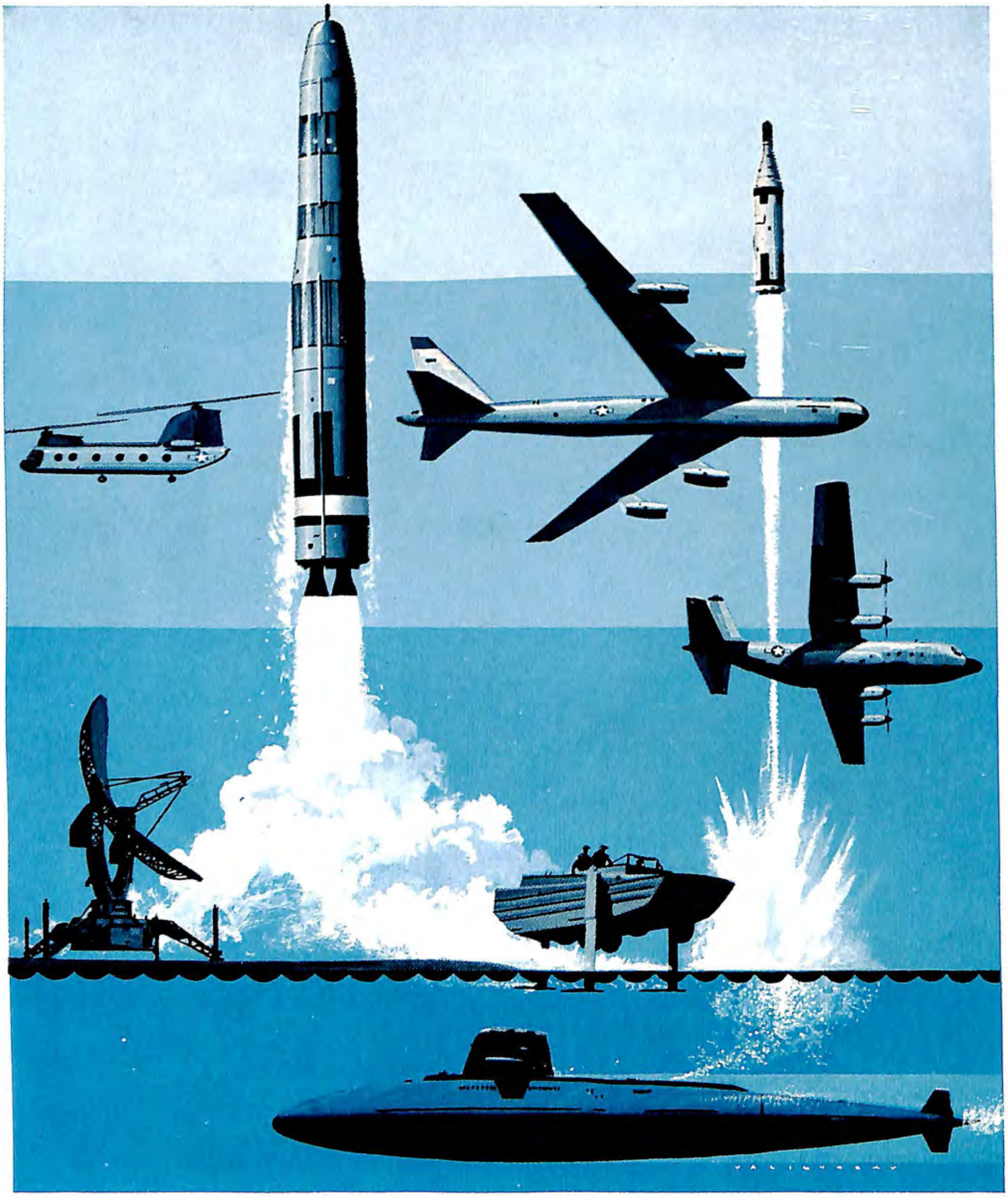

Avco helps defend America from sea to space.

Global security and peace depend upon an America geared to a space-age concept of defense. At Avco, skilled manpower and modern machines supply the attention and emphasis this concept deserves. Alert to the responsibilities of peace are: **Avco-Everett Research Laboratory**—investigating problems in gas dynamics and space technology; **Crosley**—communications, radar, infrared, electronic control systems, missile fuzing; **Lycoming**—aircraft, marine and industrial power plants, missile subsystems; **Nashville**—aircraft and missile aluminum and stainless steel structures; **Pre-Flite Industries Corporation**—jet engine starters, ground support and test equipment; **Research and Advanced Development Division**—basic and applied research in electronics, physical sciences, and engineering.

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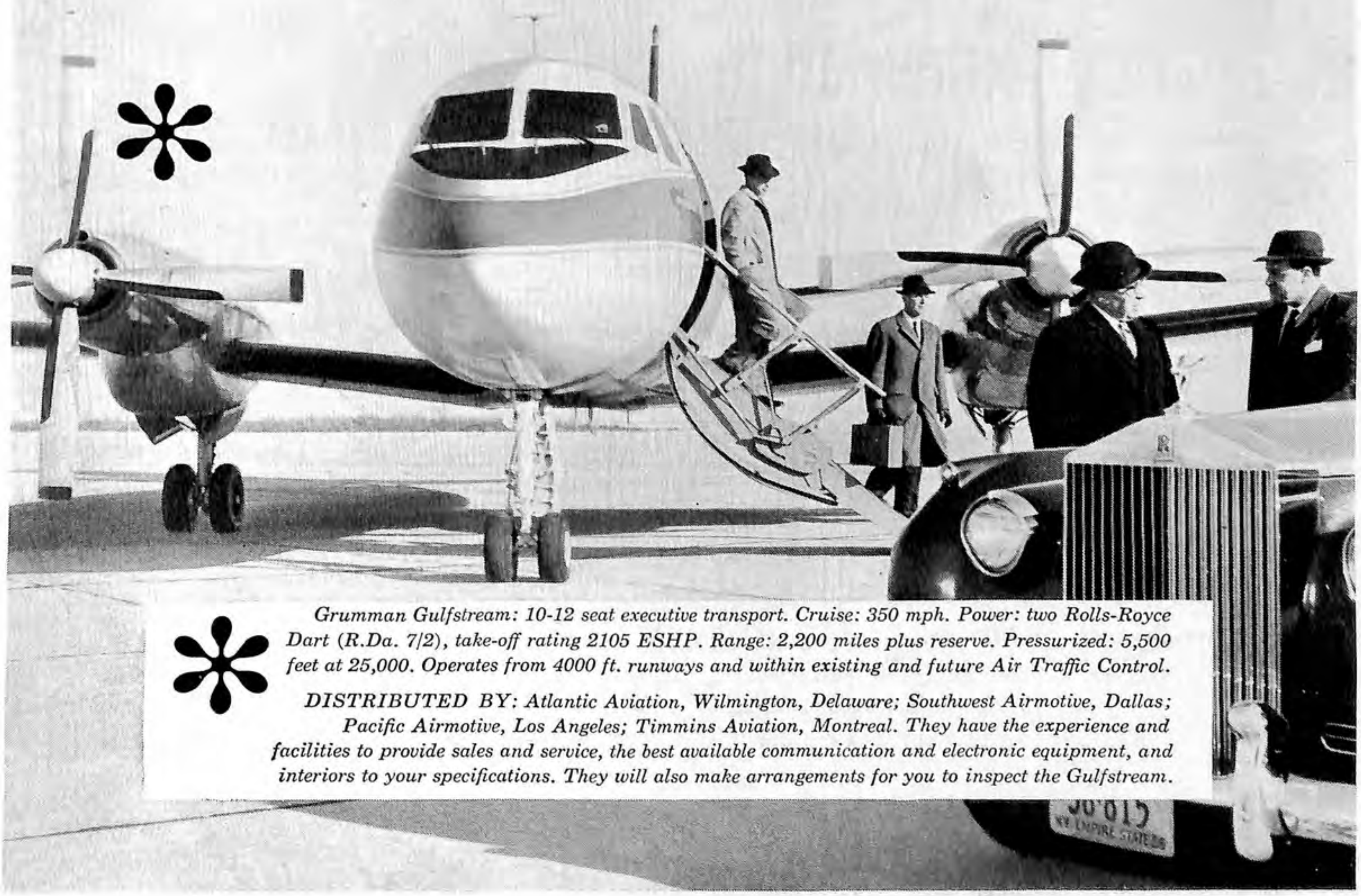
TO CORPORATE OFFICERS:

Quality, a word too often built up, is built into both the Gulfstream and its Rolls-Royce Dart engines. This modern aircraft, with fail-safe construction, typifies the reliability inherent in Grumman products for 29 years; while the engines have already been proved by millions of hours of airline operation. The achievements by these two leaders in their respective fields assure you of quality and safety in a true sense of the word.

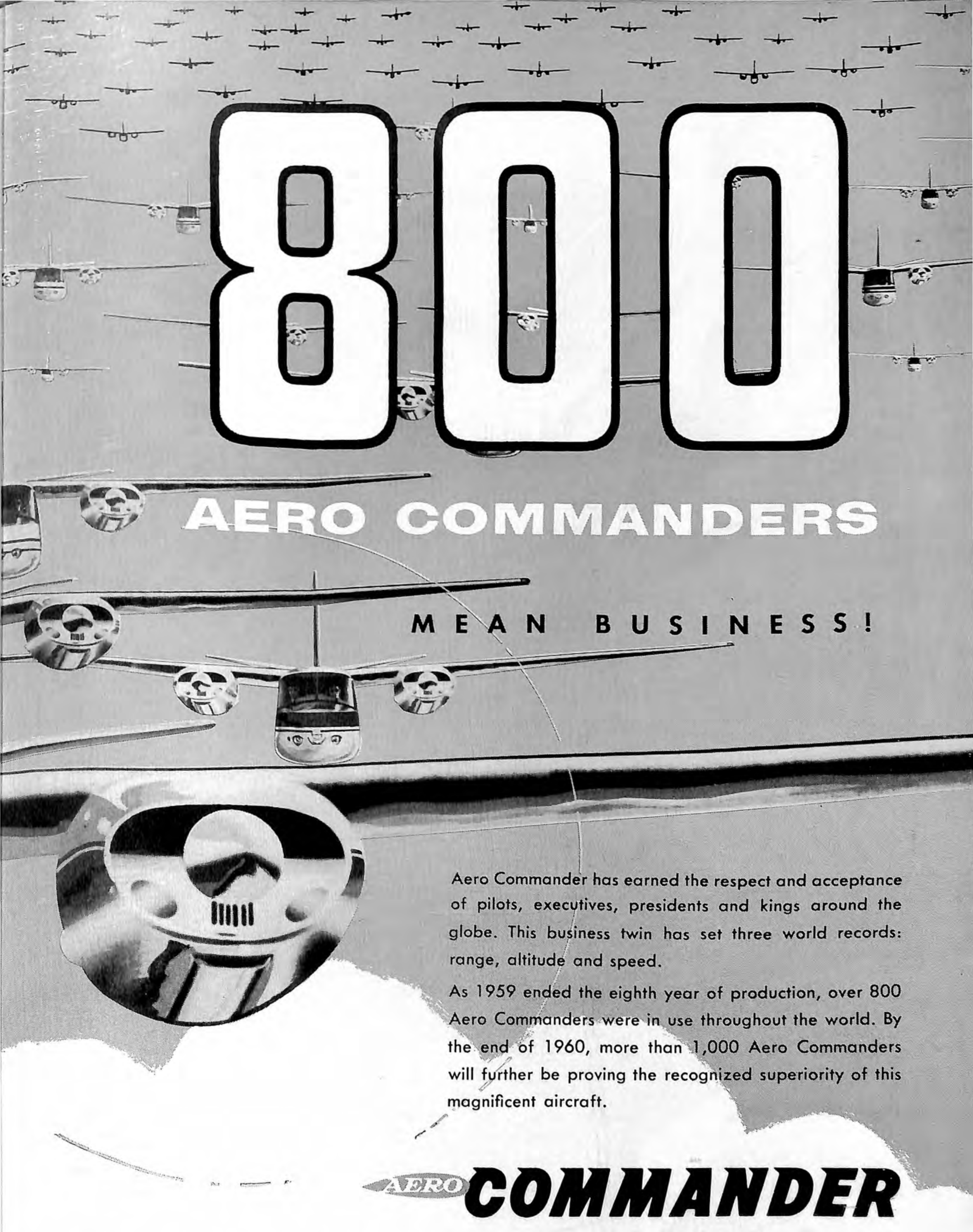
The new Grumman Gulfstream, the optimum in executive transportation, features high air speed, pressurization and short field characteristics designed specifically to meet your corporate flying requirements.

Leroy R. Grumman
Chairman of the Board
Grumman Aircraft Engineering Corporation
Bethpage · Long Island · New York



Grumman Gulfstream: 10-12 seat executive transport. Cruise: 350 mph. Power: two Rolls-Royce Dart (R.Da. 7/2), take-off rating 2105 ESHP. Range: 2,200 miles plus reserve. Pressurized: 5,500 feet at 25,000. Operates from 4000 ft. runways and within existing and future Air Traffic Control.

DISTRIBUTED BY: Atlantic Aviation, Wilmington, Delaware; Southwest Airmotive, Dallas; Pacific Airmotive, Los Angeles; Timmins Aviation, Montreal. They have the experience and facilities to provide sales and service, the best available communication and electronic equipment, and interiors to your specifications. They will also make arrangements for you to inspect the Gulfstream.



AERO DESIGN & ENGINEERING CO • BETHANY, OKLAHOMA

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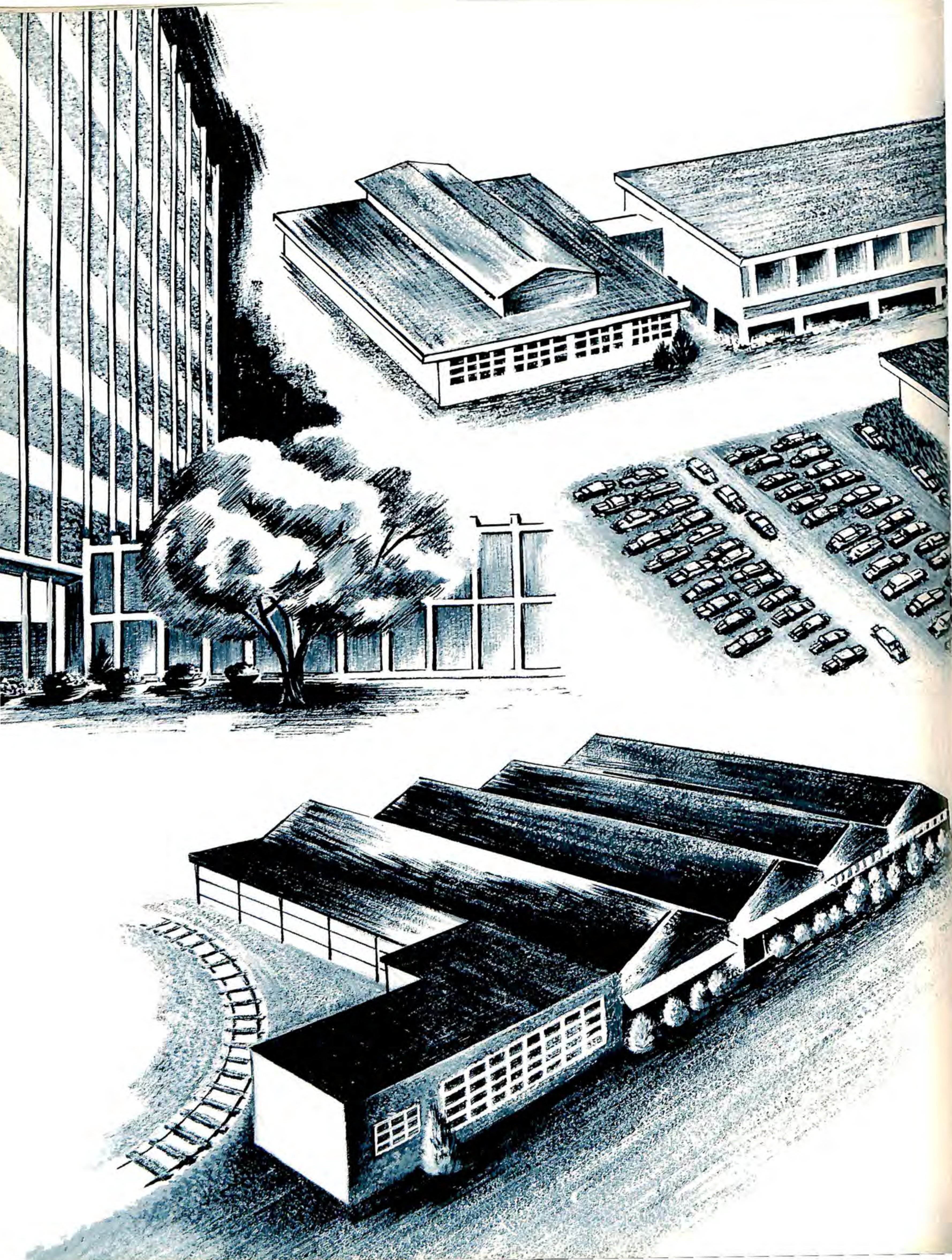
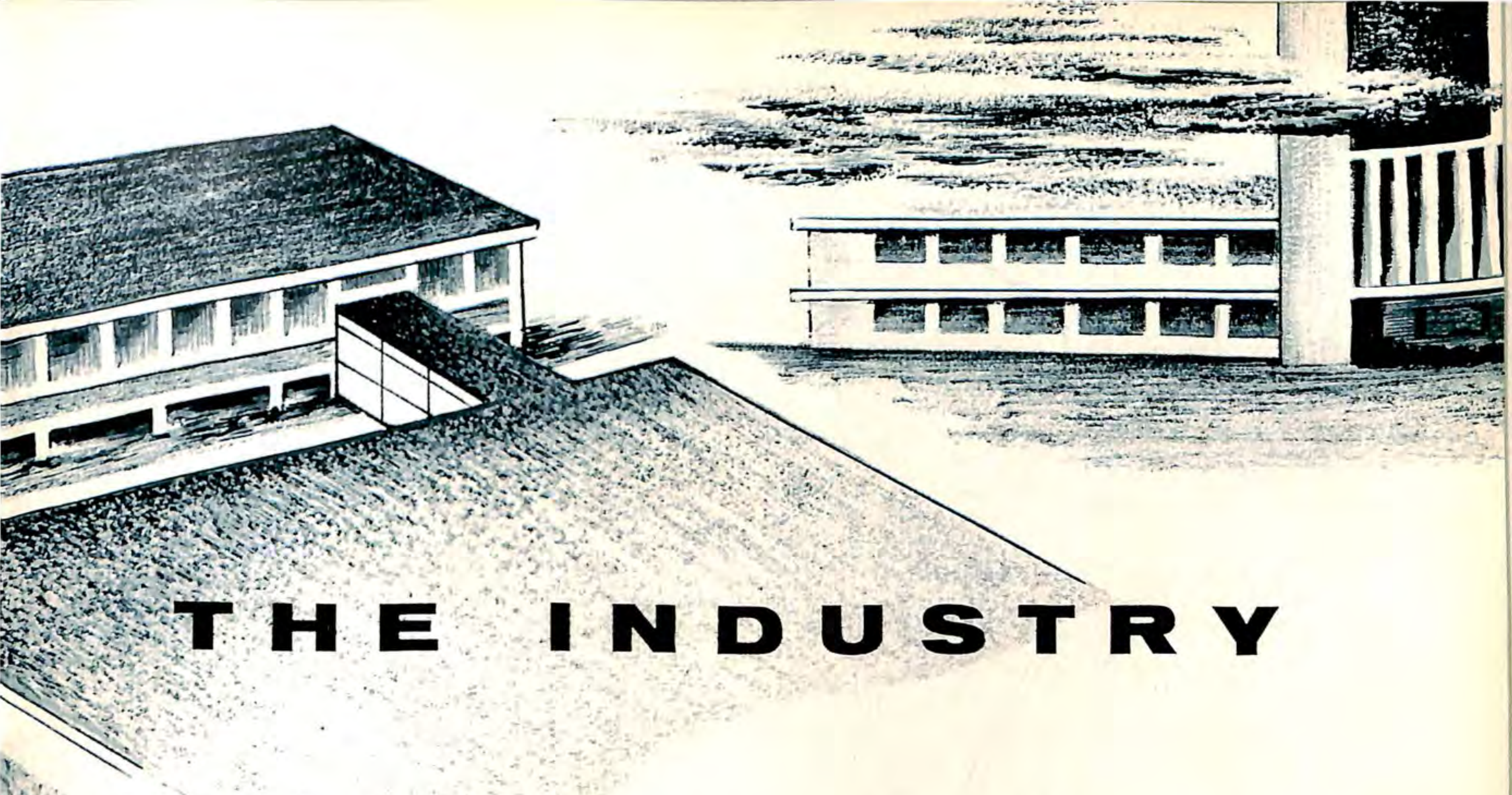




THE INDUSTRY

The year 1959 in the aerospace industry was one marked by further increases in the *rate* of technological change, occasioned by still greater emphasis on the guided missile, continuing military demand for increased performance in manned aircraft, and assumption by the industry of a new role as the supplier of vehicles and equipment for space exploration.

The changing nature of the industry was accorded official cognizance in July, when Aircraft Industries Association changed its name to Aerospace Industries Association. The changes effected in 1959 were not new and startling. They were, rather, a continuation of a trend under way for several years, but in 1959 the changes became still more noticeable.

There was further diversification of effort on the part of companies who for years had been known as specialists in one branch of aerospace production. The shift in the type of personnel employed by the industry became more marked; a still greater percentage of skilled technicians, scientists and engineers joined the work force, with an attendant rise in payroll costs. There was increased emphasis on research and development, not only for the end items and their major components, but for new types of tools and equipment with which to build them. A facilities expansion program, started years earlier, reached new heights in 1959 as industry found it usually cheaper to build new facilities especially designed for the complex products of the Space Age rather than to attempt to modify old aircraft manufacturing plants.

Manufacture of manned aircraft continued to constitute the major portion of the industry's work load, but production of guided weapons again gained in proportion. At year end, there were 45 missile projects involving production in varying numbers. AIA estimated total production of aircraft for the calendar year 1959 at 11,000 units, including 8,000 civil and 3,000 military planes.

Production of turbine-powered airline transports moved into high gear, with five turbine types being delivered in quantity. Four of the five types were in service by year-end and the fifth was slated for service inaugural in 1960.

Overall sales remained at about the previous year's level, as increased missile production took up the slack in declining military aircraft production. Industry's changing status brought about a further reduction in the work force. From 757,600 at the end of 1958, it dropped to 736,500 during the first half of the year and was expected to drop further by year end.

Despite the changing technology, it was a very active year, and the industry made a great many notable contributions in a widening area of responsibility. They are detailed in the company summaries which follow.

AIRFRAME, ENGINE AND MISSILE MANUFACTURERS

AERO DESIGN AND ENGINEERING COMPANY

During 1959, Aero Design and Engineering Company, Bethany, Oklahoma, delivered the 800th Aero Commander produced by that company. On September 28, an Aero Commander 680E was delivered to a Washington construction company. That date marked a little more than eight years that the company had been in operation producing the twin engine, six passenger executive transports. It was on August 25, 1951, that the first completed production Commander rolled from the line at Tulakes Airport in Bethany.

During April the Aero Commander established a world class speed record. Flying in connection with the World Congress of Flight, Las Vegas, Nevada, the Commander averaged 226.148 miles per hour, over the official 2000 kilometer (1242.7 mile) course. This mark for its class erased the old record set in 1953 by a Russian Yak II. The speed record added to the laurels of the sleek business airplane. The Commander also holds the class altitude record, 30,361 feet, and formerly held the world class distance record.

Aero Design and Engineering Company was producing four models of the Aero Commander. They included models 500, 560E, 680E and 720. The 720, or Alti-Cruiser, is the only light twin engine airplane being manufactured with a pressurized cabin. All four models have the same size airframe differing in engine size and special equipment.

The model 500 was introduced during 1958 to put the Aero Commander airplane in a more competitive position in the business aircraft market. The 500 features 250 horsepower 0-540 Lycoming engines. It has the extended wing for greater lift without sacrificing speed, grosses 6000 pounds with a useful load of 2150 pounds.

The Aero Commander 560E is known as the long-ranger of the fleet. It has a range of 1625 miles with a 30 minute reserve and is powered by 280 horsepower engines. It is the 560E that formerly held the distance record.

The 680E is the model holding the speed and altitude records. It is powered by two supercharged 340 horsepower engines, cruises at 226 miles per hour with a top speed of 255 miles per hour and has a useful load of 3025 pounds.

The 720 Alti-Cruiser, a pressurized business airplane, has a top speed of 255 miles per hour with a cruising speed of 226 miles per hour. The airplane is powered by Lycoming GSO 480 engines and has a service ceiling of 25,360 feet.

AEROJET-GENERAL CORPORATION

Aerojet-General Corporation, major producer of propulsion systems for the Space Age, reported sales of approximately $350 million for the fiscal year ended November 30, 1959. The 1959 sales compared with $218 million for 1958 and $162 million for 1957. Company employment increased during the year from 17,000 to approximately 24,000.

New construction and plant acquisitions during the year brought total plant facilities of the company to $118 million.

Aerojet continued development of the powerplant for the Air Force's Titan ICBM missile, with four successful launchings of the Titan missile being carried out during the year. The company's Solid Rocket Plant made substantial progress in the development of the Air Force's Minuteman

ICBM missile and the Navy's Polaris IRBM missile. The company was also involved in such major space programs as Saturn, Delta and Dyna-Soar and various Thor-Able projects.

The company also was producing rocket power plants, boosters and components for the Air Force Genie, White Lance and Bomarc programs, the Navy Tartar, Eagle, GAR-9, Sparrow III, and the Army's Hawk. Through purchase during the year of the Rheem Manufacturing Company's Defense Production Division at Downey and Riverside, California, Aerojet acquired contracts for the Army's SD-2 Drone. Aerojet reorganized the new Downey facilities into three divisions, Ordnance, Aeronautics, and Metal Parts Manufacturing. Ordnance Division was producing the high-explosive warhead for Nike Hercules. At year's end more than 2200 were employed in these divisions.

In November 1959, Aerojet announced organization of a new AETRON Division, combining the company's talents and experience in missile facilities engineering, electronics and instrumentation.

The company's wholly owned subsidiary, Aerojet-General Nucleonics, doubled its facilities at San Ramon, California, after incorporation into it of Aerojet's Turbo-Machinery Division and units of the company's Nucleonics Division formerly located at Azusa. It continued work on the application of nuclear propulsion to rockets. AGN neared completion of the first phase of one of its major projects, the AEC's Gas Cooled Reactor Experiment in Idaho, continued mass production of its world-known training reactor, the AGN-201 and introduced the larger first pool-type reactors the AGN-211, and later the AGN-451.

The most concentrated effort of the ASW Division was development of the Navy's Mark 46 Torpedo. Also in ASW work, Aerojet's Atlantic Division located at Frederick, Maryland, specialized in acoustics and underwater communications. Separately, the Atlantic Division developed automatic postal and package handling equipment which was demonstrated during the year to Post Office Department officials and representatives of American Railroads.

In the rocket field, Aerojet successfully operated the largest liquid-hydrogen thrust chamber ever fired. It also produced during the year the most powerful rocket engine ever developed for sled use. A new engineering building, more than doubling the company's engineering facilities at Azusa was completed to accentuate the company's expanding Systems Division.

Late in the year Aerojet established a Long-

Aerojet-developed engine powers Titan.

Range Planning Group at Monterey, California, staffed with scientists far removed from the company's day-to-day activities and able to devote full time to scientific prospects and forecasts.

The company continued development and quantity production of its series of Aerobee Sounding rockets. These are one or two stage rockets capable of carrying scientific payloads to altitudes of between 75 and 350 miles and are used by all the services and by scientific groups for high-altitude research in connection with missile and satellite programs. A new series of space-probe vehicles, called ASTROBEE was designed with capabilities of reaching altitudes of from 500 to 5000 miles.

Extensive additions were made by the company to chemical laboratories and development shops at Sacramento, as well as to facilities at Azusa and San Ramon and at Frederick, Maryland. Implementation of the company's agreement with Stauffer Chemical Company of New York moved ahead with the inauguration of the Stauffer-Aerojet plant at Sacramento for production of High Energy Fuels.

The company's foreign operations, which include Bristol-Aerojet, Ltd., a joint company formed by Aerojet-General and the Bristol Aeroplane Company of England during 1958, were further extended through an agreement with Mitsui and Co., Ltd., of Japan for marketing of selected Aerojet products in Japan; and with Westinghouse International for the promotion of Aerojet-General Nucleonics products throughout the world.

During the year, Aerojet-General's technical services staff at Cape Canaveral, Florida, was augmented to assist system contractors in flight testing Titan, Polaris, Thor-Able and lunar probe vehicles for which Aerojet supplies propulsion. The company also reorganized its custom and field service activities and opened a new District Office at Detroit, Michigan.

The Avionics Division continued to develop and supply to the Air Force an advanced-type infra-red fire control system for the Lockheed F-104 Starfighter. The Facilities -Engineering Division, which at year's end was incorporated into AETRON, provided instrumentation and range safety devices at both Vandenberg Air Force Base and the Pacific Missile Range at Pt. Mugu, California, which is under Navy jurisdiction.

The Plastics Division developed new rocket casings and packaging devices for shipment of shells and other ordnance. The Ordnance Division was especially successful in further demonstrations of its radical explosive metal-forming process.

New applications for JATO (take-off assist and in flight thrust augmentation) rockets were developed. The devices were made optional equipment by several manufacturers of commercial aircraft, including Beechcraft, and JATO Junior, certificated by CAB in 1958 was in increased demand for private and corporate planes. Aerojet has produced more than 800,000 JATO units in the 17 years of its existence.

Aerojet-General is a subsidiary of The General Tire and Rubber Company of Akron, Ohio.

ALLISON DIVISION
GENERAL MOTORS CORPORATION

Contracts for development of Minuteman ICBM rocket engine cases and a unique satellite powerplant were among highlights of 1959 for the Allison Division of General Motors Corporation as it began putting into effect a long-range space-age planning program.

Allison stepped up development and deliveries of first- and second-stage rocket engine cases for the solid-propellant Minuteman under a sub-contract to Thiokol Chemical Corporation. Precise new metallurgical controls and testing methods brought about the use of light, high-tensile metals—a vital factor in overall weight reduction.

Elaborate, massive fixtures and templates were designed by Allison to shape accurately these "clean" steels into various components of the maximum strength, minimum weight rocket cases.

To assure uniformity of the Minuteman cases, Allison instituted a rigid program of dimensional inspections during all machining operations to control the exacting tolerances. All cases were pressure tested at tensile loads up to 190,000 pounds per square inch. Full-scale engines had been test fired before year's-end.

While this work was underway, studies also were being made on pyrophoric fuels and their application to ramjet engines. In another area, researchers were delving into the complexities of a strategic interplanetary system.

Under a contract awarded by the Air Force, Allison was perfecting a Stirling-cycle solar power system capable of operating two years unattended as a source of power for space satellite instruments. Developed to a practical efficiency by N. V. Philips Gloeilampenfabrieken of Eindhoven, Holland, this modernized version of a powerplant that once turned riverboat paddle wheels is now being further improved by General Motors Research Laboratories and Allison.

In mid-year, Allison awarded Cornell Aeronautical Laboratory, Inc., a contract for the creation and preliminary design analyses of general support missile systems as part of a program to develop a preferred system.

More than a dozen commercial airlines by the end of 1959 had accumulated a total of 698,764 engine flight hours and 69,876,400 aircraft flight miles on the Allison-powered Lockheed Electra. Included among these carriers are American, Ansett/Australian, Braniff, Cathay Pacific, Eastern, KLM Royal Dutch, National, Northwest, Pacific Southwest, Qantas, Trans-Australia, Tasman Empire Airways and Western.

A 16,200-horsepower Navy version of the Electra, designated the P3V-1, will become America's first propjet submarine hunter-killer aircraft. Powered by four Allison T56-A-10W propjet engines rated at 4585 horsepower with water/alcohol power augmentation, the P3V-1 will be utilized for low-and-slow sea-scanning flights as well as for mid-ocean searches from small advanced bases.

T56-A-8 propjet engines geared to Aeroproducts turbopropellers will power the twin-engine Grumman W2F-1 airborne early-warning radar plane. The W2F-1 will operate from aircraft carriers at sea, patrolling the extremes of defense perimeters to detect impending attacks by enemy air and sea forces.

Work was begun on the first production conversion of a Convair 340 to Allison propjet engines and Aeroproducts turbopropellers. By late 1959, sales of 501-D13 conversion engines were firm for 19 aircraft, including those of five corporate operators and two airlines.

Allison T56-A-7 propjet engines of the 4050-horsepower class went into service in nacelles of the USAF's new Lockheed C-130B Hercules, a "big brother" to the original C-130A that has been in USAF operational service since 1956.

Development work continued on the new 6,500-horsepower Allison T61 propjet engine, which utilizes a twin-spool compressor for greater flexibility and better fuel economy through a higher compression ratio. An Aeroproducts turbopropeller for the T61, the powerplant selected for the giant Lockheed Super Hercules, was being developed under an Air Force engineering contract.

Allison-powered Lockheed C-130B Hercules.

Allison Division's small 250-horsepower T63 gas turbine engine for fixed and rotating wing aircraft and stationary powerplants continued to gain attention. First announced installation revealed for the T63 in its turbo-shaft version was in the modified Bell HUL-1 light utility helicopter. First small, high-performance gas turbine engine to be introduced into the military and commercial light aircraft field, the T63 has been under development at Allison since June, 1958. A turbopropeller for the T63 was being developed at the Aeroproducts Operations of Allison with Air Force funds under a separate contract.

T56-A-1A propjet engines for the USAF's C-130A Hercules continued in production, as did the Model 501-D13 propjet engines for the Lockheed Electra and the Allison Super Convair.

Sales and service for Aeroproducts turbopropellers were consolidated into one organization located at Indianapolis as a means of further improving service to both commercial and military customers. The Aeroproducts organization continues to maintain engineering and production operations at Vandalia, Ohio.

AVCO CORPORATION

Avco Corporation made notable achievements in several areas of aerospace endeavor during 1959. The name of the company was changed from Avco Manufacturing Corporation early in the year to reflect more clearly the continuing expansion in the fields of research and development.

On April 8, 1959 the Air Force made the first recovery of a nose cone that had travelled the full ICBM range of 5,500 miles. This experimental re-entry vehicle, launched atop a Thor-Able mis-

Avco tests component for ICBM nose cone.

sile, was protected from the intense heat of atmospheric re-entry by Avcoite, an ablative ceramic material developed at the Avco-Everett Research Laboratory and the Avco Research and Advanced Development Division.

Little more than a month later, on May 14, ceremonies were held to dedicate the Avco Research Center at Wilmington, Mass. Home of the corporation's Research and Advanced Development Division, this $23-million facility includes laboratories and support equipment among the finest in the country. Its environmental testing, flight simulation, materials development and systems analysis capabilities are among the most complete to be found in any private industrial organization.

Dedication of the Center drew leaders from industry, government, science, the military, finance and education, and was highlighted by a panel discussion of "Mankind in the Space Age," in which several of the free world's most eminent scientists participated.

In connection with the dedication ceremonies, scientists at the Avco-Everett Research Laboratory announced duplication in the laboratory of the million mile-per-hour shock waves caused by solar storms in outer space. This phenomenon of interplanetary shock waves was re-created within a four billion watt electric shock tube developed at the Everett laboratory.

During August the corporation announced receipt of contracts totaling $110 million for development of re-entry vehicles for the Air Force Titan and Minuteman ICBMs.

CROSLEY DIVISION

The year 1959 saw Avco Cor ration's Crosley Division become the prime contractor to the Air Force for production of ASG-15 fire control systems for the B-52 bomber and the FPS-26 height finder radar for continental defense. In addition, Crosley received prime contracts on highly classified ordnance work, missile range safety devices, and other communications equipment. The division was awarded research and development contracts for direction finding equipment and advanced fire control systems concepts.

Early in the year Crosley announced expanded work in the infrared field, and currently it is conducting "state-of-the-art" research into systems and concepts. Crosley's Infrared Group, one of the largest in the nation, was rapidly building up its facilities.

Dr. Ernst A. Steinhoff, world famous missile engineer, joined Crosley during the year and under his direction a Crosley Missile Department was formed. Crosley produces various missile components and the division expects to take on additional research and development work in this important new area.

During the year, Crosley perfected the ART-32 Radio Rescue Beacon for use in locating downed aircraft. Developed for military aircraft, the beacon has an unusual feature in that a small blimp-shaped balloon is deployed. When released, the balloon lowers the beacon to the ground and also supports a 55-foot antenna wire. The Beacon sends out a coded message on two radio frequencies and has an operating life up to 24 hours.

Crosley also was involved in air traffic control, marine electronics and human factors engineering.

NASHVILLE DIVISION

Avco's Nashville Division, formed in late 1958, continued its development programs and reached production status on Avcomb stainless steel honeycomb structural material. Avcomb is used where high heat resistance and high strength-to-weight ratios are required, such as in high Mach aircraft and missiles of the future.

Nashville received two important subcontracts in 1959 in conjunction with the supersonic B-70 Valkyrie bomber. The division was producing Avcomb structures on a second tier contract for Lockheed-Marietta and Dalmo-Victor Company.

With installation completed of a new brazing furnace, Nashville greatly expanded its capability to produce stainless steel honeycomb structures. Nashville now has a total capability for stainless steel and aluminum honeycomb. The furnace accommodates both flat and contoured panels up to seven feet wide and 25 feet long. Nashville also was working on a cost-reducing tooling technique that will greatly simplify production of the material.

Avco's Nashville Division continued production of complete empennage sections, wing tips and leading and trailing edges for Convair's 615 mile-per-hour 880 Jetliner. Preliminary tooling effort also got underway for the Convair 600 empennage. Along with these two programs, Nashville was working on important components for the Grumman F9F Cougar and the complete empennage for the Lockheed C-130 Hercules logistics carrier. Additionally, the division finished a long term modernization and overhaul program on Navy R4Ds.

BEECH AIRCRAFT CORPORATION

In addition to accelerated commercial airplane manufacture, Beech Aircraft Corporation in 1959 emerged as a leading contractor in research, development and production programs involving new weapon systems and space exploration. Total commercial and military sales for fiscal 1959, ending September 30, were in excess of $90 million. Of this combined volume, business aircraft sales topped $37 million, while the sale of aerospace products and services for military and scientific use amounted to more than $53 million.

The year was highlighted by introduction of two all-new commercial airplanes, the twin-engine Beechcraft Model 65 Queen Air executive transport and the versatile single-engine Beechcraft Model 33 Debonair. Other new models unveiled at the company's annual distributor-dealer sales meeting in November included the 1960 Beechcraft Super G18, Twin-Bonanza, Travel Air and Bonanza. With the two completely new planes, Beech in 1960 will offer to the business aviation market the largest executive line in its 28-year history.

More than 800 business aircraft were delivered in fiscal 1959, representing an increase of approximately 100 units over the previous year. Delivery of the 450th Beechcraft Super 18 during 1959 brought to more than 6,850 the total number of units in the Model 18 series that have been built for commercial and military customers the world over. Other milestones in 1959 included delivery of the 800th Beechcraft Twin-Bonanza, the 280th Travel Air and the 6,100th Bonanza.

Another significant development in 1959 saw the twin-engine Beechcraft Super 18 become the world's first civil aircraft under 10,000 pounds gross weight to receive Federal Aviation Agency approval for standby rocket power. This special installation

Beechcraft Super 18 executive transports line up for delivery.

consists of two lightweight Aerojet-General solid fuel rocket engines which add instant thrust to the plane's main powerplants, thus providing greater safety and operating versatility. Later in the year FAA also approved the same type of installation for the Beechcraft Twin-Bonanza.

Twice during 1959 Beech set new all-time records for monthly dollar volume sales of business aircraft products. In April Beech reported commercial sales of more than $5.4 million—the largest dollar volume month for business aircraft in company annals. Then in August commercial sales soared over $6.1 million for a new dollar volume business aircraft record. And as of September 1, 1959, the backlog of orders for commercial aircraft stood at over 360, compared with some 30 units on order on the same date one year earlier.

Beech export sales in 1959 also enjoyed healthy growth. At the end of the fiscal year sales of aviation products to foreign markets amounted to $7.8 million—a 70 percent increase over the export volume in fiscal 1958. Deliveries of Beechcraft Mentor trainers, export counterpart of the Air Force and Navy T-34, continued during the year. Besides the United States, the Mentor now serves the governments of Argentina, Chile, Colombia, El Salvador, Japan, Mexico, Philippines, Spain, Turkey and Venezuela.

Other important activities in the commercial aircraft field during the year included operation of the 11th annual Beechcraft Service Clinic in which more than 1,500 airplanes were given free maintenance checks at various distributor locations throughout the country. Since inception of this program in 1949, more than 11,500 aircraft inspections have been made by factory technicians at no cost to owners. It is the only service of its kind in the aircraft industry.

New contract awards in 1959 indicated that the company's highly diversified design, engineering and production capabilities have established Beech as a top producer in the advanced air and space fields. In April, North American Aviation selected Beech from a field of 14 competing companies for the development and manufacture of an alert pod for the Mach 3 USAF B-70. Over 165 design criteria were considered in the competition. A major system of the B-70, the Beech-designed power device will enable USAF's intercontinental manned bomber to become airborne in record time from any base in the world.

In May, the Air Force named Beech winner of a $1 million facilities expansion contract for construction of a "transient heat" laboratory at the firm's Boulder (Colorado) Division. It was the first contract of its kind ever awarded by USAF. Transient heating is a relatively new method of simulating thermal conditions of space flight from launch to engine burn-out; it subjects missile and rocket structures to the continually rising temperatures encountered in travel through the atmosphere at extremely high velocities.

Also in May the Department of Defense announced that Beech had won a joint service competition for an air launched Mach 2 expendable missile target system to be designated KD2B-1. Designed to fly twice the speed of sound and from 5,000 and 70,000 feet, the rocket-powered KD2B-1 will be a low cost operational target with speed and altitude performance matching the capabilities of enemy threat aircraft. Beech won the award in a field of 18 guided missile and aircraft manufacturers. The target will enter service in 1962.

First Army order for an initial quantity of Beech-designed KDB-1 medium performance targets was received in 1959. Already in volume production for the Navy, the Army will use the remote-controlled, recoverable piston-engine target for air defense system evaluation and training. Originally developed under a Bureau of Aeronautics contract, the first production Navy KDB-1 flew in August. The 600-pound vehicle flies above 40,000 feet and at speeds of 300 knots.

During the year Beech delivered to the Army the first twin-engine L-23F multi-purpose transports, a completely new airplane with a wide range of military applications. A follow-on contract from Republic Aviation extended production of USAF F-105 aft fuselage sections and ailerons until mid-1961. The year also marked on-schedule completion of the Army L-23D Seminole, Lockheed T-33 wing and B-47 external fuel store production programs. Under new projects, work commenced on quantity orders for F-100 external fuel tanks, containers for the Polaris missile and new lightweight Model 314L generator sets.

At Boulder, the company expanded its programs in cryogenic engineering, high energy fuels and environmental testing. Important projects in 1959 included production environmental testing of Martin Titan and Convair Atlas ICBM propulsion system components to insure their functional dependability. Other activities embraced development and testing of rocket fuel systems and assemblies, and design and fabrication of cryogenic ground support and servicing equipment, such as liquid gas transports, gas liquefiers, transfer systems and storage containers.

By year-end, Beech was engaged in more than 130 different aeronautical projects ranging from executive aircraft manufacture to space vehicle system design studies and evaluation. They included prime contracts with the military and subcontracts with other aerospace manufacturers, such as Convair, Lockheed, Martin, McDonnell, North American and Republic. Also in 1959 Beech continued important production of assemblies for the supersonic F-101, F-104 and F-106 jet fighter-interceptors. Additionally, it produced a number of radar-equipped RL-23 aircraft for the Army.

At the close of 1959, Beech had nearly two million square feet of plant area in use at six major facilities—three in Wichita, Kansas, and one each at fully-integrated divisions in Herington and Liberal, Kansas, and in Boulder, Colorado. Total employment was approximately 7,000. Also in operation were two wholly-owned subsidiaries, the Beech Acceptance Corporation, Inc., and Beechcraft Research & Development, Inc.

BELL AIRCRAFT CORPORATION

As aircraft, missile and space technology continued to develop in 1959, Bell Aircraft consolidated its efforts to place added emphasis on V/STOL aircraft, space vehicles, rocket engines and avionics equipment.

Development of a jointly funded USAF and Navy V/STOL tactical fighter continued during the year and culminated in completion of a full-scale mock-up for inspection by a joint military review board. A series of studies were made for all types of operational missions defining speed and radius capabilities of various VTOL configurations. With flight tests of research vehicles, extensive wind tunnel tests and studies for powerplant design, jet impingement, hovering controls and stability, the company demonstrated the potential of the concept.

The X-14, VTOL jet-powered airplane, successfully demonstrated in full transition last year, was delivered to the National Aeronautics and Space Administration's Ames Research Center at Moffett Field for flight evaluation.

With military support, the Ground Effects Machine was also the subject of expanded study and test effort.

Bell engineers devoted considerable study during the year toward safe environments for space travel and to navigation in near space of manned and unmanned satellite vehicles, and to controlled flights in cislunar areas and beyond.

The year saw continued development of the Hustler rocket engine which is used to power the final stage of the Discoverer satellite, the first of which was placed in polar orbit in February, 1959. The Bell engine, which proved reliable on all firings, demonstrates the highest possible performance for any rocket engine in its thrust range. Tests during the year proved its practicability for other, more advanced, space programs.

Bell's rocket engineers also made important contributions in the field of rocket fuels and, under various contracts, further investigated the use of high-energy propellants, propellant and package storage, catalytic reaction for mono-propellants at sub-zero temperatures, lubricity of various types of rocket propellants, solid gas generators and mono-propellant stability. A prototype mobile unit for the calibration of missile launch base equipment was also developed.

Artist's concept of Bell VTOL transport.

Bell Aircraft's rocket engineers were very active in the development and production of reaction controls for missiles and vehicles operating outside the earth's atmosphere. The company provided precision controls for several such projects: X-15, Mercury, Vega, Centaur, and others still classified.

Bell also considered many of the other technical areas associated with vehicles like the hypersonic glider Dyna-Soar, for which the company has resolved many of the flight path and re-entry difficulties. Research in this area included stability, instrumentation, vehicle guidance, cooling, and the management of flight energy.

Until very recently, metals adequately fulfilled structural requirements. As vehicle speeds increased to Mach 15 and beyond however, it was found that conventional design radically limited the use of conventional materials. Bell scientists have applied modern technology to the study of materials capable of withstanding the stresses of travel in space and where such were not available, of making old ones serve.

Increased interest in ceramics led to extensive experiments for ceramic structural design and attempts were made to utilize the better heat resistant properties of this material as well as others such as coated molybdenum, the newly developing nobium alloys, beryllium, dense silicon carbide and coated graphite, several of these having application to Bell's "double-wall" principle of hypersonic airframe construction. Theoretical and experimental development work was also conducted on leading edges of hypersonic vehicles based on metallic and non-metallic refractory materials having a high temperature capability. A plasma jet was developed and produced in the engineering and research laboratory for use in such programs within and outside the company.

A major technological breakthrough by the company's Avionics Division in inertial instrumentation and gyro design, coupled with a highly accurate accelerometer, permitted development of a high-performance navigation system for aircraft, missiles and space vehicles with greater accuracy than has been known so far.

A similar accelerometer was produced in quantity for the Army's Sergeant surface-to-surface guided ballistic missile. The unit's extremely stable configuration allows very high performance over a wide range of acceleration, vibration and temperatures and is also readily adaptable to either analog or digital applications.

Additional developments applicable to the field of inertial navigation included a digital velocity meter utilizing a production accelerometer and special electronic circuitry. The output of the instrument is a frequency proportional to the acceleration measured by the accelerometer. A novel technique is used to obtain an extremely linear relationship between acceleration and frequency.

Avionics engineers were also developing radar countermeasures techniques and visual surveillance devices and producing equipment to provide identification capability for ground surveillance radars.

The service test model, AN/GSN-5, of Bell's Automatic All-Weather Landing System was completed and flight tested during the year. With this advanced model greater landing accuracy was achieved than ever before. The service test model was scheduled for delivery to the Federal Aviation Agency at NAFEC, Atlantic City, New Jersey, for evaluation early in 1960.

The Navy was formulating plans for installation of the Bell landing system on a number of aircraft carriers while American and foreign airlines, concerned with the growing air traffic problem, were also contemplating installation of the device.

BELL HELICOPTER CORPORATION

During 1959, Bell continued production of its two commercial helicopters, the three-place 47G-2 Trooper and the four-place 47J Ranger. Bell helicopters were at work in a variety of jobs in 52 foreign countries, their theaters of operation ranging from polar regions to equatorial jungles.

In 1959, roughly 75 percent of the company's business was military, as Bell continued production of several models for all of the U.S. military services. The Army was the company's largest customer.

Bell was turning out production quantities of the Army's HU-1A Iroquois jet powered helicopter under a contract announced early in the year for 110 of this model.

Development work continued on the XV-3 convertiplane, which on December 18, 1958, made the first successful 100 percent conversion flight. Both Bell and the Air Force completed their respective XV-3 flight test programs during the year, and turned the convertiplane over to NASA at Moffett Field, California. The XV-3, a fixed-wing, tilting rotor aircraft, was also being developed for the Army.

Bell also continued its work in rotary wing instrumentation development and the first dynamic flight simulator for helicopters was in operation at the company's Fort Worth plant as industry coordinators for the joint Army-Navy Instrumentation Program.

Employment in October, 1959, was approximately 2,900.

BOEING AIRPLANE COMPANY

The Boeing Airplane Company probed the space age, helped strengthen the arsenal for peace and gave the nation a full introduction to the commercial jet era in 1960.

Perhaps the most spectacular impacts were made by the Air Force announcement early in November that Boeing had been given prime responsibility for developing the new Dyna-Soar boost-glide vehicle, and by the 707 jetliner which rolled steadily in ever increasing numbers from the Boeing Transport Division in Renton, Washington, near Seattle. Trans World Airlines, Continental and Qantas joined Pan American and American in the air line parade. Braniff, BOAC, Air France and Sabena were scheduled to join the list before the year was out.

More than 60 of the 197 Boeing 600-mile-an-hour jets on order were in service by October, with both the 707-120s and the long-range Intercontinental 707-320s establishing new route records as they moved into commercial operation. Such transcontinental travel times by the 120s as Los Angeles to New York in four hours and a few minutes, and New York to Los Angeles in four and three-quarters hours became commonplace. The Intercontinental showed what it could do before entering Pan American service with a non-stop Seattle to Rome flight in 11 hours and six minutes, and a London-Seattle jump in 9:38.

The Military Air Transport Service also took delivery of three VC-137s, its version of the 707, early in the year. President Eisenhower became the first president to travel by jet when he flew to Germany in one of the VC-137s in August.

Alongside the 707 final assembly line at the Renton plant, KC-135 tanker-transports continued to roll out for the Air Force's Strategic Air Command. The 300th of these military outgrowths of the 707 prototype was delivered in August.

The improved IM-99B Bomarc made its first appearance in May when the 400-mile range missile was fired experimentally from Patrick Air Force Base, Florida. During the early flights, the solid propellant system for the "B" was demonstrated satisfactorily. Testing of the "B" continued as the now well proved IM-99A went into first operational service at McGuire Air Force Base, New Jersey. Other bases nearing operational status at year's end were Otis Air Force Base, Massachusetts, Dow Air Force Base, Maine, and Suffolk Air Force Base on Long Island.

During flight test the "A" missile demonstrated

Scale model of Boeing vehicle designed to study Mars.

its ability to make intercepts in multiple firings, to change course in mid-flight and attack a second target after the first one had been "scrubbed," and to work successfully with manned interceptors in mixed attacks on jet drones.

In another flight the Bomarc intercepted and made a direct hit on a supersonic Regulus missile.

Test of silo configurations for the Minuteman intercontinental ballistic missile opened dramatically in mid-September when a full-size model of the three-stage ICBM was test fired successfully from its underground launcher at Edwards Air Force Base, California.

The flight test was the first of a series designed to investigate the design of the operational Minuteman launch silo.

In the words of Major General O. J. Ritland, Commander, Air Force Ballistic Missile Division, this and subsequent tests "further strengthens our confidence that the solid propellant Minuteman can indeed provide the advantages of fast reaction, dispersal, survivability and economy."

Sharing with Boeing in a test phase of the Minuteman program were large and small businesses throughout the nation. The first major Minuteman contract was awarded by Boeing to a California company. Since then subcontracts amounting to many millions of dollars have been awarded to firms in such widely scattered areas of the country as Connecticut, Florida, and Oklahoma.

At one point in the program six companies were awarded study contracts involving launch control systems, communications, techniques, for Minuteman. These involved four different communications methods, plus so-called hybrid techniques involving a combination of methods. Five of these companies are headquartered in the east, one in the west.

Boeing's entry into the space age field continued to expand, with research design including a manned orbital research station and counter-moon probe, and a space vehicle capable of carrying men on reconnaissance trips around the earth or to planets within our solar system.

In keeping with the transition to the space age, Boeing announced in August the consolidation of three organizations into a single division. The company's Seattle and Pilotless Aircraft divisions and its Systems Management Office joined forces as the Aero-Space Division. Lysle A. Wood, Boeing vice president and manager of the Pilotless Aircraft Division, was named general manager of the new division.

In the small gas turbine field, Boeing's newest development in the 520 series continued successful testing by the Industrial Products Division. The series covers a horsepower range from 350 to 600, with marine, turboshaft and turboprop engines all under test. More than 100 Turbo-Starters, Boeing turbine compressor ground support units, have been ordered by several United States, Canadian and European airlines and aircraft service firms.

Continued on-schedule production of the B-52G missile bomber, which during 1959 established a number of impressive records, coupled with announcement of the more advanced B-52H model, highlighted the year's activities at the Wichita, Kansas Division. The last of the Seattle-built B-52s left the West Coast plant in January.

The B-52H will have all of the missile-carrying and other capabilities of the B-52G plus additional advancements. First model is due off the assembly lines early in 1961. Plans call for the B-52H to be phased in with the B-52G to i ure uninterrupted production.

Among B-52G accomplishments were a non-stop flight of more than 13,000 miles over 49 state capitals and the District of Columbia, a non-stop nonrefueled mission covering more than 9,000 miles, and flights to altitudes of nearly 60,000 feet. Also successfully concluded were B-52G cold weather tests in Alaska.

A research project disclosed during the year involved a new and revolutionary instrument landing system for aircraft. It weighs less than ten pounds and costs only a fraction of present systems.

As anticipated, employment at both Seattle and Wichita continued to decline during the year. October totals were approximately 60,000 at Seattle and 25,000 at Wichita.

Sales for the first nine months of 1959 totaled $1,131,066,874, and net earnings $8,166,681. This compared with sales of $1,276,095,539 and net earnings of $27,328,805 for the same period in the previous year. Unfilled orders at September 30, 1959, totaled $2,170 million, including $695 million in commercial jet transport orders.

CESSNA AIRCRAFT COMPANY

The announcement of a proposed three-for-one stock split following approval by Cessna Aircraft Company's board of directors on October 21, 1959, climaxed a record year for the company. Both sales and earnings exceeded any previous year in the company's history.

Sales by Cessna, excluding Aircraft Radio Corporation volume, were $91,665,000 as compared with $86,159,520 in fiscal year 1958. ARC did a total volume of $14,124,000 in the 12-month period ended September 30, 1959 of which $8,800,000 was after February 1, 1959 when ARC became a wholly-owned subsidiary of Cessna. ARC is a leading manufacturer of airborne electronic navigation and communication equipment and is located in Boonton, New Jersey. For the combined company, total sales were $105,790,000. Preliminary earnings indicated were $7.40 per share on the shares outstanding at the end of the year including ARC earnings for the full 12-month period.

Commercial aircraft sales for 1959 were up about $8.4 million over 1958, while industrial products sales increased about $4.1 million. Cessna's industrial products division manufactures hydraulic pumps, valves and cylinders for farm machinery and light industrial equipment. Military volume declined as a result of completed contracts.

During 1959, the company marketed seven commercial planes and planned to have nine products in the 1960 line of aircraft. Models in production during 1959 included the two-place Model 150, the four-place Models 172, 175, 180, 182 and Skylane, and the five-place twin-engine Model 310C. New products being added to the 1960 line included the four-place Model 210, a high-wing, single-engine monoplane with retractable landing gear, and the new Skylark, a deluxe package-priced version of the Model 175.

Cessna 172s ready for mass flyaway delivery.

Pilots Robert Timm and John Cook, flying a standard Cessna 172, set a new world's record for nonstop endurance flying at Las Vegas in February. The two pilots kept their 172 aloft 64 days, 22 hours and 19 minutes, more than six times around the world in straight line flying.

In March, Cessna rolled its 1,000th Model 310 off the company's commercial division assembly line and delivered the new plane to Stephens-Adamson Manufacturing Company of Aurora, Illinois.

The world's first high-wing, single-engine commercial monoplane with retractable gear was announced in April and it received FAA certification the same month. The new Model 210 has a top speed of 199 miles per hour and a cruise of 190 miles per hour.

The same month, Cessna also announced the sale of 36 L-19s to the French armed forces for observation and reconnaissance duty in North Africa. A $1.5-million expansion program at the firm's industrial products division in Hutchinson, Kansas, was announced in April. During the same month, a twin-engine Model 310C completed a 17,000 mile demonstration tour to 27 cities in 19 countries through Asia.

Corporate changes during 1959 included the promotion of Del Roskam to vice-president in charge of aircraft divisions, appointment of V. G. Weddle as general manager of the commercial division and the election of Robert L. Lair as vice-president and general manager of the military division. During the year, President Dwane L. Wallace and Vice-President Thomas B. Salter completed 25 years with the company.

In the military picture, Cessna continued production on its two-place twin-jet T-37 Air Force trainer, and produced U-3A administrative and light cargo planes for the Air Force during the early part of the year. The company completed a long-term subcontract for Lockheed and continued producing components for the Boeing B-52G and the Republic F-105.

In early October, Cessna entered the military utility market by introducing a new four-place jet, designed to fulfill military needs for a multi-mission, low-cost jet. The new jet is designated the Model 407.

In late October, the company kicked off its 1960 commercial plane sales campaign with a mass meeting in Wichita attended by more than 1,000 distributors, dealers and salesmen. The meeting was held to unveil the 1960 product line and usher in a new era in business and private aviation which Cessna calls the "Soaring Sixties."

Following the meeting, the company held a mass flyaway of more than 350 new 1960 Model 172s carrying a retail value of over $3.5 million. Both meeting and flyaway were the biggest in the history of the industry.

CHANCE VOUGHT AIRCRAFT, INCORPORATED

Chance Vought Aircraft, Incorporated, facing the rapid technological changes affecting the aircraft industry, moved into 1960 with a newly developed operational five-division organization designed to strengthen the company's space age capabilities and increase emphasis on research and development.

While Vought was increasing emphasis on space programs, electronics and research, it was also continuing to advance in the field of aircraft design and development with its Crusader series of Navy aircraft.

The newest Crusader, the F8U-2N all-weather-type aircraft, incorporating an increased capability for detecting and destroying enemy targets in darkness and in inclement weather, was to reach the fleet during 1960. It will join the F8U-1, the Navy's fastest operational fighter, the F8U-1P photographic airplane and the F8U-2 Crusader.

The corporate structure realignment encompassed five divisions—astronautics, aeronautics, electronics, range systems and research—each under a general manager and reporting to a cognizant vice president.

Divisional scopes included:

Aeronautics Division: To concentrate on products and systems which operate principally within the earth's atmosphere. Included in this category are piloted aircraft, atmospheric missiles, anti-submarine warfare devices, tactical weapons and subcontracting components.

Astronautics Division: To concentrate on vehicles for exit from the atmosphere, space exploration and re-entry and on ballistic and anti-ballistic missiles whose range carries them out of the atmosphere and beyond.

Range Systems Division: To concentrate on the establishment and operation of missile and space vehicle test ranges.

Chance Vought Research Center: A separate research function aimed at generating new knowledge by scientists working on ideas in a creative atmosphere. Other divisions will be strengthened and supported through a strong basic and applied research program.

Electronics Division: To intensify the company's operations in the electronics field to a much greater degree, although Vought has been active in this field for a number of years.

In the field of automation and electronics, Vought in 1958 formed Genesys Corporation in Los Angeles, California, a wholly-owned subsidiary which concentrates on commercial electronics in the computer field.

In further diversification action, Vought in 1959 acquired a majority interest in National Data Processing Corporation of Dallas, manufacturer of data processing equipment. National Data Processing retained its autonomy; it gained capitalization needed for expansion.

The first Scout research rocket, assembled by Vought and marking the company's first venture into the space age, was scheduled for firing in 1960 by the National Aeronautics and Space Administration. The company's role in the NASA program included building the payload airframe, transition section and control surfaces and integration of Scout's four solid rocket stages and construction of a launcher for the 70-foot, 35,000-pound vehicle.

NASA said Scout is capable of putting a 150-pound payload in a nominal 300-mile orbit and sending a 100-pound instrument payload some 5,000 miles or more in a high altitude shot. It will be used for space, orbital and re-entry research.

Also in the field of space research, Vought was a member of the Boeing Airplane Company team in an Air Force competition for development of the Dyna-Soar boost-glide vehicle.

Backing up its research and development program, the company had in operation a $4-million high speed wind tunnel designed to generate airflows up to 3,800 miles an hour in addition to its low-speed wind tunnel. An expanded and modernized heat treating facility, designed to handle the exotic metals that will be used in building the advanced rockets and space vehicles of the future, was scheduled to be in operation during 1960.

In the field of heat studies, the company established a $450,000 high temperature research laboratory which tests the ability of fuels, fluid and pneumatic systems to withstand heat of great intensity. A $1-million hydraulic facility also was used for research on hydraulic assemblies and production of precision hydraulic equipment. Another facility, utilizing a ramjet test installation, measures the ability of nose cones to tolerate the terrific heat encountered in re-entry into the atmosphere from outer space.

Year-end employment was more than 10,000.

The company also worked on a study contract for the Air Force for a new deterrent weapon system, termed "SLAM" for Supersonic Low Altitude Missile. Powered by a nuclear ramjet engine, it would have practically unlimited range and would deliver devastating nuclear weapons anywhere on the globe with extreme accuracy.

In addition to its Crusader contracts with the Navy and its "team" space-age projects with other aircraft companies, Vought was working with North American Aviation on the Air Force's Mach 3 B-70 Valkyrie intercontinental bomber. Vought will design and build the aircraft's horizontal and vertical stabilizer sections. The company was selected as a member of the North American team from a competing group of 21 contractors.

Vought independently was studying space systems, crew quarters and control rooms for spacecraft. It was working on advanced propulsion systems and plans to prove out designs in its own space research vehicles and in team-developed spacecraft such as it is helping to design.

Studies in the field of anti-submarine warfare were another area in which Vought was making progress. For the Office of Naval Research, the company was studying advanced devices in the general field of submarine detection. For the Navy Bureau of Aeronautics it instituted exploration of new means of protecting forces at sea from submarine attack.

The company, in its 1959 nine-month financial report, reported sales totaling $191,686,384 and net income of $4,297,437, or $3.61 a share, and said that "the lower ratio of earnings to sales during the third quarter of 1959 is attributable to a continuation of planned emphasis on research and development effort directed toward product diversification." Unfilled orders at September 30, 1959, included orders represented by letters of intent, amounted to $313,000,000.

CONTINENTAL AVIATION AND ENGINEERING CORPORATION

Continental's J69 turbojet Research and Development program resulted in the birth of a complete family of versatile powerplants based on the J69-T-29. The J69-T-29 engine, a 1700-pound thrust turbojet for target-missiles, was in production for the Ryan Q-2C Firebee. This versatile powerplant design uses a single-stage axial plus single-stage centrifugal compressor, an annular combustor, and a single-stage axial-flow turbine. Fixed geometry is used throughout resulting in a rugged, dependable, low-cost powerplant.

Variations of the T-29 engine included 1900 and 2400-pound target-missile and man-carrying engines with and without afterburners, an aft-fan version, a boundary layer control engine composed of a T-29 type engine driving a separate high performance compressor through a "free"-turbine, as well as a shaft-turbine in the 3500-horsepower class. In addition, a derated 1400-pound thrust long-life engine was undergoing final development for manned aircraft and was selected as the powerplant for the Cessna 407 jet utility transport. The boundary layer control engine was scheduled for delivery to the USAF for use on the Lockheed C-130. Market requirements will determine the transition of the others from development status to production availability.

The J69-T-25 remained in production for the Cessna T-37B USAF jet trainer. Turbo-compressor engines for ground support equipment as well as for pressure jet helicopters were produced throughout 1959 as well.

At year-end the company was working on a new special shaft turbine engine in the 400-500-horsepower class for both helicopter and turboprop aircraft.

Over 2000 J69 engines had been built by year-end in addition to approximately 1100 turbo-compressor engines. The CJ69-1025 civil version of the 1025-pound thrust J69-T-25 became the second Continental built turbojet to receive FAA certification. The company continued its association as U. S. licensee for turbines built by Societe-Turbomeca of France. Turbomeca ARTOUSTE II-B engines were supplied to both Curtiss-Wright and Piasecki for use in their respective aerial jeeps undergoing development.

CONVAIR
A DIVISION OF GENERAL DYNAMICS CORPORATION

Noteworthy among the research, development, and production accomplishments of the Convair Division of General Dynamics Corporation during 1959 were these: attainment of Air Force operational status for the Atlas intercontinental ballistic missile; start of production on vehicles for space exploration; delivery to the customer of the first Convair 880 jet transport; delivery of first B-58 Hustler supersonic bomber to the Air Force and demonstration of the bomber's low-level flight capabilities to match its high-altitude performance; delivery of first F-106 advanced all-weather supersonic jet interceptors to North American Air Defense Command; announcement of production of advanced Terrier supersonic guided missile; development of Red-Eye, a shoulder-fired missile system.

In addition, the promotion of August C. Esenwein to the post of Convair Division executive vice president was announced. He succeeded J. V. Naish, who in 1958 had been elevated to the Convair presidency and to a senior vice presidency of General Dynamics Corporation.

Total Convair employment in the General Office, the Scientific Research Laboratory and the five operating divisions in California and Texas was 67,232 on September 25, 1959, as against 62,073 on October 1, 1958.

CONVAIR-ASTRONAUTICS

Successful firings of the Air Force Atlas intercontinental ballistic missile (ICBM) from launch complexes on both the Atlantic and Pacific coasts paralleled continued production of the missile by Convair-Astronautics at San Diego, California.

Indicative of the Atlas's position as the sturdy wheelhorse of the early Space Age was the awarding to Convair of the first contracts to develop vehicles—Centaur and Vega—for space exploration.

Three flight test Convair 880s line up in San Diego.

Two Atlas Series B missile firings late in 1958 heralded the advances made during 1959. One was the first full-powered Atlas flight of more than 6,000 statute miles down the Atlantic Missile Range from Cape Canaveral, Florida, on November 28, 1958.

The other was the historic flight of Atlas 10-B—the "talking" satellite—launched into orbit from Cape Cananveral on December 18, 1958, as the only rocket in the Free World capable of propelling and guiding itself into a satellite around the earth. Ten-B completed 500 revolutions before re-entering the atmosphere and burning up on January 21, 1959.

Progress continued, and the first successful Atlas Series D launching occurred at Cape Canaveral on June 20, 1959.

A series of ten successful Atlas launchings toward late summer included the firing of the first operational Atlas, the first Project Mercury launching, and the flight of an Atlas equipped with a new operational nose cone.

An Air Force Strategic Air Command crew from the 576th Strategic Missile Squadron, 1st Missile Division on September 9, 1959, fired the first operational Atlas on a 4,400-mile trajectory out over the Pacific Missile Range from its pad at Vandenburg Air Force Base, near Lompoc, California.

On the same day, thousands of miles distant, the first launching of Project Mercury (man-in-space) occurred at Cape Canaveral. Code-named "Big Joe" and boosted by Atlas 10-D, the Convair-Astronautics-fired missile sent an instrumented capsule far down the Atlantic Missile Range. The National Aeronautics and Space Administration (NASA) reported excellent data from the recovered capsule. Missile 10-D was the sixth Series D missile and the 30th Atlas ICBM to be flight-tested.

The Atlas had been selected earlier by NASA to boost the first United States man into orbit in Project Mercury. The capsule in which he will "ride" during the flight was under development by the McDonnell Aircraft Corporation. Project Mercury is designed to allow its capsule to circle the earth at altitudes of from 100 to 150 miles for up to 24 hours, initiate descent by retarding rockets, decelerate by aerodynamic drag, and land by parachute. In this connection, NASA's seven Astronauts—one of whom will be the first launched in Project Mercury—spent a week at Convair-Astronautics for orientation in Atlas design philosophy and an inspection of Atlas production facilities.

A successful launching of the new Mark III nose-cone-equipped Atlas was achieved over the Atlantic Missile Range early in October.

Convair-Astronautics received an NASA contract for development of the Vega space vehicle, a multistage rocket which will be the first United States space vehicle in the "medium" energy class. Vega employs a modified Atlas booster, a Convair-built second stage, and, optionally, a third stage supplied by the Jet Propulsion Laboratory. Vega will be able to inject a 740-pound experimental communication relay into a 22,000-mile "24-hour" orbit.

NASA has contracted with the company for eight Vega flight vehicles and one engineering evaluation vehicle.

Convair-Astronautics received an Advanced Research Projects Agency (ARPA) contract to develop Centaur, a space vehicle program later transferred to NASA. Centaur consists of a modified Atlas, plus a Convair-built upper stage, to be powered by the first liquid hydrogen rockets, the latter under development by Pratt & Whitney Aircraft. Centaur will be the first United States space vehicle in the "high energy" class, capable initially of putting 4½-ton payloads into satellite orbit or of sending large instrumented probes into deep space.

Azusa Mark II, an advanced missile tracking and impact-prediction system completed and checked out by Convair-Astronautics, was installed at the Atlantic Missile Range during the year. Azusa Mark II is capable of detecting at distances of hundreds of miles changes in missile position as small as 1.2 inches. It will be able to track space vehicles to the moon and beyond.

The first Atlas missile was delivered in September to Warren Air Force Base, Wyoming, where work was being pushed on two of the three Atlas complexes planned there. Activation of other USAF Atlas-designated sites was started at Offutt Air Force Base, Omaha, Nebraska; Fairchild Air Force Base, Spokane, Washington; and Forbes Air Force Base, Topeka, Kansas.

Convair-Astronautics completed a two-story, 100,000-square-foot engineering and product support building at San Diego, let a contract for a new Space Research Laboratory, and broke ground for missile stand S-3 at the nearby Sycamore Static Test Site, for use in testing Vega.

Karel J. Bossart, familiarly known as "father of the Atlas" and technical director of Convair-Astronautics, was presented the 1959 James H. Wyld Memorial Award by the American Rocket Society for his "outstanding contribution to the application of rocket power."

Division employment on September 25, 1959, totaled 16,736, including off-site personnel, as compared with 11,474 on October 1, 1958.

CONVAIR-DAINGERFIELD

Research and developmental testing of full-scale supersonic jet engines for missiles and aircraft was achieved during 1959 by the Ordnance Aerophysics Laboratory which Convair operates at Daingerfield, Texas, for the Navy Bureau of Ordnance. This work was conducted for BuOrd's Bumblebee Program and for other Department of Defense programs.

Convair-Daingerfield facilities included a blowdown cell, a high-altitude cell, and two sea-level cells, and supporting shop, maintenance, data processing, and instrumentation equipment. On September 25, 1959, employment totaled 260; this figure was 249 on October 1, 1958.

CONVAIR-FORT WORTH

B-58 Hustler production continued at Convair-Fort Worth as the Mach 2 bomber met or exceeded its design performance estimates during intensive flight testing.

The first tactical B-58 was delivered to the Air Force's Strategic Air Command in October. Earlier, USAF had announced that SAC's 305th Bomb Wing, Bunker Hill Air Force Base, Indiana, would be the first B-58-equipped SAC unit.

That the supersonic bomber is not only the world's fastest and highest-flying jet bomber but also the lowest-flying and fastest was indicated in a dramatic late summer demonstration proving the aircraft can sneak under enemy radar defenses without detection. In a 700-mile-per-hour hedgehopping flight at 500 feet above ground, a B-58 flew 1,400 miles from Fort Worth to Edwards Air Force Base, California. In this simulated low-level attack on the base, the Hustler proved it has enemy penetration capabilities greater than any other aircraft in existence. The flight emphasized the B-58's easy handling characteristics under difficult conditions, for none of the three Convair crew members reported pilot fatigue, despite the non-stop, nonrefueling flight lasting four hours and three minutes. Return leg of the flight was made at altitude. The flight further stressed the multi-purpose capabilities of the B-58, originally designed to perform at altitudes exceeding 50,000 feet.

Thirteen Air Force B-58s which had completed their phase of the intensive B-58 flight test program were to be returned early in 1960 to Convair-Fort Worth for conversion by the factory into tactical aircraft. Work to be done on each of the 13 aircraft was to be different, since each initially was instrumented for a different phase of the flight test program. One of the major changes was to be the installation of new and improved models of the General Electric J79 turbojet engine, four of which power the bomber.

Convair-Fort Worth was announced early in 1959 as the winner of an Air Force competition to design the nation's first nuclear-powered bomber, a fleet of which it was said could fly anywhere in the world and return without refueling, as well as maintain continuous airborne alert if necessary.

Among the diversity of B-58 systems tests conducted during the year were those of an escape capsule for each of the three crew members. The encapsulated seat is designed to protect crew members against high-speed, high-altitude ejection and to provide a habitable environment on land, sea, or ice.

USAF's Air Materiel Command named Convair to supply training devices to teach B-58 crews how to fly and operate the bomber's subsystems. The company also developed three-dimensional training aids to give Air Force crews the "feel" of the B-58 without tying up the actual aircraft or equipment costing thousands of dollars.

More than 100 persons have flown at twice the speed of sound in the B-58. The 100th was Lieutenant General Mark E. Bradley, USAF, Deputy Chief of Staff (Materiel), who thus joined one of the world's most exclusive clubs, the Bomber Wing of the Mach 2 Club.

USAF retired its last Convair-built B-36 intercontinental bomber February 12 at Fort Worth's Amon Carter Field. The aircraft was a gift to the City of Fort Worth as a memorial to the men who built, maintained, and flew the Strategic Air Command bombers which played a major role between 1948-1958 in maintaining United States' policy of "peace through airpower."

Frank W. Davis, who had served as division chief engineer since 1954, was promoted to be a Convair vice president and Fort Worth plant manager. Employment was 19,660 on September 25, 1959, compared with 20,759 on October 1, 1958.

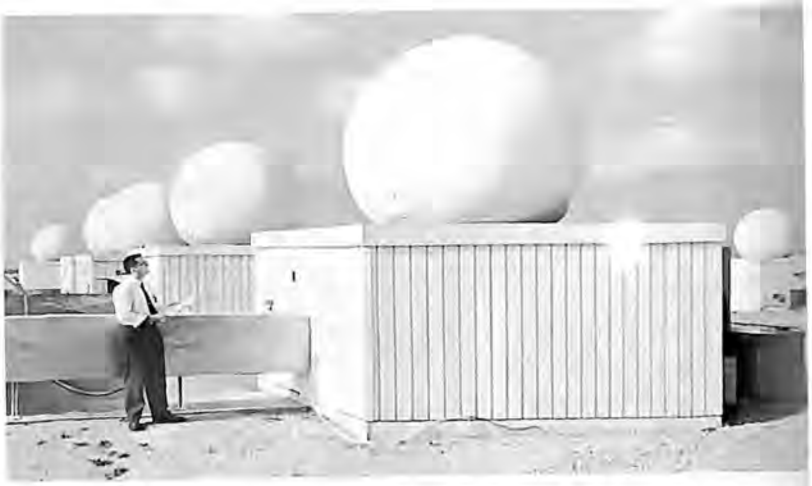
CONVAIR-POMONA

Production of Tartar and advanced Terrier supersonic, surface-to-air guided missiles continued at the Naval Industrial Reserve Ordnance Plant operated by Convair at Pomona, California.

Advanced Terrier incorporates improved guidance features and substantial improvements in coverage over original Terriers, which have been operational with fleet units for five years.

Tartar, the newest and smallest of the Navy's surface-to-air guided missiles, is designed for use from ships as small as destroyers and for secondary batteries aboard cruisers.

For intercepting enemy aircraft at long range and higher altitudes than conventional anti-aircraft guns, Terrier eventually will see service on 27 additional ships, including two Forrestal-class carriers, three guided missile cruisers, a nuclear-powered



Convair tracking system for missile range.

guided missile cruiser, 19 guided missile frigates, a nuclear-powered guided missile frigate, and a nuclear-powered carrier. Terrier currently is operational aboard two guided missile cruisers, USS Boston and USS Canberra, and one guided missile destroyer, USS Gyatt.

Terrier also is suitable for beachhead operations by the Marine Corps. The 1st Medium Anti-Aircraft Missile Battalion, stationed at the USMC base, Twentynine Palms, California, is equipped with mobile Terrier missiles.

Terrier's solid-propellant powerplant is produced by Allegany Ballistic Laboratory, a division of Hercules Powder Co. Northern Ordnance, Inc., builds the missile's launching equipment. Other concerns associated with the Terrier program include Hicks Corp., Boston; Bell Telephone Laboratories, Whippany, New Jersey; Vitro Laboratories, Silver Spring, Maryland; Reeves Instrument Co., New York; Ford Instrument Co., Long Island City, New York; and Radio Corporation of America.

Tartar was scheduled to appear in the fleet in mid-1960. Developed by the Bureau of Ordnance under the technical direction of the Applied Physics Laboratory of The Johns Hopkins University, Tartar was described by BuOrd Chief Rear Admiral Paul D. Stroop as "highly effective against both low and high-altitude targets."

Since space aboard ships is severely limited, use of miniaturization techniques was required to package the sophisticated guidance, propulsion, and construction systems into the small, lightweight Tartar airframe. The complete missile is about 15 feet long and is slightly over a foot in diameter. Its small-stage, solid-fuel, dual-thrust rocket motor was designed and developed by Aerojet-General Corporation.

The Army, the Marine Corps, and Convair-

Pomona disclosed plans for joint development of Red-Eye, a new surface-to-air, shoulder-fired, guided missile system. The Army Rocket and Guided Missile Agency, Army Ordnance Missile Command, awarded the company a contract totaling nearly $6 million to develop the weapon.

Designed to give combat troops the capability of destroying low strafing or bombing aircraft, Red-Eye is readily man-transportable. The missile launcher is about four feet long, three inches in diameter, and weighs nearly 20 pounds. When capped at both ends, the launcher tube serves as a shipping container for the missile. Red-Eye is a composite structure containing propellant, an electronic guidance system, and a high-explosive warhead.

Convair-Pomona continued its support programs for other phases of Convair production, in addition to work on ground support equipment for the Navy and the Air Force.

Two unrelated activities were of note during 1959. One was Air-Launched Rocketsonde, a sounding rocket fired from a launch tube hanging from three parachutes high in the sky to obtain high-altitude atmospheric information wherever present-day aircraft can fly. This new design concept resulted from a three-year program conducted for USAF's Air Research and Development Command by Convair-Pomona. Company engineers worked closely with the Aerial Reconnaissance Laboratory and the Directorate of Procurement at Wright Air Development Center in developing the new device for making meteorological studies.

The other program found Convair-Pomona engineers counting aircraft over the San Francisco Bay area to gain first-hand knowledge about the dimensions of the air traffic control problem. This project was part of a broad research program initiated by the Federal Aviation Agency, which was evaluating several proposals for controlling movement of aircraft in good and bad weather.

On September 25, 1959, Convair-Pomona employment totaled 5,906; the figure was 4,708 on October 1, 1958.

CONVAIR-SAN DIEGO

Major production programs at Convair-San Diego included F-106A/B advanced all-weather supersonic jet interceptors for the Air Force and the Convair 880 jet airliner for domestic and foreign carriers.

Three Model 880s logged more than 400 hours of flight time in an intensive testing program during which the aircraft met or exceeded all design and performance estimates. The Federal Aviation Agency Model 880 flight-test program started in the fall and FAA certification of the transport for airline operation was expected in May 1960.

Trans World Airlines was scheduled to take delivery of its first two Model 880s in November and December 1959, and Delta Air Lines its first in January 1960.

Design work continued and production was begun on the Convair 600, a 635-mile-per-hour jet transport, and research and development programs for guided missiles and electronic systems continued at a high level.

Employment as of September 25, 1959, stood at 24,061, including off-site personnel. Comparable figure on October 1, 1958, was 24,555. Total floor space was 5,095,641 square feet in the two plants of the division.

The first Convair 880 jet transport rolled out of the plant on December 15, 1958, during ceremonies attended by some 2,000 guests. First flight of this 615-mile-per-hour airliner occurred January 27, 1959, and lasted an hour and 14 minutes, with chief engineering test pilot Don Germerraad at the controls.

Convair 880 production was scheduled to reach six a month in June 1960. Production of the initial Model 600 for American Airlines began in 1959 and the plane's scheduled first flight was set for September 1960. Deliveries to airlines were scheduled to start in the spring of 1961.

By mid-October, Convair had received orders for 85 Convair 880/600 transports. Fifty-one 880s were on order, as follows: Trans World Airlines, 30; Delta Air Lines, 10; REAL of Brazil, 3; Civil Air Transport of China, 1; and Capital Air Lines, 7. Model 600s were on order from American Airlines, 25; and SAS/Swissair, 9.

Negotiations for sale of the last of 176 Convair Metropolitan 440 twin-engine piston-powered transports were completed during the year.

Five squadrons of the North American Air Defense Command received their first operational F-106 advanced jet interceptors off the San Diego production line. Squadrons activated were at McGuire Air Force Base, New Jersey; Geiger Air Force Base, Washington; Andrews Air Force Base, Maryland; Castle Air Force Base, California; and Loring Air Force Base, Maine.

Six operational Air Force squadrons of Convair-built F-102 jet interceptors competed in Project William Tell II, the second annual USAF world-wide weapons meet held at Tyndall Air Force Base, Florida, in October 1959. Participating F-102s flew in from bases in continental United States, Alaska, Okinawa and Germany.

In the missile field, a Convair-San Diego developed supersonic ballistic cargo missile, Lobber, was initially fired at the Army's Camp Irwin, California, in December 1958. A 50-pound payload was delivered intact by the 9-foot-long, solid propellant missile over a range of approximately six miles. Additional firing tests were conducted during 1959.

Convair-San Diego likewise continued extensive studies for the Advanced Research Projects Agency, Department of Defense, on ballistic missile defensive systems.

Indicative of the importance placed upon electronics, Convair-San Diego established a separate electronics organization in October 1959. The new department began with 730 employes and 300,000 square feet of floor area for manufacturing, engineering, research, marketing, and office operations. The organization will expand development and production of airborne and ground-based radar, special ground test equipment, data handling instrumentation, and other electronics products.

An evaporative cooling system to prevent airborne radar equipment from burning up in heat generated in hypersonic flight was under development for the Navy.

Work began on a $2-million contract for design and production of a radar for a navigation-bombing system for North American Aviation's A-3J carrier-based attack bomber.

Convair's hydrostatic test tank was remodeled at San Diego to accommodate a Model 880 fuselage for a six-months' pressure-testing program to simulate 20 years of rugged, medium-range airline operation.

A $2-million contract for design, construction, and installation of an automatic data handling system for Wright Air Development Center Laboratories, Dayton, Ohio, was undertaken.

Work was started on an Air Force study contract to investigate use of sub-zero coolants in machining.

Manufacturing development personnel studied high-energy forming processes during the year and expected to accelerate their exploration of manufacturing by these methods during 1960. New brazing methods and materials and new tooling materials for high-temperature work were evaluated, and new methods developed for fusion and resistance welding.

Tooling plastics were evaluated in a search for more stable and more heat-resistant material, and several programs were conducted to evaluate ceramics for structural parts and as cutting tools.

On May 14, 1959, Convair-San Diego dedicated a $2-million high-temperature structures laboratory for research in simulating extreme loads and temperatures encountered in the high-speed flight of aircraft, missiles, and space vehicles.

During 1959, 45 plant improvement projects totaling approximately $6,613,000 were completed by Convair-San Diego. Major program was the rehabilitation of Plant I's two engineering buildings, begun in 1958. Other large projects included relamping of major buildings at Plant II, together with installation of new steam generating equipment and improvements in the heating system.

The plant moved, in December 1958, into a new $2.5-million facility at Holloman Air Force Base, New Mexico, assigned to Convair for the F-106 interceptor armament test program.

CONVAIR-SAN DIEGO ENGINEERING RESEARCH

Among the engineering research programs conducted by Convair-San Diego during 1959 were these:

Investigation of the aerodynamics of hypervelocity and high-altitude flows to determine the effects of real gas, including mean free path effects on lift and drag;

Analytical and experimental investigation of heat transfer in the vicinity of protuberances and detached boundary layers of high-speed aircraft and missiles;

Anti-missile research in fields of shock physics, ablation, molecular beams, hypersonic flow fields, and high-temperature air;

Studies of the mathematical and physical aspects of hydrodynamical stability, with special emphasis on effects due to a superimposed magnetic field;

Theoretical and experimental development of underwater body and control surface forms that will cavitate to a minimum extent during high-speed maneuvers;

Studies in guidance dynamics to determine guidance geometry and equations, data transmission, filtering, guidance computer, and attitude reference requirements;

Studies of refractory materials related to development of methods to produce fibers of refractory oxides and the feasibility and effectiveness of low-density, low-thermal-conductivity ceramic foams;

Investigations of the phenomena of structural failures caused by sonic vibrations, with tests conducted in the nozzle of a siren at sound levels up to 165 decibels;

Development of a hypersonic (Mach 7 to Mach 25) shock tunnel for experimental research in gas dynamics, hypersonic flow fields, and aerodynamic heating;

Continuing studies on advanced radar techniques, research on displays and tracking systems for airborne radar systems, and development of high-power low-weight sonar transducers and focusing systems for anti-submarine warfare applications;

Under a joint program with Ames Research Center, the instrumentation of a range section to collect data on ionization effects;

Research on infrared and photoconductor materials and their applications;

Experimental demonstrations during an ASW time-compression program which indicated improvement in detection possible when radar information is stored and re-displayed at higher than normal rate;

Research expected to result in development of automatic checkout equipment for jet transports;

Studies of a method for cooling electronic equipment by an evaporative film-type process, for installation in high-Mach aircraft;

Continuing studies on an "electric stick" project, this being the second phase of a planned developmental program to provide solutions to critical aircraft control problems that may be encountered in future weapons system developments.

CONVAIR SCIENTIFIC RESEARCH LABORATORY

Twenty-five basic scientific research projects were undertaken during 1959 by the Convair Scientific Research Laboratory (CSRL) in the fields of physics, chemistry, combustion, fluid mechanics and mathematics.

The Laboratory received its first outside direct financial support when the Atomic Energy Commission awarded to it a contract for work by the chemistry group on the thermodynamics of liquid surfaces.

Specialized equipment for the solid state physics laboratory was installed leading toward the early experimental investigations of diffusion in crystalline solids.

Employing the world's largest radio telescope, CSRL scientists probed the universe to a depth well beyond the penetrating power of the telescope's optical counterpart at nearby Palomar Observatory, in San Diego, California, county. The radio telescope has been scanning the heavens from Clark Dry Lake bed, some 100 miles east of San Diego in the Anza Desert.

Employing the University of Southern California Engineering Center's supersonic wind tunnel, CSRL scientists working in the fluid mechanics area gathered data for an analysis of the effects of mass transfer on the supersonic boundary layer. In another study, the effect of film boiling on skin friction and heat transfer of a body was postulated and tests devised to check out the theory.

In keeping with the policy of supporting worthwhile scientific research by groups outside the General Dynamics Corporation family, the CSRL, on behalf of Dynamics, joined the thermoelectric cooling research group organized by the Battelle Memorial Institute to underwrite research in this field. The group comprises many industry sponsors from throughout the free world.

One of the earliest projects sponsored by the Scientific Research Department within a Convair operating division progressed to the point that new experiments were conducted in the shock tube program at Convair-Astronautics. Some instrumentation problems remained to be solved, but the device itself was nearly fully developed.

Of the 58 persons who staffed the CSRL, 26 were scientists.

CURTISS-WRIGHT CORPORATION

Continued diversification and the development of a variety of new products marked the progress of the Curtiss-Wright Corporation in 1959. Among the principal new products announced were the Curtiss-Wright Air-Car, a completely new method of transportation; a coal-based road paving binder material for roads and airports; a VTOL "Flying Platform"; and a low cost expendable rocket powered target.

Announcement of the Air-Car was made in March, and interest was immediate and world wide. The vehicle travels on a cushion of low pressure, low velocity air over any unobstructed terrain and water at a height of six to twelve inches. The Air-Car does not have conventional wheels, axles, brakes, clutches, transmission or frame. It can travel in any direction and turn on its own axis. The vehicle is powered by conventional piston engines ranging from 50 to 200 horsepower and can travel at speeds up to 60 miles per hour.

The new vehicle has great significance as a new concept in transportation. Utilization of the Air-Car, presently for off-highway use, ranges from normal motor and marine applications to specialized farm, ranch, exploration and airport uses.

The Model 2500, a four passenger, 300 horsepower vehicle went into production in November 1959 at the South Bend Division of Curtiss-Wright, in South Bend, Indiana. The Corporation plans to produce a complete line of Air-Cars, ranging from a compact, two passenger model to a large freight carrying vehicle.

In October, 1959, the Wright Aeronautical Division in Wood-Ridge, New Jersey celebrated its 40th anniversary. In the same period, on November 5 the Turbo Compound marked its 25 millionth flying hour. The Turbo Compound continues to serve in first line equipment used for commercial transportation by the leading airlines of the world. In military operation, Curtiss-Wright powered aircraft continued as first line equipment. The AD4, FJ4 and F11F-1 aircraft on major aircraft carriers are powered by Curtiss-Wright turbojets. The "lifeline" of the Continental Defense System is also sustained by Curtiss-Wright powered equipment, in such aircraft as the P2V-7 and WV-2 and 3.

Development and advanced engineering was being done by Wright Aeronautical on a series of air breathing engines, such as the turbofan, supersonic turbojet, dual cycle and a wide range of ramjets. Applications for these engines was projected for future aircraft developments.

Space age projects received high priority at Wright Aeronautical. Work was started on the development of pre-packaged throttleable liquid rockets. New manufacturing and metallurgical processes were developed and being used to produce large solid rocket motor cases and motor nozzles for the use in missile vehicles.

During 1959 the Propeller Division of the Corporation in Caldwell, New Jersey announced the development of an all mechanical propeller, mechanical flight controls and actuation systems for aircraft. Mechanical actuation is scheduled for use in the folding wing tips of the B-60. All units in the mechanical system will be flight tested during 1960.

One of the Corporation's most rapidly expanding divisions, the Electronics Division, announced both the acquisition of a new plant in East Paterson, New Jersey, which will double the present production facility and the acquisition of Inter Mountain Instruments, Inc., of Albuquerque, New Mexico during the past year.

One of the most significant advances in simulation during 1959 was the development of PHO-TRAN, a radar land mass simulator which provides realistic presentation of simulated land mass areas for training in tactical radar application. PHO-TRAN achieves substantial reductions in the overall size of the equipment required, while broadening its application to reproduce land areas at a scale of 5 million to one. The design includes extremely high and low altitude presentations without loss of picture fidelity, and provides for countermeasures by an instructor to supplement training.

Development of a television optical system, to train photo recon personnel, utilizes a combination of closed circuit television and photo optical lenses to provide realistic images of ground targets.

During the year, production continued of both stationary and trailerized Electronic Flight Simulators for both military and commercial customers, including jet simulators for t[illegible] jet airliners now in use by the major airlines. The division is also building a complete Weapons System for the Swedish SAABJ-35 supersonic jet fighter.

Other important simulation programs were being carried on by the Electronics Division, including simulations for missile firing submarine control centers and missile guidance.

The Electronics Division broadened its participation in the electronics field with the production of components, solid state relays, thermal time delay relays, digital motor and delay lines. In addition, products such as power transistor test systems, transistor curve tracers and airborne digital computer systems greatly enlarged the division's capability in instruments and systems sales.

Early in 1959, the Research Division, at the 80-square mile research and development center in Quehanna, Pennsylvania announced development of a new black top, coal based road and airport paving material. Tests demonstrated that the new material has greater load carrying capacity, higher resistance to damage from heat and cold, superior skid resistance and provides superior adhesion of aggregates in the presence of water. It also has unusually high resistance to solubility by JP-4 jet fuel, lubricating oils, fuel oils and gasoline which makes the new binder useful in modern airport construction.

The Commonwealth of Kentucky was conducting a one-year evaluation program of the new material in actual use, and installed twelve one-half mile test strips throughout the Commonwealth. The Commonwealth of Pennsylvania also provided funds for a similar program.

The Research Division continued its advanced engineering projects on noise suppression, supersonic compressors, and high temperature ceramics and cermets for missile applications.

Considerable work was done on turbojet noise suppression, including both inlet and exhaust suppressors. A ground run-up suppressor developed by the Research Division is now being produced by the South Bend Division for the Navy. Tests were also conducted on an in-flight inlet suppressor developed by the Research Division.

For the past few years considerable development has been accomplished by the company on the design, construction and operation of a supersonic compressor for the turbojet engine. This compressor has now been operated successfully under static and supersonic inlet flow conditions.

Development work was being done on high temperature ceramics and cermets for missile applications. Fabrication techniques were developed for high temperature refractory fuel elements, in conjunction with the Pluto project, a nuclear powered ramjet missile. Also for the same project, the Division was engaged in the production and fabrication of beryllium oxide structual components for nuclear missiles.

Curon, the multi-purpose, multi-cellular product of the Curon Division, entered the jet field with the Boeing 707 in 1959. Because of its lightweight, thermal, acoustical and cushioning properties, Curon will be bonded to all carpeting on the Lockheed Electra as well as the 707. The Aerocommander uses Curon bonded to vinyl for decoration and soundproofing. In Piper aircraft, Curon is used for carpet underlay, sidewall padding trim and seat padding.

DOUGLAS AIRCRAFT COMPANY

Start of regular commercial transport DC-8 Jetliner service and continued activity in the missiles and space field highlighted company activity during 1959.

The DC-8 was certificated by the FAA August 31, one month ahead of schedule, and went into commercial operation September 18. First of the DC-8s were delivered on schedule to both United Air Lines and Delta Air Lines June 8.

In the comprehensive flight test program for the Jetliner, a Delta DC-8 flew non-stop from Long Beach, California to Miami, Florida, July 22 in the record time of 4 hours, 43 minutes. An intercontinental version of the Jetliner visited numerous European countries in August, hopping non-stop from Los Angeles to London, 5,823 statute miles in 10 hours and 42 minutes. On another flight, Long Beach to Montreal, an average speed of 610 miles per hour was achieved.

Eighteen airlines throughout the world have ordered a total of 150 DC-8s at a cost of approximately $800 million.

Douglas also announced its intention to enter the medium and short-range Jetliner field with the DC-9, an advanced Jet transport to be powered by four new turbofan type engines.

The proposal to deliver certified DC-9s early in 1963 was contained in a letter transmitted to 40 airlines by Donald W. Douglas, Jr.

Board Chairman Donald W. Douglas announced the company would also manufacture a turbofan powered, swing-tail cargo version of the DC-8 Jetliner.

The Douglas Long Beach division, which is the site of DC-8 production, was also producing the C-133 Cargomaster, the largest Air Force cargo transport. The C-133B, a new version of the Cargomaster, capable of carrying the Atlas ICBM fully

Douglas plans to enter medium short-range jetliner field with DC-9.

assembled, will be turned over to the Air Force in the spring.

At the Santa Monica division, where production of the DC-6/7 series of commercial piston-powered airplanes came to a close near the end of 1958, a conversion program of DC-7s into Speedfreighters was begun. Ten DC-7s were converted for American Airlines and six for United Air Lines.

Production of the A3D twin-jet attack bomber and the A4D midget attack plane for the Navy continued at the El Segundo division. Contracts for new versions of these Navy aircraft such as the A3D-2P photographic reconnaissance airplane and the A4D-2N have extended production periods.

In missiles and space technology, a field in which Douglas has been active since 1941, the Air Force assigned the company responsibility for design of a new-type air-launch ballistic missile (ALBM) as one of the nation's important new weapons.

The ALBM will take its place with the intercontinental and the intermediate range ballistic missile in the nation's weapon systems arsenal. It will be designed for launching from present and future Strategic Air Command bombers against targets many hundreds of miles away.

The company's role in space research received added impetus with the award of a $24,067,500 contract for the Delta launching vehicle from the National Aeronautics and Space Administration.

The contract calls for manufacture of a dozen vehicles, similar to the Thor Able, during the next two years. Using a modified Douglas-built Thor, manufactured at the Santa Monica division, as a first stage, Delta will be capable of putting 250 pounds in a normal 300-mile orbit or sending a 100-pound payload on deep space missions.

Thor, workhorse of the space age, reached near operational status in England, and set a high standard of reliability during its test-launch program. It has been the booster for long-range multi-stage vehicles and for scientific explorations of the Geophysical year. It was the first stage of the Air Force Pioneer which traveled 71,300 miles into space.

First test firing of the Douglas-built Nike-Zeus, highly promising and important anti-missile missile, took place at White Sands, New Mexico, in August. The Zeus project, now well into the development stage, was expected to play an increasingly important part in the company's overall effort as a defense contractor.

The Douglas Charlotte, North Carolina plant manufactures the ground-to-air anti-aircraft Nike Hercules, most advanced operational version of the Nike series.

Douglas also continues to manufacture the air-to-air Air Force Genie which carries an atomic warhead.

In organizational changes, Gerald E. Donovan was named vice president—finance, succeeding Frederick E. Hines who resigned for reasons of health. Bernard L. Brown was named treasurer, replacing Harry W. Strangman who remained on in an advisory capacity.

Nat Paschall, vice president—sales, resigned because of the pressure of personal business affairs. He will continue in a consulting capacity to the company. J. R. McGowen, director of commercial sales, was elected vice president—commercial programs, and C. R. Able, director of weapon systems, was elected vice president—defense programs.

The Douglas company allied with the General Aniline and Film Corporation in January to form Data Graphic Systems, Inc.

In May, Douglas dedicated a new $10 million Aerophysics Laboratory at El Segundo, California which is capable of testing aircraft and missile models at simulated speeds exceeding 8000 miles per hour.

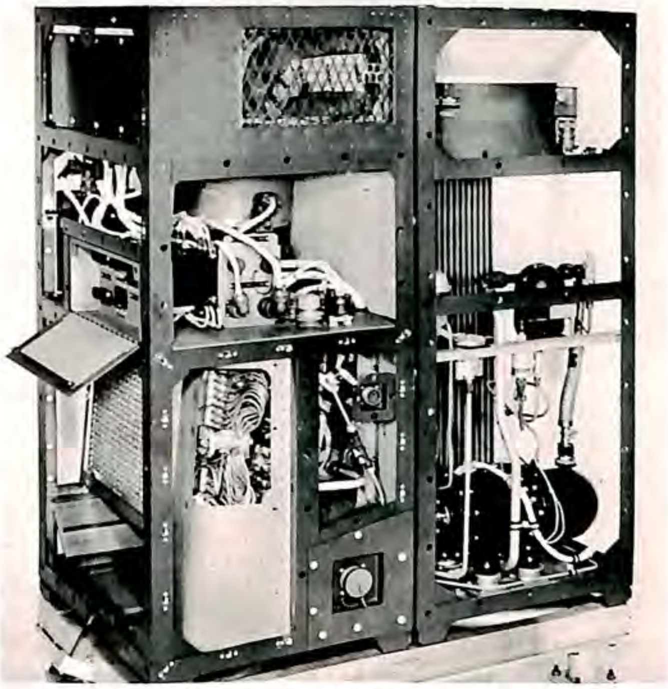
As the year drew to a close the company's total employment stood at approximately 70,000, compared with a peace-time high of 83,000 in the spring of 1957.

FAIRCHILD ENGINE AND AIRPLANE CORPORATION

The Fairchild F-27 propjet, which signaled Fairchild's re-entry to the commercial field last year, became the first American turbine-powered transport to complete a year of scheduled airline operation on September 28, 1959. At year's end, more than 80,000 flight hours had been logged by 12 airlines and 18 corporation business F-27s operating the F-27 in Canada, South America and the United States, including the new states of Alaska and Hawaii.

Seven airlines received F-27s in 1959, following into service West Coast Airlines, Aerovias Venezolanas (AVENSA), Quebecair, Piedmont Airlines and Northern Consolidated Airlines, each of which began F-27 operations in late 1958.

The first airline F-27A—so designated because of its large Rolls-Royce RDa. 7/Mk. 528 engines—was placed in service by Bonanza Air Lines in March. Pacific Air Lines, also operating the F-27A, commenced propjet service in April.



Stratos Division's ground support air conditioner.

Hawaii had its first turbine-powered airliner service in June when Aloha Airlines introduced the F-27 in the new state. June also saw Wien Alaska Airlines inaugurate F-27A service at the "top-of-the world." Aerovias Ecuatorianas (AREA) became the first airline in Ecuador to offer F-27 service in July. Ozark Air Lines was preparing to introduce service in the midwest and Trans mar de Cortes was set to begin F-27 operations in Mexico as 1959 drew to a close.

With 18 F-27 business propjets in service, more corporations were flying the F-27 in 1959 than any other American turbine-powered transport. Corporations operating the F-27 business propjet included such firms as Bank of Mexico, Pepsi-Cola Bottling Company, Champion Spark Plug Company, Continental Can Company, General Tire & Rubber Company, Ideal Cement Company, Johns-Manville Corporation, Kimberly-Clark Corporation, Noland Company, Raytheon Corporation, Reynolds Metals Company, R. J. Reynolds Tobacco Company and Westinghouse Electric Corporation.

In June, an F-27 operated by the Westinghouse Electric Corporation was selected as the "Flagship of the U. S. Business Fleet" at Reading Aviation's 10th Annual Maintenance & Operations Meeting. At the same show, the Noland Company F-27 was judged to have the best corporate interior in its class.

During 1959, three airlines and three corporations re-ordered F-27s indicating the on-the-job acceptance of the aircraft.

AIRCRAFT AND MISSILES DIVISION

Production, research and development were prime factors in the 1959 history of the Aircraft and Missiles Division. During the year a strong emphasis placed upon improving the division's capabilities in technical fields resulted in a diversification of production and engineering activities and in an enlargement of the division's productive capacity.

In addition to producing F-27s, the division also expanded its subcontract work for Boeing Airplane Company with an eight-and-one-half million dollar follow-on contract for production of vertical fins, outboard wing panels and fuselage sections of the Boeing B-52.

The year was also one in which the division continued research and development in the field of pilotless planes, its principal effort being expanded in the USD-5 surveillance drone system for the Army. The division was responsible for the development of the USD-5 airframe and associated systems.

In other aspects of aircraft development and production, the division continued development of V/STOL aircraft with special emphasis on the Army project, the M-224, a VTOL aircraft which flew for the first time late in the year. A combination high flotation tire and landing gear system was also tested in 1959. Modification and overhaul of Air Force C-119 Boxcars and Navy aircraft took place at the division's St. Augustine, Florida, facility. Production of mobile engine-test stands for Lockheed Aircraft Corporation was underway at the Fairchild subsidiary, Jonco Aircraft Company, Shawnee, Oklahoma, which also contributed to the division's F-27 production program.

Development and construction of such diverse articles as radar dishes and lamp posts also were accomplished by the division in 1959.

Utilizing the largest metal-bonding facility in the United States, which is part of the division, the posts—typical street lamp posts—were constructed under subcontract to Olin-Mathieson Chemical Company. Several were placed in the vicinity of City Hall, New York, as test installations. Sharing the maintenance-free characteristics of the prototype aluminum bridge developed and tested by the division in 1958, the lamp posts are designed to save thousands of dollars normally spent for upkeep and painting of other posts.

ARMALITE DIVISION

The lightweight automatic Armalite AR-15 infantry rifle, using a special high velocity .222 cartridge, was introduced in 1959 by the Armalite Division. Tests were conducted by three separate Army corps. Results were favorable and demonstrations in 11 countries in Europe and Asia resulted in orders for field tests quantities from nine of the countries where the weapon was demonstrated. The AR-15 rifle was being manufactured in the United States under a license agreement with Fairchild by Colts Patent Fire Arms Company, Hartford, Connecticut. The AR-7, a sporting version of the Armalite developed Air Force and adopted as a survival rifle, was being produced by the Armalite Division in Costa Mesa, California. The design of the AR-7 embodies the unique feature of stowage of the entire barrel and action into the fiber glass stock. The length of the rifle in the stowed configuration is 16 inches. Assembled, ready for firing, the length is 34½ inches. Rifle weight is 2¾ pounds. As in the Air Force survival rifle, the AR-7 floats in water. Further development in material and advanced principals of design were expected to contribute much to the advancement of the art of fire arms both in commercial and military fields.

ASTRIONICS DIVISION

The Astrionics Division of Fairchild, formerly known as the Guided Missiles Division, increased its concentration on the electronic aspects of avionic and space age equipment. Its major program during 1959 consisted of the guidance and control, data acquisition and data transmission links for the USD5 surveillance drone under development by Fairchild for the Army Signal Corps. The system, details of which are covered by security classification, is one of the most advanced electronic airborne systems yet devised. It is designed to control the "bird" under all weather conditions and to report back to headquarters during day or night information regarding the disposition of enemy forces and his activities. The past year also saw further development of systems based upon the division's proprietory Padar passive detecting and ranging systems. Contract for the development of a Pacor system for installation in combat aircraft was received from Hughes and development is being carried on. Under still another contract, issued by the Federal Aviation Agency, use of the Padar principle as a proximity warning indicator was studied.

The division also continued its work in the training devices field having manufactured both countermeasure trainers and radar tr[illegible]iners.

STRATOS DIVISION

Besides continuing to produce environmental systems and auxiliary power units for aircraft, the Stratos Division during 1959 placed into production a compact air conditioner for ground support of the Hawk missile. The system with a nominal rating of 3.2 tons uses Stratos' unique Heli-Rotor compressor, a rotary positive displacement machine which has a built in volume ratio. The unit housed in two separate cabinets weighs only 350 pounds complete with charge and controls and can deliver as much as 4.2 tons when the compressor is driven by a higher speed compressor motor. Besides supplying cooled conditioned air at flows up to 90 pounds, the system also provides heating capacity to 37,000 BTU per hour. Equipment in production at the main Bay Shore plant includes air conditioning systems for the Boeing B-52, the Convair F-106, the Fairchild F-27 and the Martin Mace missile. The division also continues to supply air turbine drives and fuel flow proportioners for military aircraft. One principal item in this field was Model TP25-2B air turbine drive for operating the alternator and hydraulic pumps on the Lockheed C-130B turbo-cargo transport.

Stratos' Western Branch during 1959 again supplied a variety of cryogenic valves for missiles and designed and produced a number of cryogenic valves for the X-15. Included were lox, fill and drain valves for the Atlas and Thor ICBMs, various shut-off valves, high pressure helium relief valves and other items for the X-15. In addition, the Western Branch received a contract for development of a 12 cfm, 3,000 psi compressor for missile ground support used by the Army. It developed new applications of its "Pogo Sti[illegible]." pneumatic actuator for stores ejection systems and continued to supply stores ejection systems for various ASW applications.

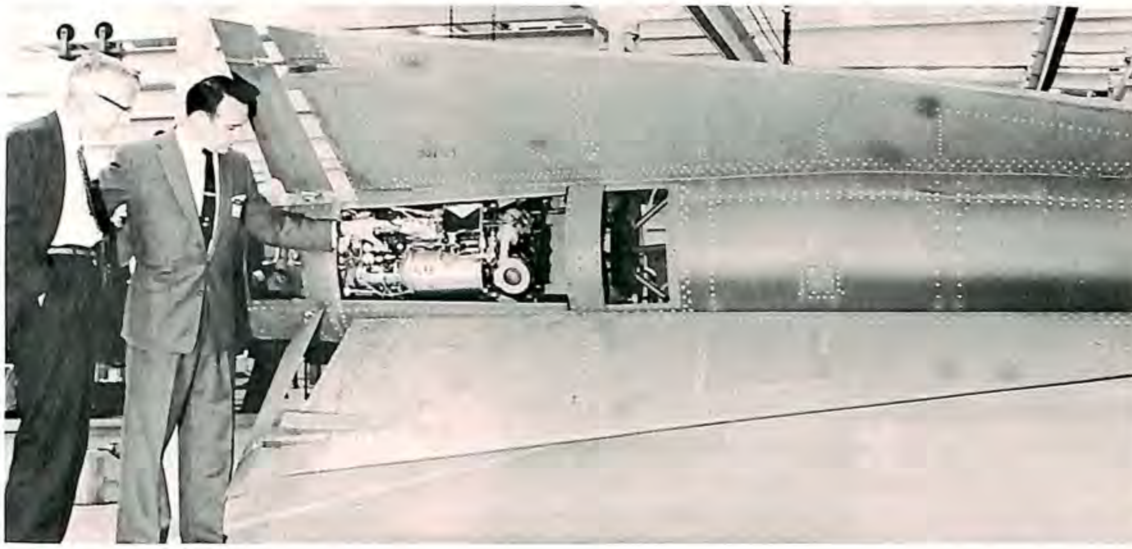
THE GARRETT CORPORATION

The highest annual sales in the history of The Garrett Corporation indicated wide acceptance of products and systems developed and manufactured during 1959. During fiscal 1959, Garrett's seven divisions and three subsidiaries reported sales of more than $193 million.

Seventy-six percent of Garrett's sales dollars were for nearly 2000 end products produced and installed on almost every aircraft and missile in development or in production.

Garrett's largest division, AiResearch Manufacturing Company of Los Angeles, which had been selected to supply the pressurization system for the North American X-15, also contracted to develop

AiResearch power unit is used in Nike Hercules.



the environmental control system for Project Mercury, manned satellite.

It drew upon experience gained in developing systems for such aircraft as the Boeing 707; Lockheed Electra; Grumman Gulfstream; Fokker Friendship; Northrop T-38, N-156; Caravelle; Lockheed C-130; and others. The Project Mercury system is regenerative and pressurizes and air conditions both the capsule and astronaut's suit, utilizing pure oxygen.

First reports on the performance of AiResearch's turbocompressor aboard the 707 resulted in recommendation of extension of service life between overhauls. Pan American Airways was the first airline to benefit from this extension.

AiResearch's experience in heat transfer studies helped solve one of the electronic industry's most critical problems—cooling. Compact, lightweight packages were developed and delivered for use on many high altitude missiles.

Aircraft engine fuel icing problems were also solved with the development of a reliable, compact fuel heater. Midway through the year it was announced that AiResearch was awarded a multimillion dollar contract for the production of fuel heaters for the B-52. Other units were on the DC-8, JetStar and others.

Production continued on auxiliary power units such as the liquid propellant, turbine driven unit for the Nike Hercules. After establishing the West's largest APU production and research facility, AiResearch was awarded contracts for the APU on the Nike Zeus and SUBROC missiles.

Reliability standards for air data equipment were established for the industry by AiResearch when in the middle of the year it operated six complete central air data systems for 6000 hours with an average 1500 hours perfect operation. By comparison, these figures are 30 times greater than the 48 hour mean time between failures reported for systems of similar complexity. At the end of the year, AiResearch was supplying complete central air data systems for the North American A3J, McDonnel F4H and developing a system for the North American B-70 and Lockheed F-104G.

Among the many new product lines introduced by AiResearch in 1959 were hot gas generators. First unit delivered was a spin stabilization system for the Lockheed Polaris missile. Other hot gas servo systems were being readied for shipment at the year's end.

Garrett's AiResearch Manufacturing Company of Arizona, the free world's largest producer of small gas turbines, announced in the fall a three-year development program of nuclear and solar power systems.

Under a contract from the Wright Development Center, AiResearch had developed a turbo-generator system to provide electric power for space vehicles with applications including space communications, vehicle environmental control functions such as heating and cooling, and electrical propulsion.

A lightweight, constant speed drive and starter unit was developed which could automatically start jet engines, shifting into a constant speed drive to supply shaft power for electrical conversion. First to order the unit was Grumman Aircraft Engineering Corporation for its A2F aircraft.

After announcing the development of its smallest gas turbine—a 30 horsepower unit—AiResearch Phoenix unveiled its largest. It was a 105 horsepower turbine (GTCP 105-1) compressor unit with an oversize two stage centrifugal compressor. It is capable of starting two Convair B-58s at one time.

While production continued on AiResearch's MA-1A jet starter unit, AiResearch was also awarded a contract for a cartridge starter installed on the Republic F-105. This cartridge starter provides the advantages of numerous pneumatic starts in addition to emergency starting, independent of ground support equipment.

AiResearch's gas turbines (GTCP 85-91) were also the heart of ground starting power vehicles ordered by most of the nation's leading airlines. These units provide pneumatic power for starting, air conditioning and other low pressure pneumatic operations. The electric power is used for instrument preflight checkout. Among the airlines ordering the units are Eastern, Braniff, TWA, Qantas, National and KLM.

Continued development of new pneumatic valves and controls was carried on through the year by AiResearch Phoenix.

Other valves were produced by Garrett's AiResearch Industrial Division. It announced a contract for a pressure control system for a Polaris-carrying submarine.

At Los Angeles International Airport, AiResearch Aviation Service Company was preparing for future jet business aircraft. Designated as an official repair and overhaul station for the F-27 by Fairchild, AiResearch also installed several executive interiors in Grumman Gulfstream aircraft. However, during 1959, the bulk of Aviation Service's activity centered around repairing, overhauling, modifying and installing executive interiors in piston aircraft. At the end of 1959, AiResearch conservatively estimated it converted to business use 90 percent of all Convair 4 s.

In the East, Air Cruisers Division, Belmar, New Jersey, developed a new line of life rafts, preservers, and escape slides for the new commercial jet airliners. Incorporating a new patented principle of inflation—the jet pump—Air Cruisers equipment demonstrated an unprecedented quick-inflation quality. Its 26-man life raft is inflatable in less than 10 seconds. In the fall it marked production of its 1000th escape slide.

Extensive research and manufacturing programs carried on in all divisions resulted in ambitious expansion programs during 1959. AiResearch Phoenix purchased an additional 33 acres, including warehouse and office space; Aviation Service leased additional property on International Airport. The largest expansion program was in Los Angeles where The Garrett Corporation purchased a 66-acre site in Torrance, California. By midsummer, construction began on the first building in a multi-unit complex. The first increment, an electronic and electromechanical production facility, was a $2.6 million edifice. Its completion was set for early 1960.

GENERAL ELECTRIC COMPANY

General Electric thrust reverser.

AIRCRAFT ACCESSORY TURBINE DEPARTMENT

Highlights of 1959 at General Electric's Aircraft Accessory Turbine Department included the following:

During the X-15's series of successful test flights, the only power aboard for bringing the research plane safely back to earth was supplied by two small auxiliary power units built by the department. Simultaneously producing both electric and hydraulic power, the 40 horsepower units operate completely independent of the X-15's rocket engine and become the sole power source after engine burnout.

Production of hydraulic constant speed drives for the Douglas A4D Skyhawk, the McDonnell F4H supersonic fighter and Convair 880 and 600 jet transports. The 40 kva drive used in the Convair 880 exceeded its proposed time-between-overhaul in a 2300 hour test run. After 1300 hours operation, the drive was disassembled and inspected for wear. Parts of the drive were in such good condition and the load carrying ability was still so excellent that the drive was reassembled and run an additional 1000 hours.

Development of a starter for aircraft nuclear powerplants.

Development of a hydraulic power source for flight control of the Polaris missile.

Development of an auxiliary power unit for driving fuel and oxidizer pumps in the Centaur second stage.

Start of production of rocket engine turbopumps for the Vega program.

Development of a starter for the J93 engine scheduled to power the B-70 bomber.

MISSILE AND SPACE VEHICLE DEPARTMENT

The Missile and Space Vehicle Department of General Electric continued producing Thor nose cones during 1959, which were shipped by air to continental and overseas bases. Of the heat sink, or Mark II, type, these nose cones were being produced on a $29 milion incentive contract.

Meanwhile, research and development work toward providing "second generation" nose cones continued. At the Aerosciences Laboratory of GE-MSVD, the huge, 120-foot shock tunnel was used to conduct its 1000th test since it was put into use in 1957. Plasma jets, solar furnaces, and other test devices were worked hard to check the progress in this area, and out of these investigations evolved a new ablative material for re-entry vehicles, capable of surviving the rigors of re-entry and of being fabricated more easily than earlier ablative materials.

Materials research vehicles rose frequently aboard Thor-Able and Atlas vehicles during the year. In May, the first such vehicle to be recovered over ICBM ranges, the RVX-1, was picked out of the South Atlantic Ocean. The May recovery represented a joint venture between Avco and GE-MSVD, for G.E. built and instrumented the vehicle while Avco coated it with its ablative material. In July, this feat of ICBM recovery was duplicated by the Air Force when another G.E. RVX-1 was recovered.

In August, the largest re-entry vehicle ever flown in the free world was fired down the Atlantic Missile Range by Atlas. This vehicle, called RVX-2, was also of the ablative type. It was recovered and returned to G.E. for analysis. In October, the first vehicle of the ablative operational configuration was flown (Mark III).

A new contract for the development of the re-entry vehicle for an air-launched ballistic missile, XGAM-87A, was awarded GE-MSVD by Douglas Aircraft Company in August.

As flight tests continued on the heat sink nose cones, increased attention was devoted to using these flights to gather additional data as well as to prove out weapon components. This activity produced the first photographs showing missile-stage separation, the first photographs of the earth at altitudes up to 700 miles, the first stabilization of a space vehicle in three axes, the first infra-red measurements of Earth from space, the first photographs of two solar bodies from space (the earth and the sun), check-out of orbital control components, and many other significant developments.

To return the photographs and other data-recording devices, GE-MSVD's data recovery capsule was perfected to a high degree of reliability. This capsule (accepted by the Smithsonian Institution in May for its permanent collection) was redesigned with a six-inch, aluminum drogue attached to it by means of a six-foot nylon cord to guarantee that the capsule would strike the ocean's surface at its strongest point.

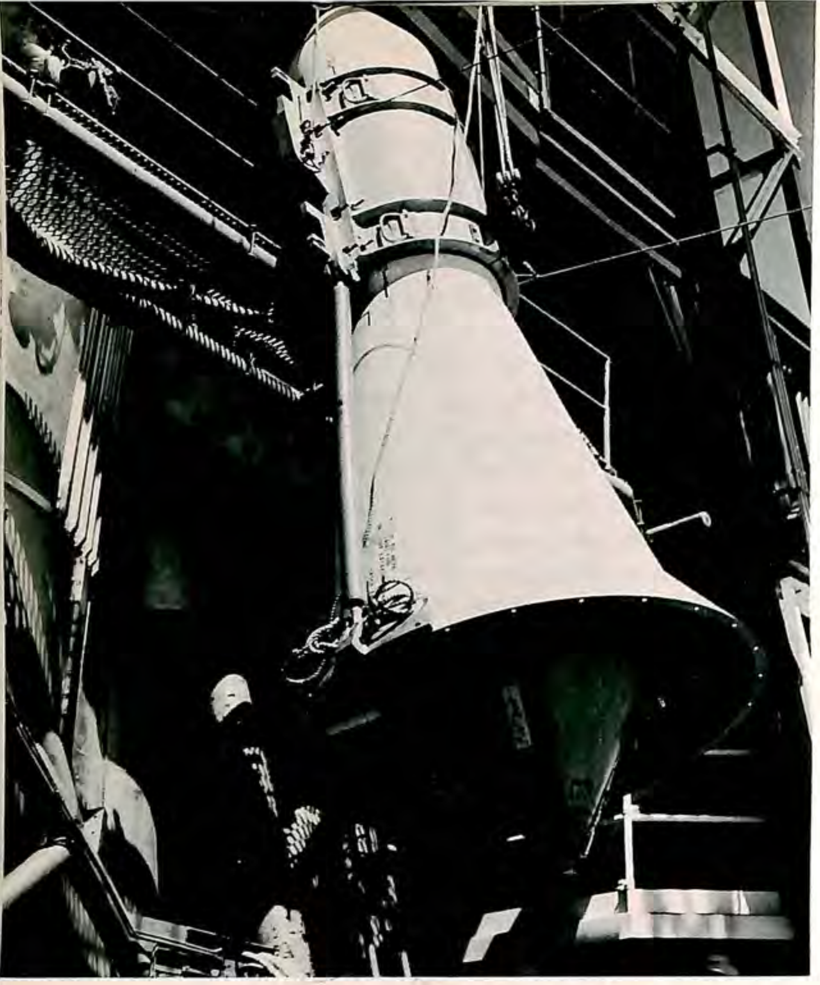
The department's man-in-space study for the Wright Air Development Center was successfully concluded, and the results, including mock-ups and other workable hardware, were turned over to the contractor.

Other work in the space vehicle area included contracts for the calculation of "roadmaps in space," the determination of orbits and trajectories required to send a space vehicle to the moon and to neighboring planets. These orbit and trajectory studies are being conducted for the Army's Ballistic Research Laboratory, the Air Force's Wright Air Development Center, and the Air Force's Cambridge Research Center.

Studies to reclaim useful food products and oxygen supplies from human wastes were conducted during the year. A system was put into operation, using the pyrolyzing technique, that produced water from urine and fecal matter, safer by actual test than that found in metropolitan drinking fountains.

Responsibility for helping establish world-wide communications by means of satellites, a subject of interest at GE-MSVD for years, was given the department in 1959, when a $5.5 million contract was awarded GE-MSVD, by the Department of Defense, to provide the satellites needed in the "Notus" program.

Programs to provide electrical power in space were actively pursued. Fuel cells, thermionic converters, magnetohydrodynamic (MHD) power gen-



Mark III Reentry Vehicle is hoisted up gantry.

eration, and radio-isotopic applications were looked into.

In cooperation with several agencies, GE-MSVD provided the first two heat shields tested for the Project Mercury capsule. These two shields were successfully tested during the year.

The re-entry and recovery vehicle for the Discoverer series of satellites was hurried to completion and test-fired in 1959. Trouble plagued the program, however, and the first attempts to recover the vehicle failed. In this program GE-MSVD, under sub-contract to Lockheed, built the portion of the Discoverer satellite that breaks out of orbit to return through the atmosphere for recovery, including the life-support system.

GE-MSVD completed its studies on the Missile A and Mauler programs and was active in bidding for contracts in these areas. Also, battlefield surveillance and arming and fuzing systems applied to missile weapon systems were objects of intense effort. In March, the department was awarded a contract, ultimately to grow to $2.5 million, for providing arming and fuzing devices for Littlejohn. Littlejohn is a supersonic, 12-foot long missile with atomic and conventional warhead capability. This contract for arming and fuzing systems was added to similar work on the Army's Lacrosse, Nike Hercules, and Honest John missiles.

Vulcan, the six-barreled cannon based on the Gatling gun, was continued in production for both American and European aircraft. Its adaptability to light aircraft, in a 7.62 NATO-round version, was further explored. Helicopter-armament studies continued.

SMALL AIRCRAFT ENGINE DEPARTMENT

During 1959 General Electric's Small Aircraft Engine Department brought its T58 turboshaft and J85 turbojet engine programs to the production stage, continued development of the T64 turboprop/turboshaft, and announced the start of a program for the CF700-1 turbofan powerplant, General Electric's first small aft fan engine.

By year-end the 1050 horsepower T58 had rolled up more than 23,000 hours of operating experience. Its list of production applications included the Kaman HU2K, Sikorsky S-62, Vertol YHC-1A, and Sikorsky HSS-2. Experimental VTOL applications included the Fairchild M224-1 and Kaman K-16.

In July the T58's commercial counterpart, designated CT58-100, received Federal Aviation Agency certification, making it the first United States gas turbine powerplant approved for commercial helicopter service.

Two months later the first order for the CT58 was received from Sikorsky Aircraft, which will use the engine in its S-61 and S-62. The Vertol Model II was also announced as a commercial helicopter to be offered with CT58 engines.

In August, the T58-8, first-step growth version of the engine, successfully completed its official military 50-hr PFRT. The T58-8 is rated at 1250 shaft horsepower with no significant increase in size or weight over the present T58 production engine.

Flight testing of the J85 proceeded at an accelerated pace during 1959 to bring total engine running time well over 7,000 hours. Two supersonic aircraft, Northrop's N-156F "Freedom Fighter" and T-38 "Talon" trainer, each powered by twin J85s, made their maiden flights in July and April respectively. Short and long-range free flights on McDonnell's GAM-72 decoy missile plus more than 70 flights in a fully instrumented pod aboard a modified F-102 fighter verified J85 altitude and speed capabilities.

J85 flight time was supplemented by exhaustive factory and field tests including an official 50-hour Preliminary Flight Rating Test and an official 15-hour Qualification Test.

In addition to the N-156F, T-38 and GAM-72, the J85 was slated to power production versions of Radioplane's Q4-B drone.

Details of the T64 turboprop/turboshaft engine were officially announced in May. Designed for military high performance support and tactical aircraft, the 2,600 horsepower class engine is one of the first gas turbines to offer the low specific fuel consumption of reciprocating engines. The turboprop configuration has a specific fuel consumption of 0.522 pound per horsepower per hour. A direct drive configuration is also being offered. It is rated at 2,690 shp, and weighs 710 pounds with 0.498 SFC.

To test the T64, the department placed into operation four new test cells at its Lynn plant. Two were dynamometer cells for turboshaft testing and two were designed for turboprops.

PRODUCTION ENGINE AND JET ENGINE DEPARTMENTS

The year 1959 saw General Electric's aircraft gas turbine organization change its name to the Flight Propulsion Division to cover better the ever-broadening spectrum of military and commercial powerplants that the company is designing, developing and producing for aircraft, helicopters, missiles and space vehicles.

In the commercial transportation area, advanced versions of the CJ-805-3 turbojet and CJ-805-21 aft-fan engines were announced, respectively the CJ-805-3B and the CJ-805-23. Rated at 11,650 pounds of takeoff thrust, the -3B offers a four percent increase in takeoff thrust and a two percent reduction in specific fuel consumption over the previous model. In the -23, the improvement was a six percent increase in takeoff thrust and a three percent reduction in sfc.

General Electric flight testing of its -3 commercial turbojets was completed when three production model engines each reached 1000 hours of flying. The Company used an RB-66 leased from the Air Force, and an XF4D leased from the Navy for these tests. Testing included cold weather flying at Duluth, Minnesota. The B-66 was then retrofitted for installation of the commercial aft-fan engine for flight testing in 1960.

Flight testing of the Convair 880, which began with the jetliner's first flight on January 27, 1959, demonstrated the aircraft not only exceeded performance guarantees, but also met or exceeded drawing board performance estimates for speed, range, takeoff and landing distances. General Electric's CJ-805-3 turbojet engine was a major contributor.

The company's turbojets were to power Convair 880 jetliners on order from Trans World Airlines, Delta Air Lines, Civil Air Transport, Aerovias Brasilia and Capital Air Lines, with the latter ordering the new CJ-805-3B powered Convair 880M. The CJ-805-23 aft-fan engine will power the Convair 600 now on order from American Airlines, SWISSAIR and Scandinavian Airlines System.

The GE J79-powered Lockheed F-104 was named winner of the Collier Trophy. The Mach 2 Starfighter, in 1959, saw increased use in the USAF Air Defense and Tactical Air Commands, and was selected for the air arms of the Federal Republic of Germany and Canadian government. Both engine and aircraft will be manufactured under license agreement in each of those countries. In addition, General Electric shipped the first of the J79 engines for 96 F-104 aircraft that the West German government will purchase in the United States.

West Germany scheduled Starfighters for air defense, tactical and reconnaissance missions. The RCAF will use its F-104s in a number of roles. Pilots of all three nations will use the two-place version of the F-104/J79 for transition and training.

In February, America's midwest received increased air protection as the 56th Fighter-Interceptor Squadron of the Air Defense Command declared itself "ready to defend" with its mighty new F-104 interceptors.

Among other J79 applications, the Air Force Convair B-58 bomber and Navy McDonnell F4H-1 fighter neared operational status in 1959. Powered by its four J79 turbojets, the B-58 in October made a low altitude supersonic cross-country simulated bombing mission, proving its radar dodging low altitude capability. The first J79 engine for the operational B-58 was shipped in 1959. The Mach 2 North American A3J and Grumman F11F-1F completed the G.E.-powered Mach 2 family.

Development activity moved ahead on General Electric's J93 Mach 3 turbojet, scheduled to power North American Aviation's B-70 long-range advanced bomber. A new multi-million dollar ram-test facility, financed largely by company funds, was completed at General Electric's Evendale, Ohio, plant to simulate extreme temperature conditions that will be encountered by the J93 and other future high-Mach engines.

ORDNANCE DEPARTMENT

A major activity of General Electric's Ordnance Department during 1959 was manufacture of an ultra-high precision radar tracking antenna for the radar guidance system of the Atlas ICBM.

The antenna is so precise that if it were possible to transmit directly from the east to the west coast, the tracker stationed in Boston could distinguish the north from the south end of a 100-foot ranch house in Los Angeles more than 2,500 miles away.

For this project, GE Ordnance constructed and started operation of a new $1,500,000 plant in the Berkshire Hills of Massachusetts.

Other projects in which the department was involved during 1959 included:

Development and production of fire control equipment for the Navy Fleet Ballistic Missile, Polaris.

Development and production to MIT design of inertial guidance equipment for the Polaris missile.

Development and production of shipboard launching system for the Talos missile for the Navy.

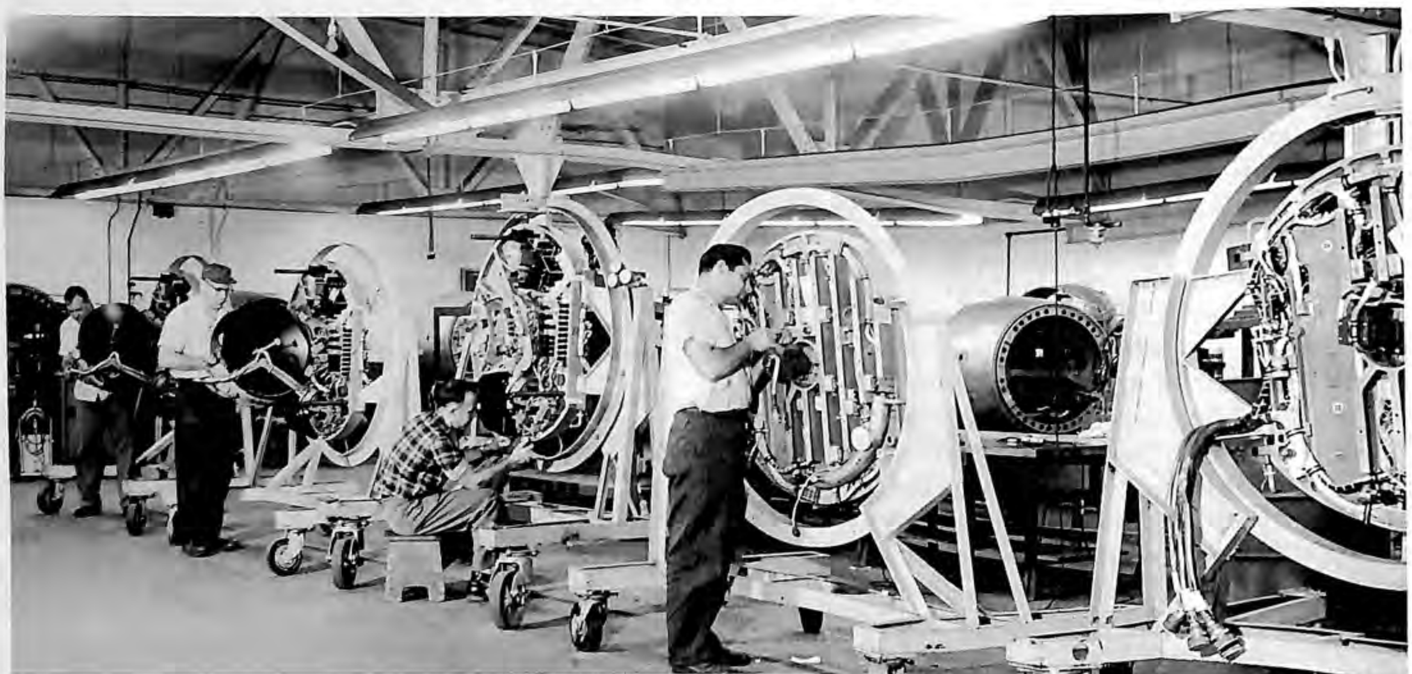
Development and production of Gun & Guided Missile Director Mark 73 for the Navy Tartar missile fire control.

Development and production of Torpedo Mark 44 for the Navy.

Development and production, as sub-contractor to G.E.'s Heavy Military Electronics Department, of MPQ-4 Mortar Locator for the Army.

Development and production, as sub-contractor to G.E.'s Heavy Military Electronics Department, of the FPS-7 long range search radar antenna for the Air Force.

GOODYEAR AIRCRAFT CORPORATION



Goodyear Atran electronic guidance systems are used in Mace missiles.

Goodyear Aircraft Corporation during 1959 helped advance the development of the Navy's Subroc underwater-to-underwater antisubmarine missile to an extended degree; delivered three 1,500,000 cubic foot airships to the Navy for airborne early warning duty, and completed the construction and assembly of integral parts for the BMEWS and Nike Zeus defense systems.

As prime weapon system contractor for the Subroc program, the company spent a busy 12-month period advancing development to the point that early component tests had been conducted and the over-all program phased into more advanced efforts.

The Subroc system is able to detect a submarine at long range, compute its course and speed, and launch the missile. Propelled by a powerful rocket, the weapon is capable of destroying enemy targets in an area of many square miles around the launching submarine.

For the Air Force's TM-76A Mace missile, now operational in Europe, the weapon's Atran guidance system and a full complement of ground support equipment had to be produced at Goodyear Aircraft on an assembly-line basis.

The self-contained Atran guidance system, developed by GAC for the Mace missile, has proven capable of guiding a missile to a pre-selected target with accuracy and reliability.

The programmed information needed to direct the missile through all necessary maneuvers is stored on film inside the missile, and the ultimate range of the guidance system is limited only by the range of the missile itself.

In October, the company announced the development of a long-range, automatic airborne system having all-weather capability and adaptable to either manned aircraft or missiles. The self-contained system, named Pinpoint, combined the best features of Atran, integrated with dead reckoning or inertial guidance components, making it particularly adaptable for long flights over water.

Pinpoint underwent a rigorous research and development program, and was being evaluated by the Department of Defense for a number of weapon systems.

Three of four ZPG-3W airships designed for airborne early warning missions were delivered to the Lakehurst, New Jersey, Naval Air Station, during the year. The fourth 3W was scheduled for delivery in early 1960.

One and one-half times larger than predecessor ZPG-2W blimps, the new airships are 403 feet long, 118 feet high, and they contain 1,500,000 cubic feet of helium.

Scheduled for service as part of NORAD's airborne early warning network, the ZPG-3W's are equipped with the latest electronic detection devices, the principal detection instrument being a new radar, the APS70, which receives signals from the largest airborne radar antenna, internally-mounted in the blimp's huge envelope.

In May, at the Aviation Writers Association convention in Washington, D. C., the company revealed its capability to have airborne by 1963 an American nuclear-powered aircraft—a 4.5 million cubic foot non-rigid airship.

Capable of 70 to 80 knot speeds, the airship could reach any point in the world from existing United States bases. Operational altitude would be 10,000 feet, range practically unlimited.

A modernized commercial non-rigid airship, named Mayflower II, was put into operation by the company in October. Based at Miami, Florida, the blimp has a 28-volt electrical system for night-sign operation. The craft is 150 feet long, 41 feet in diameter and stands 52 feet high. Inflation capacity is 132,500 cubic feet. The blimp replaced the Goodyear Airship Enterprise, which was decommissioned in September.

During the year, the company also completed ten inflatable rubber airplanes in one and two-place configurations for the Office of Naval Research. Both the Army and the Navy gave the Inflatoplane field evaluations. The services were interested in the craft for observation, reconnaissance, liaison and rescue work.

The company's Plastic Products Department made several advances, including fabrication and erection of the world's largest radome and another radome only slightly smaller.

As part of its contribution to the Air Force's Ballistic Missile Early Warning System (BMEWS), Goodyear Aircraft completed fabrication of a giant 140-foot radome which was erected atop a three-story high engineering model building near Moorestown, New Jersey, where will be conducted tests of tracking antennas (also GAC built) for the system.

Only slightly smaller than the BMEWS radome was the first radome for the Army's Nike Zeus anti-missile system. This 110-foot sphere is built of a random-pattern frame covered with sheet plastic, and gives protection to an expanded polystyrene foam Luneberg lens that will receive radar signals bounced off a hostile missile. The lens, composed of thousands of two-foot cubes of the plastic foam, was also built by Goodyear Aircraft.

For high-performance aircraft, the company announced development of a new material for cockpit canopies and windshields. Called THERMO-SHIELD, the material is a three-ply laminate of transparent high-temperature plastic on the outside, a stretched acrylic for strength on the inside, the two pieces being preformed and bonded with a material called GAC Code F-3. The laminate is optically clear and resists temperatures 100 degrees. It may be used to speeds of Mach 3.

Military production in the aircraft radome field was also extensive, including radomes for the Air Force's B-52 and B-58 bombers.

A new machine incorporating many unique features for filament winding rocket motor cases, rocket tubes and nozzles, missile frame structures and other products was completed late in the year. Built to GAC specifications, the machine is capable of winding glass, nylon, orlon, ceramics, or metals, with polyester, epoxy, phenolic or other binders.

In the cryogenic field, the company developed an insulating material 0.28 of an inch thick for wrapping around tanks of liquid helium (boiling point: minus 443 degrees F) and giving protection from the heat of the skin of a rocket in flight, which may reach 600 to 800 degrees, or a spread of 1000 to 1200 degrees.

Goodyear Aircraft continued production of antennas, ranging from the largest airborne installation to some of the smallest flush-mounted helical types. In support of its antenna manufacturing program, the company also designed and fabricated the necessary structures for antennas used in microwave transmission, radar, aircraft early warning, missile tracking and guidance and fire control systems.

During the year, the company continued to expand its Forward Planning Division, manned by top scientists, engineers and analysts to study problems of space travel, manned and unmanned weapon systems, including projects likely to become requirements in the near future.

In interesting, but rather divergent activities, the company programmed a series of balloon ascensions during the year from Minneapolis and Akron for the purpose of photographing the earth's surface from 100,000 feet, using radar and aerial cameras, while off Key West, Florida, in September, a Goodyear Aircraft-designed and built two-by-four-by-four foot escape capsule, equipped for survival, sustained an Air Force sergeant during a 72-hour open sea evaluation test.

A substantial portion of Goodyear Aircraft's business was the manufacture of airplane wheels and brakes for The Goodyear Tire & Rubber Company.

ARIZONA DIVISION

At Goodyear's Arizona facility, ground was broken for the construction of an acoustical test laboratory in March. At the same time, work started on an extension to the company's electronics building.

Expected to be finished by the end of the year, the acoustical lab incorporated the latest devices for the investigation of sound waves and their effect upon the thousands of electronic components that are or will be used in the supersonic aircraft and missiles of today, and those of the foreseeable future.

During the year, the Arizona Division received follow-on contracts for the production of aircraft canopies and miscellaneous aircraft components, while a sizeable order was received for the construction of center wing panels, bulkheads and other components for the Air Force's B-52G bomber. Similar work was scheduled for the new Boeing B-52H.

Also in quantity production were Nike Hercules reflectors and canopies for Northrop T-38 aircraft.

The division phased into production of new ground support equipment for operational Atlas ICBMs which would be us as part of new launching complexes at Atlas bases being readied for operation by the Strategic Air Command. This equipment included missile handling trailers, allied booster handling trailers, engine gimbaling support stands, erection boom, its support and associated drive mechanism, alignment rails and gages.

The new GSE designed and built by the Arizona Division permitted rapid erection of an Atlas ICBM to launch position, as well as quick emplacement of the next missile following a firing. Eliminated was the 13-story gantry tower, an integral part of previous Atlas launching complexes.

Work was also done on certain items for the ground support of Polaris.

In the area of electronics, an all-weather, high-resolution radar system which permits viewing of selected areas at extended ranges was announced during the year. The system makes it possible to distinguish small objects instead of merely showing general outlines of large areas.

Demonstrated in flight tests at the plant, the high resolution radar system was believed to have unlimited military application. It offered the range required by space vehicles of the future. Work on the program was accomplished in conjunction with engineers from Wright Air Development Center.

Development of an advanced radar mapping system for the Army was also begun at the company during the year. The project involved a study of the application of airborne radar sensing and applicable data reduction procedures to establish design parameters and military characteristics for a complete, integrated topographic mapping radar system.

A project to measure the radar reflectivity characteristics of various types of terrain by means of airborne radar was begun at the company during the year. Under surveillance were marshes, forests, cultivated fields and deserts. Purpose of the activity was to develop the art of radar mapping by which observers may "read" radar reflections to determine the type of terrain below.

GRUMMAN AIRCRAFT ENGINEERING CORPORATION

Grumman Aircraft Engineering Corporation on the heels of a 1958 effort to continue its diversification program, closed 1959 with eight different aircraft in production for the Navy, Air Force, Coast Guard and the Army, as well as for commerce.

Contract-wise, Grumman's biggest business was in the production for the Navy of its WF-2 Tracer, a carrier-based early warning aircraft, and the F9F-8T, a two-seat jet fighter-trainer in active service with Navy fleet units the world over.

Production of the YAO-1 Mohawk, a versatile propjet photo-reconaissance-utility aircraft designed to live in the field with the Army, and Grumman's sleek business-utility propjet, the Gulfstream, picked up during 1959. By year-end 50 orders for the 357 mile-per-hour Gulfstream had been received from leading oil and industrial corporations. Production in 1960 was to continue at four Gulfstreams per month.

In addition to the Gulfstream, WF-2, Mohawk and the F9F-8T (which phased out at the end of the year), Grumman began production of the S2F3, a more sophisticated version of the S2F1 anti-submarine hunter-killer. The S2F3 was undergoing testing by the Navy.

Production continued on the SA-16B, a modified version of the SA-16A, a utility-rescue amphibian. Modification programs for the Air Force, Navy, and Coast Guard SA-16As were continued with the newer B version coming off the production lines with additional wingspan and increased range and altitude capabilities.

The Ag-Cat, Grumman's new agricultural biplane, came out of the development stages in 1959 and went into production.

The company continued its progressive research and development program. Feasibility studies for nuclear powered missiles, ships, and other vehicles were begun. VTOL aircraft studies were intensified and ASW research and product improvement by the company's ASW Steering Group was also continued.

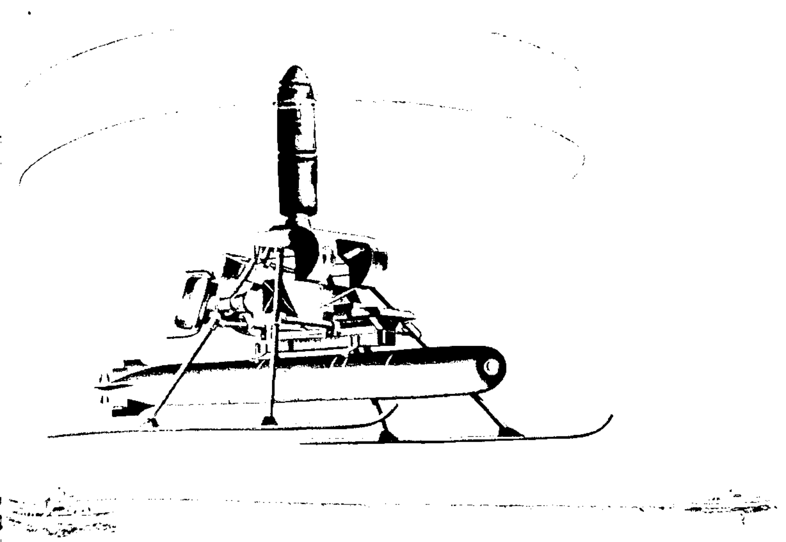
Production plans for an 80-ton hydrofoil vessel for the Maritime Administration were being completed. The company was also awaiting the first test flights of the A2F-1, a two-place, low-level attack airplane, and the W2F-1, a new early warning aircraft.

Production was begun on the Eagle, the Navy's newest air-to-air missile. Grumman will produce the airframe and ground-handling equipment.

GYRODYNE COMPANY OF AMERICA, INC.

In 1959, Gyrodyne made many important advances. The first Rotorcycles were delivered to the Navy and Marine Corps and tactical evaluation of the YRON-1s was started. Commercial interest in the Rotorcycle was high and it was anticipated that the company would start producing a commercial version in 1960.

Another important event in Gyrodyne's year was the designation of the company as weapons system manager of the airborne portion of the DASH Weapon System.



Gyrodyne develops DSN-1 Drone for Navy.

DASH (Destroyer Anti-Submarine Helicopter) was described by the Navy as "a weapon system of utmost importance in the overall anti-submarine warfare mission of the U. S. Navy." Gyrodyne was also responsible for the several highly advanced electronic systems and the shipboard handling system for the DASH program.

The year marked the entry of Gyrodyne into another interesting area—Ground Effect Machine. The company received a Bureau of Aeronautics contract to design, develop and test fly a one-man-carrying ground effect vehicle. The GEM (Ground Effect Machine) first flew in October. The company also received additional contracts to further its development of a full-scale flying amphibious Rotorcycle. Following successful model testing, a unique float principal was evolved in cooperation with the Bureau of Aeronautics, which will permit helicopters to land in waves equal to the height of the vehicle.

The company completed construction of the largest tethering fixture ever built to test helicopters in captive flight. This 164 foot tall structure is capable of handling helicopters weighing less than 1,000 pounds to those weighing as much as 25,000 pounds. An avionics facility is planned adjacent to the tethering rig to be used for assembly of the various avionics gear used in the DASH program as well as a ground school for helicopter and ground controllers. The tethering rig will be used to train the pilots and controllers in actual flight operations.

Gyrodyne's backlog of orders as of July 1 was over $5 million. The company anticipated sales during 1959 of approximately $4 million.

HELIO AIRCRAFT CORPORATION

Helio Aircraft Corporation in 1959 put into production its new high speed model H-395 Super Courier, a five-place STOL airplane powered with a 295 hp model GO-480 Lycoming engine which made possible a cruising speed of 170 miles per hour.

Like its predecessor, the new Helio Super Courier model is capable of taking off and landing over a 50-foot barrier in *less* than 500 feet with zero wind. When operated as a conventional airplane on minimum size runways, it can carry up to 1,900 pounds, or approximately its own weight, operating under Part 8 of the Civil Air Regulations for industrial purposes only.

During 1959, Helio Aircraft Corporation, in cooperation with the New York Port Authority, successfully completed 18 months of service tests on a 400 by 200 foot standard helicopter-size landing area laid out at Teterboro Airport adjacent to the taxi ramp. These tests established the feasibility of STOL airplanes using helicopter-size landing pads and thus staying off congested metropolitan area runways.

Production for domestic distribution and export of the model H-395 (the 295 hp Super Courier) and of the model H-395 A (the 260 hp Lycoming engine in the new Super Courier air frame) was continued at the company's Pittsburg, Kansas, plant. Among the provisions for increased distribution and service of the Couriers in 1959 was the signing of an agreement between Helio and the SAAB Company of Sweden, manufacturers of Swedish jets, training planes and automobiles, thus providing European-based sales, service and assembly facilities for Helio aircraft.

Early in 1959, three of the new Helio Super Couriers, designated as the U.S. Military L-28A, were purchased by the Air Force "to evaluate operational techniques" of this new type aircraft. Tests of these airplanes were conducted at Edwards Air Force Base. The results have provided a basis for development of a larger twin-engine model more explicitly fitted to meet military requirements. The new twin-engine model, now under construction, was scheduled to be flight-tested during January, 1960.

HILLER AIRCRAFT CORPORATION

Headlining the year at Hiller were first deliveries of the three-place 12E commercial helicopter; record successes in maintenance and safety of the Army H-23D "Raven" helicopter; beginning of flight test program of the USAF X-18 tilt-wing VTOL/STOL aircraft; and delivery of an evaluation quantity of one-man YROE-1 "Rotorcycles" to the Marine Corps.

First deliveries of the civilian 12E helicopter were begun in May, and initial successes were achieved particularly in sales to charter operators. Although most of the first ships went to United States operators who had immediate requirements for the 12E's highest-in-its-class 305 horsepower, foreign sales were building up in the last four months of the year. As a result, Hiller commercial sales became an increasingly larger percentage of the company's total sales.

At the same time, military production rose to new peacetime heights. During 1960, the majority of the Army's light helicopter requirements will be fulfilled by the Hiller H-23D Raven, a 250 horsepower three-place ship. Originally designed for over 1,000 hours of flight between overhaul, and radically reduced maintenance, the H-23D demonstrated important victories during this year of field service: A full 1,000 hours of flight time was obtained on several H-23Ds without overhaul requirements, and the Army formalized the 1,000-hour characteristic. At the Army's Primary Helicopter School, Camp Wolters, Texas, H-23 type aircraft achieved a maintenance-hour-to-flight-hour ratio of less than half the military average, and an accident rate of less than two-thirds the military worldwide average. With its 200 Hiller helicopters, Camp Wolters passed its 200,000th flight hour of primary training—without a fatality or serious injury.

In late fall, Saunders-Roe, Ltd. of England, completed manufacture of the USMC YROE-1 one-man "Rotorcycle", under a sub-license agreement with Hiller. Five units of this foldable, 300 pound

The Hiller X-18 began test flights late in the year.

Hiller helicopter were delivered to the Marines for field evaluation. Several more will be demonstrated to other military and civilian agencies.

The USAF tilt-wing X-18 aircraft, world's largest VTOL/STOL project, underwent a rigorous ground test program at Moffett Field, California. Upon completion of these tests in fall, the X-18 was moved to Edwards Air Force Base, California, to begin taxi and flight programs.

Hiller's new Adhesive Engineering Division in San Carlos, California continued activity in the production of high temperature bonding materials for high speed aircraft and missiles. A new development placed on the market during 1959 was "Concresive", which bonds old concrete with new.

Research and development efforts were increased in the field of helicopter rotor tip propulsion. Working in conjunction with Continental Aviation Engineering Corp., Hiller studied and proposed a new series of helicopter designs of over 25,000 pounds gross powered by turbojets mounted at the rotor blade tips.

Advanced turbine-powered light helicopter designs were finalized for introduction in 1960. Studies were also intensified at the Hiller Advanced Research Division in the field of pure jet-lift VTOL aircraft designs, and new approaches to their powerplants.

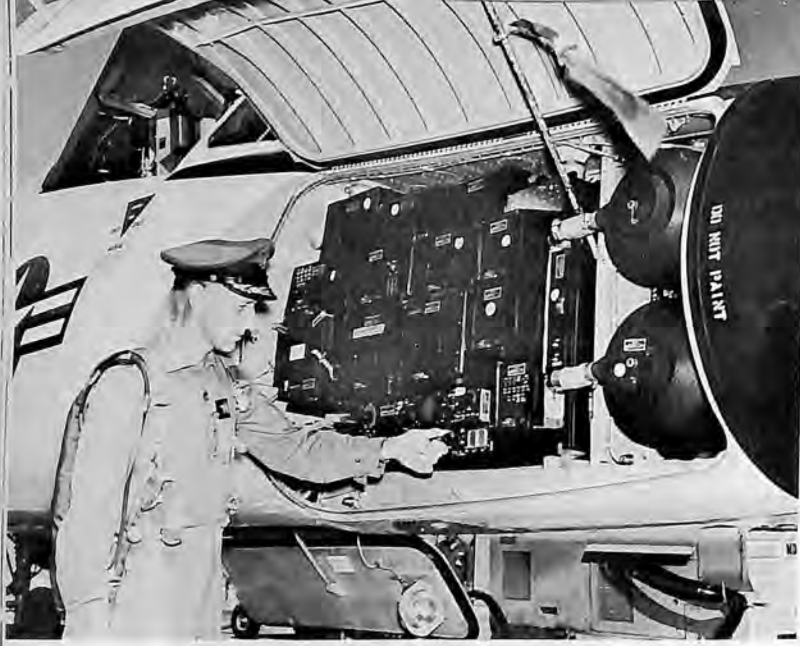
HUGHES AIRCRAFT COMPANY

The Hughes Aircraft Company underwent major expansion during 1959 in plant facilities, products and employment. Several new developments of long-term significance were disclosed during the year.

In July, the Hughes MA-1 Aircraft and Weapon Control System was introduced to the public at the activation of the first F-106 Air Defense Squadron at McGuire Air Force Base. The culmination of 15 years experience by Hughes in developing radar armament control systems for the Air Force, the MA-1 is the most advanced system of this type to be installed in an aircraft.

The F-106 has been described as the "plane with a brain" because of the MA-1 system's ability to do the pilot's "thinking" for him while he devotes his time to tactical decisions. The control system plays a major role in navigating the interceptor out to meet its target by computing course, speed, etc. from information programmed into its magnetic memory drum, together with data flashed to it by TACAN and SAGE ground stations. The automatic flight control system of the MA-1 operates the airplane's surface controls in response to this information, performing all the control functions normally carried out by the pilot from takeoff to touchdown.

Besides controlling the aircraft, the MA-1 system automatically launches the F-106's armament, the GAR-3 Super Falcon air-to-air guided missile, also produced by Hughes, and the MB-1 Douglas Genie nuclear rocket. The MA-1 system, to be installed in all F-106 interceptors, was being produced at the Hughes El Segundo, California, Division. The



Hughes' MA-1 radar armament control system.

Super Falcon is in production at the company's Tucson, Arizona, manufacturing facility.

Development of Mobot Mark I, a mobile robot with flexible steel "hands" and television-camera "eyes" which will handle radioactive materials in areas where a human cannot go, was announced. The Mobot moves about somewhat like a lift truck but has far greater dexterity and is remotely controlled by an operator who monitors its operation by television cameras. First models of the Mobot will be used to handle equipment in "hot" areas of Atomic Energy Commission work in 1960.

The company also announced it is building an "atomic clock" which is to be placed in orbit around the earth to test Einstein's general theory of relativity. The maser clock, so accurate it will neither lose nor gain one second in a thousand years, will check Einstein's proposition that a clock running in a different gravitational field above the Earth would apparently run fast relative to a clock on the ground. The atomic clock in an orbiting satellite will be checked against a similar clock on the ground during the test.

A mobile, compact tactical air defense system designed to coordinate antiaircraft missile firing at split-second speeds was developed for the Army Signal Corps by the Hughes ground systems plant at Fullerton, California. The equipment consists of a truck-mounted operations central and several battery units which provide Nike or Hawk missile batteries with electronic data on enemy planes entering a field army's zone of defense.

A parametric amplifier, a new device described as a "major breakthrough in long-range radar detection," was developed by the Hughes Microwave Laboratory at Culver City, California. The new amplifier was being produced commercially for installation in existing ground radar systems used for air traffic control. By increasing the sensitivity of the existing radar systems, the new device can increase the radar's range by as much as 100 percent. Heart of the amplifier is a microscopic parametric amplifier diode developed by Hughes research laboratories.

The commercial division of the company, Hughes Products, moved into a modern \$6-million plant at Newport Beach, California, where four completely mechanized lines for production of semi-conductors have been installed. The automated lines will perform most of the work now done by hand, and are expected to establish new standards of reliability by eliminating the factor of human error. In addition to production lines, the Newport Beach plant houses research and development, engineering, and office facilities.

The Hughes Products group was one of the first in the industry to produce engineering samples of the new tunnel diodes in 1959, and by mid-year had distributed samples to electronic engineers throughout the nation.

In other expansion, the company purchased an ultra-modern building at Malibu, northwest of Los Angeles, and began renovating the structure to house the Research and Development laboratories, now in Culver City. The move will take place in early 1960.

In January, the company acquired the Vacuum Tube Products Company in Oceanside, California, and created a separate division within the Hughes Products Group to manufacture vacuum tubes. Construction of a new building in Oceanside to increase vacuum tube production facilities was started during the year.

The Hughes International Division was created and the company entered the international market with its commercial products. Offices were established in Paris and Tokyo to head operations in Europe and the Far East. Distributor agreements were signed with foreign companies for sale of Hughes products in 12 Western European countries and the Orient.

Overall company employment during the year increased from 32,000 to 34,500.

The Hughes annual Achievement Award, presented to the Air Force all-weather interceptor squadron having the best performance record, was awarded to the 54th Fighter Interceptor Squadron, Ellsworth Air Force Base, South Dakota.

In May, the Paralyzed Veterans of America presented Hughes Aircraft Company with the "Outstanding Employer of the Year" award for the company's record of hiring physically handicapped workers.

During the year, 24 Hughes Fellowships in Engineering and Physics were awarded to graduates at 19 universities to enable them to continue studies toward doctoral degrees. In addition, 114 Hughes Fellowships were awarded graduates to begin studies for their master's degrees.

During the summer, 85 students and teachers held jobs at Hughes in another educational program designed to give educators latest information on industry's techniques and equipment.

KAMAN AIRCRAFT CORPORATION

Years of pioneering and test development with turbine powered helicopters reached a high point for Kaman when in 1959 the company converted to 100 percent turbine helicopter production. This milestone was passed as Kaman started operational deliveries of the Air Force H-43B Huskie local base rescue helicopter and began flight test development of the HU2K, Navy search, rescue and general utility helicopter. During the year, corporate growth continued and increases in sales, employees, and floor space in use were recorded.

Kaman had helicopters in service with three branches of the Armed Forces: HOK-1s in the United States and overseas with the Marine Corps, HUKs with the Navy, operating from shore installations and with the fleet, and H-43As and Bs on standby crash-alert duty at Air Force bases.

Further development of the Fairey Rotodyne, 65 passenger, 200 mile VTOL airliner for which Kaman is American licensee, was assured by continued support of the British Ministry of Supply and an impending order from British European Airways. Also, in March of 1959, New York Airways announced that it had concluded a letter of intent to purchase 5-15 Rotodynes. The unique aircraft has the ability to offer direct city-center to city-center service and to operate from small unprepared areas even with payloads of up to 11 tons.

The Rotodyne created additional attention during the year by establishing a new world's record for rotorcraft by flying an average speed of 191 miles per hour over a 100 kilometer closed course. This was more than 50 miles per hour faster than the previous helicopter record.

In the field of research and development, Kaman had contracts with the Army, Navy, and Air Force in new propulsion techniques, rotor development and increased all-weather capability as well as in advancement of drones and VTOL aircraft.

Kaman's sales volume for the first six months of 1959 exceeded sales volume for the like period in 1958: $14,196,398 compared to $9,416,473. Net earnings for the period were also increased in relation to net earnings for the first half of 1958: $324,859 compared to $207,147.

The company's backlog at the end of the year was expected to be over $50 million.

Kaman Aircraft was licensee for Fairey Rotodyne VTOL airliner.

LOCKHEED AIRCRAFT CORPORATION

Lockheed Aircraft International developed the Model 60 utility plane.

Reflecting vigorous growth through continuing diversification, Lockheed Aircraft Corporation in 1959 pushed sales past the $1 billion mark for the first time in company history. Gains in missile/satellite business and record commercial transport deliveries more than offset a decline in manned military aircraft volume.

Lockheed strengthened its skills and experience in eight basic areas—missile/space research and development, electronics, commercial and civilian aircraft, military airplanes, heavy construction, shipbuilding, nucleonics, and service. Its factories, offices, research centers, test bases, tracking stations, sales agents and representatives, and field service units spread to 22 states and nearly 70 foreign nations. The company advanced from 44th to 37th largest U.S. industrial enterprise.

From Lockheed production lines during the year came 17 different military and commercial airplane models. The company accelerated research and development work on 10 major missile/satellite programs. It added to its electronics capacity through formation ot Lockheed Electronics and Avionics Division (LEAD) and acquisition of Stavid Engineering, Inc., of New Jersey, specialists in electronics systems engineering. It entered the field of shipbuilding and heavy construction by acquiring the Puget Sound Bridge and Dry Dock Company of Seattle. It expanded foreign operations through formation of Lockheed Aircraft International.

LEAD initiated a program for volume manufacture of industrial, commercial, and military electronics devices and equipment, and revealed development of an air traffic control system (Loctracs) capable of reporting instantaneously the location, altitude, and identity of every airplane in the air over the nation. The Stavid acquisition improved Lockheed's position in radar, missile guidance systems, missile and range instrumentation, airborne bombing systems, electronic simulators, underwater ordance, and advanced electronics technology. Lockheed Aircraft Service, world's largest independent aircraft maintenance and modernization company, widened its electronics programs in design, engineering, and manufacture of missile and aircraft training aids, electronic and electromechanical recording devices, and missile and aircraft ground support equipment.

Purchase of the Puget Sound firm moved Lockheed into an area with substantial current sales volume and growth potential. Navy acceptance in August of the USS Turner Joy, a $16 million destroyer built by PSB&DD, marked Lockheed's first delivery of a naval surface craft.

Lockheed Aircraft International, formed in April, coordinates the company's growing interests abroad. It delevops overseas programs involving aircraft manufacture, repair, and maintenance, airline and airport operations, communications, engineering consultation, and technical assistance.

During 1959 LAI had active programs underway in three foreign nations and was developing programs in six others. These included supplying technical assistance in manufacture of P2V-7 antisubmarine warfare planes under license by Kawasaki Aircraft Company of Japan and development of the new Model 60, a light civilian utility plane that first flew in September. Lockheed's Georgia Division built two prototypes. A Lockheed affiliate, Lockheed Azcarate, will manufacture the Model 60 in Mexico for Central American markets.

The company's Missiles and Space Division recorded significant progress as system manager for top priority programs. The Polaris fleet ballistic missile moved substantially closer to operational status with the successful first launch of a test missile from a ship at sea. The Polaris will go into service with nuclear-powered Navy submarines in 1960. Lockheed X-17 hypersonic research missiles blasted nuclear warheads 300 miles above the South Atlantic in headline-making Project Argus. And four of six Lockheed-designed and built Agena satellites launched under Air Force direction in the Advanced Research Projects Agency's Discoverer series of polar-orbiting satellites orbited successfully. Discoverer V and VI were still in orbit in October.

The Missiles and Space Division also was system manager or principal contractor for Midas, the missile defense alarm system; Samos, an advanced satellite system; the Kingfisher target missile for the Army; and the X-7 ramjet test vehicle for the Air Force.

While moving into new areas of activity and widening its marketing range, Lockheed maintained confidence in the continuing importance of the manned airplane in military, commercial, and civilian applications.

In the military field the Georgia Division developed advanced versions of the C-130 combat transport for Air Force, Marine Corps, and Coast Guard missions. The Air Force selected the Georgia-built JetStar small utility jet as a navigator trainer. The California Division began production of the new P3V-1 antisubmarine warfare patrol version of the commercial Electra. Development of airborne early warning and several classified designs moved forward. West Germany contracted for a quantity of F-104 Starfighters built by Lockheed, and both West Germany and Canada arranged to manufacture additional Starfighters under license.

The F-104 was named 1959 winner of the annual Collier Trophy for the "greatest achievement in aviation in America" as demonstrated in actual use in the previous year, when the aircraft set world speed, altitude, and time-to-climb records.

Lockheed's commercial transport sales set an all-time high in dollar volume and number of units with delivery of 112 prop-jet Electra transports to foreign and domestic airline customers. The Georgia Division began production of commercial JetStars ordered for corporate executive transport and civil government airways control service. Two airlines chose Georgia's Super Hercules airfreighter. To accelerate supersonic research, the California Division began construction of a $5 million supersonic wind tunnel and high altitude environmental facility.

World-wide operations ranged from maintenance and modernization of military and commercial aircraft to weapon systems service, airport operation, aviation fuel handling, technical assistance in aircraft manufacturing by foreign governments and companies, economic and technical advisory services, and construction and maintenance of DEW line installations strung along the top of the world.

Lockheed Nuclear Products, a branch of the Georgia Division, made its second sale in the field of commercial nucleonics with an order to build a training reactor for Ohio State University. Late in the year the National Aeronautics and Space Administration selected LNP to provide basic engineering data as part of a nuclear rocket system feasibility study. The physics branch of the Atomic Energy Commission's division of research awarded the Missiles and Space Division a contract for basic studies of atomic nuclei properties.

Total Lockheed employment at year-end among all divisions was 59,000, a nine percent gain over the same 1958 period. Steady growth of MSD employment and acquisition of the Stavid and Puget Sound companies offset slight declines at most other divisions.

Despite its record sales volume, Lockheed's backlog remained about $1 billion at year-end. In January, 1959, following ratification by holders of a substantial majority of outstanding shares, the company split its stock on a two-for-one basis.

LYCOMING DIVISION
AVCO CORPORATION

A greatly expanded research and development program as well as production of both missile components and aircraft engines highlighted a busy year for Avco Corporation's Lycoming Division. Both its Stratford, Connecticut, and Williamsport, Pennsylvania, plants were engaged in advancing their respective states-of-the-art; Williamsport in "small" reciprocating engines for the utility aircraft fleet and the Army, and Stratford with its gas turbines and missile activities.

In the gas turbine field, Lycoming placed in volume production its T53-L-1 helicopter engine rated at 860 shp, and commenced regular deliveries of these engines for installation in the Air Force's Kaman H-43B Huskie and the Army's Bell HU-1 Iroquois. Both aircraft are in use by the respective services.

In addition, the twin T53-powered Vertol Model 107, prototype of the YHC-1, completed several hundred hours of demonstration flights, both in the United States and Europe, with nothing more than regularly scheduled routine maintenance.

The three VTOL test beds, Doak VZ-4, Vertol VZ-2 and Ryan VZ-3, each powered by a single T53-L-1 and each employing a different method of lift, continued their respective test programs.

As a demonstration of the T53's built-in reliability, in October, a helicopter version completed more than 700 hours of operation with only a single major parts replacement and a single oil change. This run was accomplished as part of a 1,000 hour tiedown test of a Bell Iroquois.

Lycoming's T53-L-3, turboprop version of the same engine but rated at 960 shp, made its initial flight in April, powering the new Grumman YAO-1 Mohawk. This version, which is the first to incorporate the "universal" concept whereby the inlet housing will accept gearing for either turboprop, helicopter or high speed applications, measures 58 inches long, has a 23 inch diameter and weighs 520 pounds. In August, the turboprop engine was ordered into production by the Air Force for the Army, and deliveries commenced in September.

Also in August, the Air Force awarded Lycoming a contract calling for the development of the T53-L-5, a 960 shp version of its helicopter engine. The new model will feature a reduction in weight with an improvement in specific fuel consumption and will incorporate the Lycoming "universal" concept. The -L-5 was scheduled for 150 hour qualification at the end of the year with "T" engine deliveries to begin around February.

Still another application for the T53, announced during the past year, was its selection by Beech Aircraft Corporation as the power source f the alert pod for the B-70 bomber currently being developed by North American Aviation.

Lycoming also installed its T53 in two marine hydrofoil vehicles, one a Navy LCVP and the other a modified World War II DUKW, wheeled amphibious vehicle. Speeds of the boats in both cases were increased approximately "sixfold." The second of these projects, called the "Flying Duck," was a prime contract and covered the complete design and modification of the boat as well as the installation of the engine.

Perhaps the biggest single development was the selection of Lycoming's second turbine family, the T55, as the powerplant for the new YHC-1B "Chinook," a 2-3 ton helicopter now under development by Vertol. Designated as the T55-L-5, the engine will be rated at 1940 shp and weigh 560 pounds with a diameter of approximately 24 inches, and an overall length of 48 inches. A unique feature will be its ability to operate at any angle from 50 degrees nose down to vertical position.

In the meantime, the T55-L-3 helicopter engine successfully completed its 50 hour preliminary flight rating test and was officially uprated from 1850 shp to 1900 shp. Specific fuel consumption was improved by five percent and weight was reduced six pounds.

On the reciprocating engine side, Lycoming was granted the first engine certificate issued by the Federal Aviation Agency, number 1-E1, awarded to the 180 horsepower VO-360-A1A helicopter engine. The horizontal version of this same engine, designated O-360-C2B, was also certificated at the same time.

The Williamsport plant continued development of several new models for both fixed wing and helicopter applications. These developments include fuel injection versions of existing models, increases in horsepower ratings of existing models and the development of several new fixed wing and helicopter engines. Several of these new models were scheduled to be introduced in 1960 while others, such as the eight cylinder fuel injection, geared and supercharged IGSO-720, were programmed for later production.

The list of new utility aircraft being powered by Lycoming continued to expand both in the United

States and abroad. New applications, some of which were scheduled to make their debuts during 1960, included the twin engine Piper Aztec, powered by two Lycoming O-540s, Mooney Mark 21, Champion Sky-Trac, Omega BS-12 helicopter. Curtiss-Wright also unveiled its Sky Car, which utilizes two Lycoming 180 horsepower engines for lift and propulsion.

Lycoming also became more active in the missile field, and its activities included the Titan and Minuteman ICBMs, Polaris IRBM, the Talos and Nike-Hercules. In addition to its production of re-entry vehicles for Titan and Minuteman, the Stratford plant began volume production of second and third stage rocket chambers for Minuteman and second stage chambers for Polaris, all under subcontract with Aerojet-General Corporation. Production of nose cones for the Nike-Hercules and diffusers for the Talos also continued throughout the year.

Advancements were further recorded in the company's mechanical constant speed drive program, with a 20 KVA Model LD3-3 being qualified by the Navy. Flight tests of the LD3-3 were accomplished in a P2V aircraft and ambient temperatures ranged from −67°F. to +365°F.

A scaled down version of this drive, along with a complete Lycoming-designed power system, was selected in mid-year for use in the Republic AN/USD-4 Swallow surveillance drone. Deliveries of the first units began in November. Other designs, ranging from 6 KVA to 120 KVA were also completed during the year.

McDONNELL AIRCRAFT CORPORATION

McDonnell Aircraft ended its first 20 years with another good year. Sales for fiscal year 1959 which ended June 30 totaled $435,878,979 and earnings were $10,037,995, about the same as the previous year. Backlog of orders on September 23, 1959 totaled over $630 million.

A significant role in the space age was undertaken by the company during the year when the National Aeronautics and Space Administration selected McDonnell to design, develop and construct the first U. S. manned space capsules. Responding to the urgency of the international situation, a definitive agreement was reached within thirteen days after negotiations started in January 1959. The company's contract for the project amounted to more than $20 million.

The capsule is designed to carry a human astronaut beyond the atmosphere into orbital flight in space around the earth and bring him safely back to earth. The program, called Project Mercury, will provide a means of recording and studying the psychological and physiological effects of space flight on Man.

Unusually thorough wind tunnel, thermodynamic, and other testing is required to assure stability and control over the wide range of conditions encountered in the atmosphere and in orbit. The capsule is designed to withstand any anticipated combination of acceleration, heat input, and aerodynamic force.

The pilot will be supported on a carefully contoured and cushioned couch. He will have the option of manual or automatic controls. Optical dis-

View of McDonnell space capsule mockup.

plays will show portions of the earth and sky, and help him to position the capsule in the desired orbital or re-entry attitude.

McDonnell took the risk of anticipating the requirement for such a program, and the Advanced Design Department of our Airplane Engineering Division began work more than a year before the announcement of the competition in which 11 other companies participated.

Three firings of a new hypersonic missile were completed in April, 1959, under Air Force contract at Cape Canaveral, two months ahead of schedule. The first two flights were completely successful and thoroughly demonstrated the significant advantages promised by our original aeroballistic theory. The firings met all test requirements and furnished valuable new basic hypersonic flight data. Sustained efforts are being made to obtain weapon system contracts to exploit this concept, pioneered by our company for five years.

Development of the GAM-72 Quail decoy missile, for which McDonnell is responsible for the management of the entire weapon system, progressed to the long-range powered flight stage. The first full-range powered missile completed the test objectives and demonstrated tactical capability in flights at Eglin Air Force Base. A new production contract brought to more than $124 million the total cumulative Air Force commitments to date for Quail missiles, training, logistic support, and B-52 launch gear.

Production of the airframe and integrated ramjet engine of Talos was scheduled through August, 1960, under subcontracts with Bendix, which aggregated $43,491,500 since March, 1951. Talos is the Navy's longest range surface-to-air missile now operational with the fleet. Research and development to give more striking power to an improved version of Talos was to be carried out, in cooperation with the Applied Physics Laboratory of Johns Hopkins University, under a prime contract with the Navy Bureau of Ordnance.

The Missile Engineering Division, under Air Force contract, was making a study of exotic metals for use in missiles and spacecraft, and also made extensive progress in advanced engineering work in space technology, including communication satellites and lunar probe studies.

The F4H Phantom II, after an intensely competitive flight-test evaluation, was selected by the Navy in December, 1958, for production. The new Phantom II, named after the Navy's first carrier-based jet fighter built by McDonnell, will succeed the current subsonic all-weather fighters in fleet service. It was scheduled to meet the Navy's requirements for the new generation of high performance all-weather fighters in the 1960's.

Although it is a carrier-based fighter equipped with folding wings, arresting hook, and strength for catapulting and arrested landings, the Phantom II incorporates outstanding interceptor qualities for fleet and shore defense. Powered by two J79 engines and manned by a pilot and radar operator, the Phantom II is armed with Sparrow III and Sidewinder guided missiles, and is capable of destroying enemy airborne vehicles at long ranges under all conditions of weather, day or night. It can deliver nuclear and conventional weapons accurately on distant surface targets.

Contracts with the Navy called for deliveries of the Phantom II through 1961. From the signing of the first production contract in September, 1952, 517 Voodoos in three versions had been delivered to the Air Force through August, 1959.

RF-101C photo-reconnaissance Voodoos were delivered during the year to operational squadrons in Japan, Okinawa, and the NATO countries by trans-oceanic flights, many of which themselves set records. F-101C fighter-bombers were deployed to the Third Air Force in England. The final delivery of the RF-101C to the Tactical Air Command on April 25, 1959 brought to 327 the number of Voodoos in the F/RF-101A/C series delivered to the Air Force. As of the same date, the total operational flight time of the Voodoos had reached the 60,000 hour mark.

The F-101B two-place interceptor was operating in six squadrons of the Air Defense Command based in the United States. Production deliveries of this advanced version of the Voodoo were scheduled through December, 1960.

Two new speed records were added during the year to the three trans-continental marks previously established by the RF-101C Voodoos of the Tactical Air Command. On April 8, Colonel Edward H. Taylor set a new 1000 kilometer closed course record of 700.047 miles per hour, and one week later on April 15, 1959, Captain George A. Edwards flew an average speed of 816.279 miles per hour over a 500 kilometer course for another world record. Both marks were set at Edwards Air Force Base by 837th Air Division pilots from Shaw Air Force Base.

During 1959, the F3H-2 F3H-2N, and F3H-2M Demons were continuously deployed in the Mediterranean, Caribbean and Far East, aboard seven carriers, including the Navy's two newest and largest, the U. S. S. Ranger and the U. S. S. Independence. Flying day and night the Demons were the backbone of fleet defense during the critical operations in the Lebanese and Quemoy crises. Twelve Navy squadrons were equipped with F3H Demons.

Deliveries of this primary all-weather fighter were completed in November, 1959. In all, 522 Demons were delivered to the Navy.

Continued work was done on several applications of the "unloaded rotor" principle, which was extensively developed on the McDonnell XV-1 convertiplane in prior years. Flight testing of the Model 120 pressure-jet rotor helicopter continued in preparation for evaluation by the Navy.

Increased interest in the McDonnell rotor led to a contract with the Army Transportation Corps to furnish further technical data for a large vertical take-off and landing (VTOL) aircraft. In addition, use of this rotor on VTOL aircraft is being investigated for new concepts of antisubmarine warfare.

Basic construction of the $5,324,903 Polysonic Wind Tunnel and Thermodynamics Laboratory, started in May, 1958, was completed in April. Shakedown was in progress, and calibration operations were to begin in the near future. The four-foot by four-foot test section of the tunnel will accommodate a five percent scale model of the F4H Phantom II. The average test cycle for a typical 60-second blowdown will be approximately 30 minutes.

The newest addition to the research and development facilities was the $1-million Hypervelocity Impulse Wind Tunnel on which construction began in August, 1959, with completion scheduled for the spring of 1960. This advanced wind tunnel will make possible measurements of aerodynamic forces and heat transfer at airflow speeds of Mach 12 to 24. By means of an electrical arc discharge, the pressure (up to 100,000 psi absolute) plus temperature (up to 15,000°F) of a fixed mass of air is built up, then released through a tungsten throat, and expanded to hypervelocities over a test model in a 50-inch diameter test section.

THE MARQUARDT CORPORATION

During Marquardt's 15th anniversary year, share owners of the company voted to change the company name from Marquardt Aircraft Company to The Marquardt Corporation. This action was characteristic of the industry's trend toward reflecting broader activities in air and space technology. Marquardt extended its endeavors in the fields of advanced air and space propulsion systems, controls and accessories, nuclear systems, trainer and simulator systems, and advanced research rocketry.

At the outset of 1959, Marquardt realigned its corporate structure with the establishment of the Power Systems Group, comprised of a Propulsion Division, Controls and Accessories Division, and Test Division. Later in the year a Nuclear Systems Division was established under the Power Systems Group for the development and manufacture of nuclear propulsion systems and other nuclear products. The new division's primary responsibility was work on Project PLUTO, the joint Air Force-Atomic Energy Commission program for the development of a nuclear ramjet engine.

At Marquardt's Ogden, Utah, production plant, construction of a Marquardt-Air Force Jet Laboratory was completed, climaxing a three-year planning and development program to extend the Ogden plant's production and testing capabilities. The $14-million advanced jet laboratory was designed to acceptance test ramjet engines under controlled conditions, simulating altitudes in excess of 100,000 feet and speeds above Mach 3. Marquardt-Ogden's increased capabilities further insure the company's record of having delivered every ramjet to the Air Force "as-per-contract-schedule." Ogden-produced ramjets were being used operationally as cruise propulsion systems for the Bomarc interceptor missile.

Marquardt-Ogden's production capabilities were further enhanced during 1959 with its installation of the world's largest known precision metal forming machine, the Hufford Spin-Forge. The 500,000 pound, 60-inch by 60-inch roll-forming machine "cold-forms" complex ramjet parts of many configurations in one or two short operations.

Early in 1959, Marquardt reported that more than 200 flights of its RJ43 series supersonic ramjet engine had been completed in operations on the Boeing Bomarc interceptor missile, Lockheed Kingfisher target drone, and the Lockheed X-7 test vehicle. In accomplishing this flight program, the Marquardt RJ43 ramjet established speed and altitude records for air-breathing engines, having exceeded Mach 4 and 80,000 feet.

As successful engine performance results continue to be recorded on Bomarc IM-99A flight tests, significant progress was made during 1959 in the

Ramjet parts on Marquardt forging machine.

company's development of an advanced ramjet engine for the Bomarc B missile, under developmental testing at year-end. In the latter half of 1959 Marquardt announced its development of the "Hyperjet" engine, a combination propulsion system which integrates the best features of the rocket and ramjet engines in a single powerplant. "Hyperjet" is an engine with controlled rocket thrust for static launch, boost, operation in space and re-entry. It utilizes the ramjet's specific impulse for acceleration and hypersonic cruise within the earth's atmosphere.

In addition to its efforts in precision ramjet controls development and production, Marquardt's Controls and Accessories Division was engaged in such projects as the engine control system for the General Electric nuclear turbojet; inlet control systems for the McDonnell F-4H and the North American Hound Dog missile; auxiliary power systems, pumps, and actuators.

At Marquardt's ASTRO Division (Air Space Travel Research Organization), advanced research capabilities were expanded with the construction of a 25,000 square-foot engineering-administration office building at Van Nuys. Plans were under way for the construction of an advanced research laboratory building in close proximity to the ASTRO building. An adjunct to ASTRO's operations is a research field laboratory at Saugus, California, which has an aerodynamic test capability approaching Mach 12 and temperature test capability to approximately Mach 7.0 (3700° Fahrenheit). ASTRO was engaged in basic and applied research programs in optics, mechanics, ae dynamics, thermodynamics, materials and structures, fuels, electronics, nucleonics, nuclear propulsion, chemical propulsion and electrical propulsion systems, and space medicine research.

Among the major projects in which Marquardt's Pomona Division was engaged was production of AN/GPS-T4 radar signal simulators for training Air Force controllers to direct interceptor missions. The division also developed a land mass simulator system which shrinks the map scale factor to 1:3,000,000, enabling the use of a single eight-foot map to simulate realistically radar reflectivity and shadow effects of a 4,000-mile mission. The Pomona Division was also working on ground support and handling equipment for missiles and target drones, data display systems and systems engineering programs. A 50,000 square-foot engineering-administration building, scheduled for completion in 1960, will include expanded electronic laboratory facilities to accommodate the Pomona Division's longer range programs.

Cooper Development Corporation, a Marquardt subsidiary, continued to demonstrate technical capabilities in rocket systems, specialized solid rocket motors, and various components for space and missile systems. Cooper rockets and instrumentations were being used in connection with high altitude weather and atmospheric sounding research, studies of solar phenomena, particulate samplings, and in the final stages of propelling satellites into orbit. Cooper provided the hardware for ASPAN sounding rockets used in the Naval Research Laboratory's Project Sunflare. Significant advances were also made by Cooper in the application of heat resistant ceramic coatings for rocket components.

According to an unaudited mid-year financial review for 1959, Marquardt forecast its highest sales and net profits in its 15-year history, with sales expected to reach $70 million and profits to be $1.8 million—a 40 percent and 60 percent increase over 1958.

Marquardt further predicted long-range future efforts directed toward quadrisonic ramjet-powered transports, which the company said are feasible on the basis of current engineering concepts and require virtually little modification of techniques or materials being used today.

THE MARTIN COMPANY

The Martin Company strengthened its position in missiles and electronics and continued its steady transition from manned aircraft to space age projects during 1959.

The extent of the changeover—begun in 1946 with development contracts in the guided missile field—was strikingly indicated by Martin's 1959 backlog: more than 72 percent missiles and electronics. "We are for all practical purposes out of the aircraft business, George M. Bunker, Martin's board chairman and chief executive officer said during 1959. "We don't expect to ever design and produce another aircraft."

The company, meanwhile, continued to show sales gains. Martin reported 1959 was the firm's ninth consecutive year of increasing sales volume. In addition, the company again improved its net income despite an increase in cost-plus-fixed-fee contracts.

Martin also consolidated the Air Force Titan intercontinental ballistic missile program into a single integrated division by incorporating the recently organized Titan base activation division, headquartered in Denver, into the overall project.

In a management realignment, George M. Bunker, president and board chairman since 1952, vacated the presidency to William B. Bergen, executive vice president. Bunker remains board chairman and chief executive officer.

William Bergen, as principal operating officer, directs Martin's seven divisions: Baltimore, Orlando, Denver, Cocoa, Nuclear, Space Flight and RIAS.

In education, Martin expanded its Foundation Scholarship and cooperative engineering education programs.

Martin presented the Navy a special trophy to be awarded annually to Naval squadrons competing for standards of excellence in anti-submarine warfare. The trophy was named in honor of the late Captain Arnold Jay Isbell, World War II naval officer who was awarded the Distinguished Service Medal for his ASW achievements.

BALTIMORE DIVISION

These were among Martin-Baltimore's top achievements during 1959:

Launching of Vanguard II and Vanguard III earth satellites.

The rendezvous in space of a Martin-built Air Force 199-B air launched ballistic missile with the Explorer VI "paddle wheel" satellite.

Successful launchings of the Air Force TM-76B Mace surface-to-surface tactical missiles from a simulated ground shelter and deployment of the "A" model with front line NATO forces in West Germany.

The final Vanguard launching vehicle wrote a happy ending to a sometimes stormy and troubled earth-satellite program. On September 18 it placed the 50-pound Vanguard III satellite and attached 50-pound third stage into an orbit expected to last from 30 to 40 years.

On February 17 another Vanguard rocket placed the 23.3-pound Vanguard II satellite and 50-pound third stage into orbits expected to last 200 years.

These satellites are companions of the 3.25-pound Vanguard I artificial moon launched March 17, 1958, into an orbit now expected to last 2,000 years. The 50-pound Vanguard I third stage also is in a high and stable orbit. With the launching of Vanguard I the project achieved its primary objective of placing an instrumented satellite into orbit during the International Geophysical Year (IGY).

Vanguard's accomplishments included:

First successful demonstration of sun-powered batteries (Vanguard I); determination that the earth is somewhat pear-shaped (Vanguard I) ; crude but useful data that proves the feasibility of a system for gathering cloud-cover information (Vanguard II); development of a worldwide tracking system and adaptation of all three Vanguard stages for an entire series of more ambitious space vehicles.

The potentialities of air launched ballistic missiles as a versatile weapons system were dramatically demonstrated October 13 when a Martin crew piloting an Air Force B-47 over the Atlantic Missile Range launched a two-stage 199-B ALBM which co-orbited for a short time with the Explorer VI "paddle wheel" satellite. This 199-B was the last of a group built by Martin for the Air Force's Air Research and Development Command to demonstrate the feasibility of firing ALBMs from aircraft. The firing was also a demonstration of the missile's guidance system accuracy by placing it at apogee in the proximity of Explorer VI. The Martin flight test program involved both single-stage and two-stage missiles.

The TM-76A Mace, in production since mid-1958, became operational in June, 1959 and was replacing the Air Force TM-61 Matador surface-to-surface missile with NATO tactical units in West Germany. The Mace, with greater speed and range and self-

Martin Company built this RB-57D jet bomber for Strategic Air Command.

contained, independent ATRAN (map matching) or inertial guidance systems, is a vastly improved version of the Matador, deployed overseas since 1954.

The Air Force in August began a series of successful launches of the new inertially-guided TM-76B missiles from simulated ground shelters at Holloman Air Force Base, New Mexico. Flight test training with the TM-76B birds was moved late in 1959 from Holloman to the Atlantic Missile Range, Cape Canaveral, Florida, where the TM-76B's longer range (more than 1,200 nautical miles could be fully tested. The Air Force released approximately $100 million in November from other adjusted programs to continue MACE B procurement.

The Mace has nuclear capability and is impervious to electronic jamming. In addition, a recovery kit can be interchanged with the warhead to permit reuse of the missile through parachute recovery for training purposes. The Air Force says studies indicate the Mace's warhead effectiveness and range can be "appreciably" increased.

The Navy continued research and development work aimed at putting a turboprop nuclear seaplane in the air by 1964, and to this end Martin's Nuclear Division received a contract in July to begin studies of airframe designs for an anti-submarine warfare nuclear seaplane.

The Navy's front-line ASW patrol seaplane operating over coastal and foreign waters was the Martin P5M Marlin. Production orders for new P5M-2 models were announced early in the year for both the Navy and the French government (under the Military Assistance Program). The first of these new models, completed for the Navy in July, was equipped with a new integrated and fast-acting ASW detection system which later was installed in other Navy ASW aircraft. The new system was also being installed in 160 fleet Marlins which were being modernized at Baltimore under a $60-million "high priority" program scheduled to continue through June, 1961.

The Navy's venerable "Big Four" Mars seaplane transports, which had been in retirement for three years, embarked upon a new career in August when announcement was made that a coalition of British Columbia forest industries had purchased the aircraft to serve as an aerial fire fighting brigade. The seaplanes will be used to scoop water from lakes and shower it on fires which are taking a heavy toll in Canadian forests.

The Navy's sudden decision to terminate the P6M SeaMaster program in August was attributed principally to the military budget squeeze, although the statement was later made that "the military requirement for a high performance seaplane will continue to exist."

In materials research, Martin-Baltimore engineers, in conjunction with Nuclear Metals, Inc., of Concord, Massachusetts, reported the successful fabrication of structurally sound beryllium sheet material which was used to construct the world's first beryllium structure. They said use of beryllium in basic airframes would lead to the solution of many aerodynamic and structural heating problems connected with space flight and re-entry of the earth's atmosphere at 18,000 miles an hour.

In connection with the P6M SeaMaster program, Martin developed the aircraft industry's first portable frequency-converting jet engine noise suppressor for aircraft possessing engine afterburners. A license agreement between Martin and the Koppers Company, Inc., led to orders for the suppressor units from the Air Force, Navy and several West Coast aircraft manufacturers.

A machine cutter was developed by Martin-Baltimore to machine compound contour structural shapes from honeycomb core material. The device, dubbed "Hula Head" because it performs a Hawaiian hip dance movement, is the first known method of performing this operation within required tolerances and finish without a filler substance to make the sandwich-like core rigid during machining.

Under a contract with the National Aeronautics and Space Administration, Martin-Baltimore was reducing raw data telemetered from the RIAS-Bartol Research Foundation cosmic ray experiment in the Explorer VII satellite launched by an Army Juno II rocket October 13. The cosmic ray instrument package is recording the impacts of heavier cosmic ray particles in an effort to determine the origin of the rays.

ORLANDO DIVISION

A survey of events at Martin-Orlando in the past 12 months indicated that a substantial change took place in the nature and scope of activity.

Two missile systems were phased from research and development into production status with both becoming operational (Lacrosse and Bullpup); commendations were received on Missile Master production, deliveries and reliability; an accelerated development program was instituted for Pershing; a modest, but well-staffed company-funded research and development effort was established; facilities were expanded to a substantial degree; and employment was increased by some 60 percent.

Air Force procurement of Bullpup air-to-surface guided missiles increased the scope and potential of that project, with the added program of USAF-funded research and development on Bullpup modification.

Some specific highlights concerning the projects at Martin-Orlando included:

In March, Major General John B. Medaris, commanding general, Army Ordnance Missile Command, announced that the Pershing selective combat range artillery missile would be developed on an accelerated basis. All Army tests, for example, would be scheduled concurrently with those programmed by Martin-Orlando. This approach to weapon system development was a new one and was expected to reduce substantially the lead time required to push Pershing to operational status.

On July 22 a ceremony was held at Ft. Sill, Oklahoma, to acknowledge the delivery of hardware for one Lacrosse battalion and completion of preliminary schooling and training for that battalion's personnel. By year end, four battalions had been activated and equipped and the first unit had completed the training program leading to a combat-ready status.

Bullpup-equipped squadrons were deployed to the Sixth and Seventh Fleets by mid-year with firm plans made for equipping Marine Corps and other Navy squadrons at a later date. High performance and reliability records were established with the basic production missiles (ASM-N-7) and an improved version (ASM-N-7a) was put into production.

The Air Force announced that the Navy-configured Bullpup would go into the Tactical Air Command inventory as GAM 83A and at the Air Force Association convention in September, newsmen were told a follow-on Bullpup, to be called GAM-83B, was being developed by Martin-Orlando.

On December 5 the Missile Master installation at Ft. Meade, Maryland, had been in operation for two years and in the process had established a phenomenal record in the area of system reliability. Analysis of operations reports showed the system, consisting of more than 294,000 parts—mostly electronic components—had a "down time" of less than one percent.

Martin-Orlando was cited on two occasions by Signal Corps agencies for the outstanding quality control standards maintained by the company and in compiling a perfect record with respect to meeting delivery and acceptance schedules.

A flexible and mobile version of Missile Master was developed by the company with the design and capability studies submitted to the military for appraisal.

A full-time staff was assigned to research and development at Martin-Orlando during 1959 and special facilities provided to permit studies in communications, solid-state physics (including thin-film research), development of advance types of MASERs, advanced weapon systems and general product improvements. Substantial progress was made—and a breakthrough in the field anticipated—in producing relatively large silicon carbide crystals.

DENVER DIVISION

On February 6, 1959, the Air Force SM-68 Titan made a successful first flight. Three successful test flights of the two-stage intercontinental missile followed during the winter and spring. In July, the Department of Defense announced that a modified Titan first stage had been chosen for the second stage of the Army's Saturn space vehicle, a three-stage workhorse designed to lift multi-ton loads into high orbit around the earth and into deep space.

Creation of an Electronics Division at Martin's Denver facility was announced in September. The new division was supporting the Titan program by concentrating on the higher performance and reliability required of Titan electronic components and systems, and was also diversifying electronic activities in order to permit developments in new equipment areas.

Initial Titan squadrons are to be based at Vandenberg Air Force Base and Beale Air Force Base, California, Lowry Air Force Base, Colorado, Mountain Home, Idaho, and Rapid City, South Dakota.

At a typical operational site, the Titan will be stored in a subterranean cylinder with ground support equipment. This "hard base" complex will consist of the major 165-foot deep "silo" housing and the 90-foot missile and three adjoining sunken cylinders. Two of these cylinders having connecting service tunnels will house a maintenance unit with electronic gear, power source, air conditioning, and hydraulic equipment. The other will be a fuel storage area for liquid oxygen.

COCOA DIVISION

The Cocoa Division, established in 1957, conducted all missile flight testing at the Atlantic Missile Range, Cape Canaveral, Florida, for Martin's other divisions. An autonomous division with its own general manager, Martin-Cocoa also provided administrative support for each project on board in such areas as programs and contracts, industrial relations, finance, procurement, quality assurance and information services.

During 1959 Martin-Cocoa launched four successive Denver-built Titans for the Air Force in less than three months (February 6 and 25, April 3 and May 4) and four Baltimore-built Vanguard satellite-carrying rockets for the National Aeronautics and Space Administration, including Vanguard II and Vanguard III.

In addition, Martin-Cocoa completed complex installations and began a flight test program of the Baltimore-built TM-76B Mace, the Air Force's inertially guided tactical missile, and completed activation of the launch complex for the Orlando-built Pershing.

Technicians prepare second stage of Titan for erection on launch stand at Cape Canaveral.

Martin-Cocoa also provided support for several launches of the Air Force's 199-B air launched ballistic missile, including the unique satellite intercept mission on October 13. Cocoa Division facilities and personnel also were used to help prepare the RIAS-built cosmic ray experiment contained in the Explorer VII satellite launched by an Army Juno II rocket under NASA supervision on October 13.

Facilities assigned to and operated by Martin-Cocoa at Cape Canaveral included three hangars, four launch complexes for the Titan, a complex with hard and soft launch sites for the Mace and a complex with two launch pads for Pershing.

NUCLEAR DIVISION

The Nuclear Division started off 1959 with its first major reactor contract and the first display of SNAP-3—the much publicized "atomic battery."

In January, the division was selected by the Atomic Energy Commission and the Air Force to design, build, install and test-operate a "packaged" nuclear powerplant at Sundance, Wyoming. The plant will be built in air-transportable sections which can be connected at the site. Net output will be one million electrical watts of high-quality power and seven million BTUs per hour of low-pressure steam. The powerplant, designated PM-1, is scheduled to become operational in late 1961 and to be turned over to USAF crews early in 1962.

SNAP-3 is one of several Systems for *N*uclear *A*uxiliary *P*ower being built by Martin-Nuclear. Intended primarily as a proof-of-principle device, the four-pound unit uses a series of highly efficient thermoelectric elements to convert the spontaneous decay heat from one-fortieth of an ounce of radioisotope directly into electrical energy. In April, one such unit provided power for a Martin-built "ham" radio which established two-way contact between Cleveland, Ohio, and the Canal Zone. Subsequent versions of SNAP-3—each constructed without moving parts—successfully survived rigorous shock, acceleration, and vibration tests and also operated under vacuum conditions.

During the year, Martin-Nuclear also expanded its studies for the AEC of several radioisotopes besides Polonium-210 which might be used as power sources, including safely-contained forms of Strontium-90.

Under contract to the Wright Air Development Division, the division Martin-Nuclear began development of a radioisotope heater for the cathode of an electronic tube. The heater would cut power requirements of the tube roughly in half.

Early in 1959, the Nuclear Propulsion Systems Department received a $127,000 Navy contract to study designs for a nuclear-powered seaplane with an ASW mission, and during the year it continued its investigations of nuclear rocket systems and ion propulsion.

In October, Martin-Nuclear announced an $838,163 contract from the AEC to pursue development of a "Liquid Fluidized Bed Reactor" (LFBR), including the fabrication of a small reactor core for critical experiments. The new system could cut fuel costs sharply and might eliminate the need for complicated "control rod" systems completely.

Martin-Nuclear was at work under an AEC contract to develop a computation code which could provide mathematical solutions to certain problems of pressurized water reactors. Through its Nuclear Components Department, it completed the fabrication of flat plate and foil-type fuel elements for several critical experiments and research reactors during 1959 and began production—under subcontract to Allis-Chalmers—on the fuel elements to be used by the Elk River commercial nuclear power reactor.

SPACE FLIGHT DIVISION

Space Flight Division was formed August 13, 1958 to direct one of two six-company teams that have since completed source selection studies of the Dyna-Soar System, an Air Force and NASA program that seeks to develop a manned boost glider ultimately capable of hypersonic speeds and global range.

The Air Force on November 9, 1959 announced the selection of Martin and Boeing Airplane Company, leader of the other industrial team, as contractors for the Dyna-Soar System. The program was funded for $53 million through fiscal year 1960.

Martin will make the booster part of the system while Boeing will manufacture the vehicle portion.

Each contractor, subject to Air Force approval, will select all major sub-systems and components on a competitive basis, regardless of previous working relations during the developmental phase that preceded selection of the contractors.

The Air Research and Development Command's Wright Air Development Division (WADD) will be systems manager while the Air Force Ballistic Missile Division (AFBMD) will be principal agency for the adaptation of boosters for Dyna-Soar.

The boost glider will be developed under new management procedures because this is the first time the Air Force will be developing a system which draws on existing aeronautical knowledge, missile development and initial exploration of space by man.

The Air Force said Martin and Boeing were chosen because it felt it should get maximum benefits of the companies' knowledge in this specialized field of development.

Initial step in the development program will be design and test of a glider to bring man back to a normal landing from hypersonic flight speeds.

Unmanned gliders, and later manned gliders, will be launched from Cape Canaveral down the Atlantic Missile Range to explore technical and military problems connected with flight approaching orbital speeds of 18,000 miles an hour.

Preliminary investigations, the Air Force said, show that by varying the original rocket boost, and thus the velocity, and with the control available to the pilot, the Dyna-Soar glider could circumnavigate the earth and then make a normal landing.

Dyna-Soar is to accomplish boost glide flight—"dynamic soaring"—by using centrifugal force and aerodynamic lift.

The Air Force said advanced knowledge indicates the boost glide vehicle will have capabilities for many varying missions because it will be able to operate from the outer fringes of the atmosphere down to well within the atmosphere, where it can maneuver and be recovered undamaged.

The Martin industrial team included Bell Aircraft Corporation, American Machine & Foundry Company, Bendix Aviation Corporation, Goodyear Aircraft Corporation and Minneapolis-Honeywell Regulator Company.

RIAS DIVISION

RIAS, which conducts basic research not related to product development in fields ranging from biophysics to metallurgy, continued to expand its investigations during 1959. In addition, the staff at the RIAS laboratories in Ruxton, Maryland, was increased to 85 persons.

In experiments with the Air Force Cambridge Research Center, Bedford, Massachusetts, and the Bartol Research Foundation of the Franklin Institute, Swarthmore, Pennsylvania, RIAS was learning more about cosmic rays.

The RIAS-Cambridge experiment was in a gondola carried aloft by an unmanned balloon launched in June from Holloman Air Force Base, New Mexico. The instrument package sought new data on heavy cosmic ray particles.

The RIAS-Bartol instrument package was contained in the Explorer VII satellite launched October 13 by a Juno II rocket at the Atlantic Missile Range, Cape Canaveral, Florida. This experiment seeks to determine the or' in of cosmic rays and thus provide fresh clues to the nature of matter in deep space.

Progress was reported in understanding the biophysics of photosynthesis through research on monolayer films. An extremely sensitive automatic film balance was built and was being used in this study which seeks to produce a synthetic molecular layer structure similar to that of a living plant leaf.

The mathematics staff was expanded and its research culminated in an international symposium on nonlinear differential equations in Mexico City. RIAS organized the September conference and RIAS staff members were chairmen of the various round table discussions.

Considerable progress was reported in other areas, including theoretical and solid state physics and metallurgy. Also, a new group was set up to study quantum chemistry.

The research of RIAS scientists resulted in more than 40 publications in scientific journals during 1959 plus numerous lectures, seminars and informal conferences. In addition, technical conferences were held with scientists and engineers of the other Martin divisions.

NORTH AMERICAN AVIATION, INCORPORATED

When the X-15 made its first powered flight on September 17, it marked a major step toward man's conquest of space.

Flight of the research aircraft produced by North American for NASA, the Air Force and the Navy, was but one of a number of contributions made by the company during the year.

Development continued on the Mach 3 B-70 Valkyrie weapon system for the Strategic Air Command, and continued progress was made on the development and flight tests programs of the Navy A3J attack weapon system and T2J twin-jet trainer, and the Air Force's GAM-77 Hound Dog air-to-surface missile.

The company's rocket engines provided propulsion for most of the nation's successfully launched large ballistic missiles, satellites and space probes. Development of guidance and control systems for manned and unmanned weapon systems, including fleet ballistic missile submarines, continued under high-priority programs. The company also began construction of two large nuclear power reactors to be used in producing electricity for commercial sale.

Employment rose to 63,650 on September 30, a gain of some 18 percent over the previous year.

In October, North American acquired full ownership of Astrodyne, solid propellant firm at McGregor, Texas, which had previously been jointly owned with the Phillips Petroleum Co. The plant will be operated as a part of tl : Rocketdyne division.

North American's sales for the fiscal year ending September 30 totaled $1,044,899,580, compared with $904,038,848 for the previous year. Net income after all costs and provisions for federal income taxes was $30, 726,134. This was equal to $3.80 per share on 8,092,895 shares of capital stock outstanding.

Backlog of unfilled orders on September 30 was $662 million, not including orders that were negotiated but not yet funded.

Activities of the various divisions were as follows:

ROCKETDYNE DIVISION

Rocketdyne propulsion systems powered over 80 percent of the high thrust ballistic missiles launched by the United States during the year, and provided booster power for most of the nation's successful space projects, including the first polar-orbiting satellite, a space probe that reached an altitude of 71,300 statute miles, a vehicle put into orbit around the sun, and a biodmedical capsule that successfully brought back two monkeys carried 300 miles into space.

Production of engines for the Atlas intercontinental ballistic missile, the Thor and Jupiter intermediate range ballistic missile and the Redstone tactical missile continued during the year, and engines were delivered to be clustered in a 1,500,000 pound thrust booster for use in an advanced space program.

An order was received for a single-chamber rocket engine of 1,500,000 pounds thrust, and development was underway. Work was also continuing on ion and nuclear propulsion and engines that will use storable and high-energy propellants.

The division's solid propellant activities were centered in the McGregor, Texas, facility, while liquid propellant work was conducted at the Neosho, Missouri, plant and at Canoga Park, California; research and development activities were centered at Canoga Park.

AUTONETICS DIVISION

Employment at the Autonetics division increased markedly during the year, as activities in the field of electronics and control equipment continued to expand.

During the year, Autonetics began development of an advanced autonavigator for the B-70 weapon system, completed initial studies of guidance and control equipment for the Dyna-Soar manned boost-glide vehicle, and began fabrication of prototype guidance and control equipment for the Minuteman intercontinental ballistic missile. Initial deliveries were made of navigation systems for atomic-powered submarines to be armed with the Polaris missile, and of guidance and control equipment for the GAM-77 Hound Dog missile.

First deliveries of search and range radars for the Republic F-105 fighter-bomber were made, and a contract was received for development of an armament control system for the Lockheed F-104 fighters to be delivered to the German Federal Republic.

The division put into production an improved bombing-navigation system for the A3J-1 attack weapon system, and continued to produce spares for the Mg-4 armament control system for F-86K interceptors.

Data processing equipment, including RECOMP, the first general-purpose all-transistorized digital computer to be placed on the industrial market, continued in production.

MISSILE DIVISION

Flight tests of the new GAM-77 "Hound Dog" air-to-surface missile, developed and produced by the company's Missile Division at Downey, California, demonstrated the system's ability to meet all range, speed and altitude requirements. The missile can be launched from B-52 bombers to deliver nuclear warheads at supersonic speeds over a range of several hundred miles.

Flight test activities on GAM-77, which was developed under an accelerated program after the initial contract was received late in 1957, were started early in the year at Eglin Air Force Base, Florida.

The division has received a contract for development for an advanced Hound Dog Missile that will have longer range and other improved capabilities.

During the year, Missile Division completed the design, fabrication and delivery of seven booster vehicles and a launcher for use in the "Little Joe" preliminary test phase of the NASA man-in-space program. Studies of advanced booster systems for the Air Force, NASA and the Army Ballistic Missile Agency are underway.

Thor engine in environmental chamber.

Research in such areas as flight space mechanics, gas dynamics, and the geophysical, material and astronautical sciences were conducted in the newly-created Aerospace Laboratories at the division.

COLUMBUS DIVISION

The carrier-based A3J-1 Vigilante, produced by the Columbus, Ohio, division for the Navy, operated as a complete weapon system on simulated military missions, and success of the tests indicated that all performance goals would be met. Flying at twice the speed of sound, the A3J-1 can deliver either nuclear or conventional weapons over long distances at either high or low altitudes, and in any weather.

Deliveries of the T2J-1 Buckeye, a twin-jet Navy trainer, began in July after completion of more than two years of tests and demonstrations.

As a small but growing part of the company's commercial work, the design, fabrication and erection of architectural metal products for a number of major buildings was being carried out by the Columbus Division.

LOS ANGELES DIVISION

The X-15, which will carry man higher and faster than he has ever flown before, made its first captive, glide and powered flights in 1959. Detail design of the B-70 Valkyrie was initiated and tooling required to build the advanced intercontinental air weapon was being fabricated. Contractors were selected for the major subsystems on the B-70, which will be capable of cruise speeds in excess of 2000 miles per hour at altitudes above 13 miles.

Flight testing of the prototype T-39 Sabreliner, a twin jet utility airplane that will cruise at 500 miles per hour with a range (1500 nautical miles, was completed, and production was started on the aircraft under Air Force contracts. The commercial market for the Sabreliner, which was developed as an off-the-shelf item, was being studied.

During the year, the production of two versions of the famed F-100 Super Sabre was completed; six years of production saw nearly 2,300 F-100s delivered, constituting the largest proportion of fighter aircraft in the nation's military inventory.

Outstanding technical achievements were made in the development of the F-108 interceptor, but the development program was terminated by the Air Force in September, because of program priorities and fund shortages.

Under construction at Los Angeles was a 122,000 square foot complex of laboratories for use in the testing of advanced flight vehicles.

ATOMICS INTERNATIONAL

While work of this division is primarily in the design and production of reactors for research and the generation of commercial power, special studies were underway in the development of nuclear power for aviation and space vehicles.

NORTHROP CORPORATION

Northrop Corporation headquartered in Beverly Hills, California, continued during 1959 to carry on its research and development, manufacturing and marketing activities through four divisions, Norair, Nortronics, Radioplane and Northrop International, and a wholly-owned subsidiary, Page Communications Engineers. The company had approximately 70 basic products and programs concentrated in weapon systems, sub-systems and other developments related to the national defense effort.

Approximately two-thirds of Northrop Corporation's output was related to electronics and missiles. Manned aircraft programs were underway at Norair, and Radioplane manufactured target drones. Page Communications Engineers was active in the field of world-wide communications.

Programs of research and development related to the new cycle of weapon systems, space vehicles and communication techniques were underway in all company operating divisions. The company's net worth was approximately $45-million and sales continued at the rate of more than $250-million annually.

NORTHROP INTERNATIONAL

The International Division of Northrop Corporation represented the organization's varied divisions abroad.

Within the scope of the International Division were the numerous and diverse developments of Northrop's Norair, Nortronics and Radioplane divisions. Northrop International had cognizance of the corporation's expanding ties abroad, both through sales and through cooperation with government agencies and manufacturing and marketing organizations outside the United States.

Through the International Division, the advanced technology of the Northrop Corporation contributed to the mutual defense and economic advancement of the free nations all over the world.

A primary responsibility of the International Division was the presentation to the Free World's armed forces of the new Northrop N-156F Freedom

Northrop T-38 supersonic trainers underwent extensive testing in 1959.

Fighter which met the capabilities and requirements of the Free World nations militarily and economically.

At year-end, Northrop International was maintaining permanent representatives in the Far East, with headquarters in Tokyo, and in Europe at offices in Paris. The International Division's head offices were located in Beverly Hills, California.

NORTRONICS DIVISION

The latest major contract acquired by Nortronics in 1959 was for the guidance system of the Air Force's GAM-87A Air Launched Ballistic Missile. Nortronics was working with Douglas Aircraft Company, the prime contractor on the GAM-87A.

Complicating the task of providing adequate guidance for the GAM-87A was the need for precise "orientation intelligence" in the missile's navigational brain. Since the ALBM is intended for launch from both subsonic and supersonic aircraft, the guidance system must not only know target location, but also must determine instantaneously its own location and orientation in space at the time of firing.

By year-end, Nortronics' team of inertial guidance experts had devoted more than 13 years to the development of advanced missile guidance systems, beginning with the Mark I system for the SM-62 Snark. During the past two years, the division has concentrated on specific problems related to directing airlaunched ballistic missiles.

Other guidance projects included the A-5 astronertial system and A-8, an advanced star tracker for interplanetary navigation systems.

LINS, a pure inertial guidance system, is designed for minimum preflight alignment, reliability, and automatic operation at low cost. It is an extremely lightweight precision system applicable to supersonic aircraft and missiles.

Nortronics' Datico, a universal automatic checkout system for weapons, in use at year-end by Air Force maintenance depots, was being applied to solving test problems on Polaris, Hawk, Nike-Ajax, Nike-Hercules, Sergeant, Corporal, and Lacrosse. Datico provided stimulation, self-checking, and performance evaluation, including malfunction, isolation, and recording for all levels of maintenance and checkout.

The ground support equipment field generally was of importance to Nortronics' facility at Anaheim, California. Contract with Raytheon Manufacturing Company for the Hawk Missile included design and production of loader, launcher, pallet, shipping container, loading ramp, and test fixture.

Other Nortronics products included the "Q" Ball attitude-sensing nose cone for the National Aeronautics and Space Administration's X-15, and VIPS (Voice Interruption Priority System), which was the first of a number of Nortronics projects in the flight safety field.

Nortronics put increasing emphasis on research and development in space electronics. A $4-million research and development facility designed primarily for work in this field, was scheduled for completion in 1960 on the Palos Verdes Peninsula.

NORAIR DIVISION

Progress at Norair Division was marked by numerous events during the year. Two most significant were first flights of the Air Force's T-38 Talon supersonic trainer, now in production for units of the Air Training Command, and the N-156F Freedom Fighter, under development for members of the free allied nations. Both airplanes were flown by military pilots much earlier in their testing programs than is usually programmed for supersonic aircraft.

In step with the progression from development quantities to production aircraft, manufacturing facilities were relocated and enlarged for assembly of T-38 aircraft. As a further step in the production cycle, Norair was to begin operation of facilities at Air Force Plant 42 at Palmdale in 1960, for production flight operations for the Talon.

Production of the SM-62 Snark intercontinental guided missile continued throughout the year, and missiles were delivered to the nation's first intercontinental guided missile launch site operated by the 702nd Strategic Missile Wing at Presque Isle Air Force Base, Maine. Orders provided for Snark production through calendar year 1960.

The company's philosophy, "Security With Solvency," involving the employment of newest advances in science, engineering and technology and management efficiency, proved highly successful during the year. New management tools, complementing the division's PACE (Performance and Cost Evaluation) program, were installed. These included the Value Analysis procurement program and Target Cost, a method for applying total cost control to major projects through detailed design analysis.

Research and development activities were pursued in both scientific areas and in manufacturing techniques. The engineering department's Astronautic organization was conducting advanced work in the fields of astrodynamics, astro-navigation, bio-astronautics, space electronics, space materials, space physics, space propulsion and space structures, in both government and company sponsored projects.

Progress in the field of low drag boundary layer control aroused much interest in the field of logistics aircraft. Application to transport and cargo aircraft now appears feasible in providing world wide airlift at greatly reduced ton-mile costs.

Techniques providing more rapid and less expensive ways of building high strength structures for the new generation of jet aircraft and missiles were being developed. Exceptional progress was made in the areas of honeycomb processes, numerical control and forming of new space metals.

Production of major airframe structures under sub-contract represented a significant segment of the Norair work load. The Division was producing major airframe components for the Boeing KC-135 jet tankers and 707 jet airliners and for the McDonnell F-101 fighter.

RADIOPLANE DIVISION

During 1959, Radioplane received a USAF development contract for the XQ-4B, a redesigned version of the earlier supersonic target drone, XQ-4A.

In the meantime, the Air Force lifted the security wraps on Radioplane's XQ-4 and XQ-4A.

Radioplane also received a contract from McDonnell Aircraft Corporation for development of a recovery system for Project Mercury. The division's Paradynamics group, which specializes in design, test and production of special parachute deceleration and recovery systems, was working on the project.

The XQ-4 series was put into development to meet a USAF requirement for radar appearance compatibility with the Bomarc-SAGE (Semi-Automatic Ground Environment) Air Defense System.

In addition, it was designed to serve as a high-speed target for Terrier and Genie missiles as well as those programmed for the XQ-4, including Talos, Sidewinder, Sparrow III, Falcon, Nike-Hercules and Hawk.

A quantity of XQ-4 targets were being flown at the Army's White Sands Integrated Range Facilities at Holloman Air Force Base under a tri-service military launch program directed by the Air Force.

Sidewinders were fired at the XQ-4, and radar tracks were conducted with Talos and Sparrow III with actual firings scheduled in the near future.

The missile targets were being used as part of the armed forces program for evaluating advanced weapon systems.

The XQ-4 is launched from a B-50 carrier aircraft and is ground controlled. Scoring, radar augmentation and recovery systems are included in the system design.

In addition to its radar compatibility with Bomarc-SAGE, the XQ-4 series contain a Radioplane-designed flight control system incorporating maximum employment of advanced miniaturization techniques. Its scoring system can provide means of recording and transmitting the hits or misses of attacking missiles to ground facilities.

The XQ-4 series radar augmentation system simulates a bomber. The three-stage parachute recovery system enables recovery over water or land and is initiated by command, malfunction or fuel exhaustion.

Air Force personnel conducting the present military launch program received factory training at Radioplane's Van Nuys plant during the year as part of the technical support provided by Radioplane for its missile targets.

PAGE COMMUNICATIONS ENGINEERS

Page Communications Engineers, Inc. was acquired by Northrop early in 1959 as a wholly-owned subsidiary. Page projects included a $25-million multichannel scatter communication system in the Pacific for the Army Signal Corps; a 1,600-mile scatter network linking Paris, Naples and Izmir for NATO; troposcatter test paths at nine arctic sites, including the Greenland ice cap, for the eastward extension of the DEW line; the first operational extended-range troposcatter communications system —a single-hop, 690-mile path from Cape Dyer, Baffin Island to Thule, Greenland—for the Air Force; and a telecommunications network linking Tripoli and Benghazi, and the first phase of a national broadcasting system, for the Kingdom of Libya. Work began on the $10-million USAF contract for a communications complex to link England, Spain and North Africa.

Page also entered the new area of missile range instrumentation for the United States Navy at Point Mugu, Pacific Missile Range; took an active part in the development studies for transoceanic television from Canada to the United Kingdom; and made advanced communications design studies for the USAF Global Communications System.

Notable accomplishments of the Page Research and Development Department included the Anti-multipath Equipment, which provides a significant increase in telecommunications reliability; and the Decision Threshold Computer, a device which substantially improves the performance of high frequency and scatter communications circuits.

PIASECKI AIRCRAFT CORPORATION

In June, Piasecki, pioneer of vertical lift aircraft, achieved successful flight of its jet-powered "aerial jeep". This version of Piasecki's Model VZ-8P, which the company designed and first flew in September of 1958, is powered by a Continental Artouste II-B gas turbine engine.

A major step forward was taken in Piasecki's growth program in February, when the company acquired a modern electronics plant at Mayfield, Pennsylvania, near Scranton. The Mayfield Electronics Division is completely equipped to handle nucleonic, electronic and electro-mechanical manufacturing and assembly. Its 65,000 square feet of new buildings house the latest in research and quality control facilities, adding importantly to Piasecki's manufacturing capacity. Following the Mayfield acquisition, the company added a number of key governmental agencies to its customer list, including the Air Force, the Signal Corps, and the Coast Guard.

In May, the company purchased exclusive manufacturing rights to a new underwater communication and detection system. Unlike Sonar, which accomplishes underwater transmission by sound waves, the newly acquired Piasecki system utilizes electro-magnetic means, thus promising far greater underwater range and sensitivity. The system has many important anti-submarine warfare applications.

Piasecki's jet-powered aerial jeep.

Piasecki continued development work on its "Airail", a revolutionary high-speed (300 to 400 mile per hour intercity monorail system with cars of aircraft construction and propulsion.

Piasecki continued to utilize its extensive test stand and research facilities to expand its growing experience on the ducted fan. Work progressed on two classified VTOL projects, the "Ring-Wing" and the "Sea Bat".

In addition to increased domestic activities, Piasecki advanced significantly its relationships with prominent European aircraft companies as part of a program to expand the market for its products and services.

The Breguet-Piasecki 940 was successfully demonstrated by Breguet Avions at the 1959 Paris International Air Show. This new four-engine STOL (Short Take-Off and Landing) aircraft is the predecessor to the 941, a 16-ton STOL which Breguet and Piasecki are developing jointly. This type of aircraft, which will land in extremely short distances and on unprepared fields, is of considerable interest as an assault transport both in the United States and abroad.

The company ended the most successful fiscal year of its five-year history by securing a contract to design and build a second, m i-engine "aerial jeep" for the Army for comprehensive field testing. This second "Sky-Car" will have greatly increased capacity, speed and range.

PIPER AIRCRAFT CORPORATION

The year 1959 was by far the best in the history of Piper Aircraft Corporation, Lock Haven, Pennsylvania. Gross sales for the fiscal year that ended September 30, 1959, totaled $34.2 million, an increase of 21 percent over the previous year. Sales of $4,096,559 in the single month of May, 1959, were the highest monthly sales in the company's history.

Production of all Piper models totaled 2,397, up 10 percent over 1958. Piper models included in this total were the twin-engine Apache; high performance Comanche with a choice of 250 or 180 horsepower; 160 horsepower Tri-Pacer and 150 horsepower Carribbean; Super Cub with a choice of 150 or 90 horsepower and PA-18-A agricultural plane.

Deliveries of Piper's new agricultural model, the Pawnee, began during the summer of 1959. The five-passenger Aztec, new Piper twin with two 250 horsepower engines, went on the market late in the year.

Physical expansion kept pace with expanded sales volume. At the Piper Research and Development Center in Vero Beach, Florida, a new 25,000-square foot building to house tooling and plastics operations was completed and work was started on an additional 75,000 square feet of manufacturing space.

Major aviation news was made by Piper in June when Max Conrad flew a Comanche 7,668 miles non-stop, from Casablanca to Los Angeles, to establish a new world lightplane distance record.

PRATT & WHITNEY AIRCRAFT DIVISION
UNITED AIRCRAFT CORPORATION

Pratt & Whitney Aircraft made fresh strides in the liquid hydrogen rocket engine and nuclear reactor fields in 1959 at a time when passenger planes using its Turbo Wasp jet powerplants established world records.

The company received many orders at home and abroad for its new flight-tested JT3D turbofan engine and its small but powerful JT12 gas turbine. New vistas also opened with two other developments: joint work on a chemical electric fuel cell of vast potentiality; and collaring the jet's immense thrust to pump gas through cross-country pipelines.

Thrust chambers for the first U. S. liquid hydrogen rocket engine, designated XLR 115-P-1 by the Air Force, and other components were test-fired during the year in the rapid development of a new type powerplant earmarked for a variety of specific military and civilian space missions. The XLR-115, (Air Force name for the RL-10) , and its pumps, control valves, nozzles, injector plates, etc., are being developed by Pratt & Whitney Aircraft's Florida Research and Development Center as the first of a family of powerplants. Test stands have been built to take thrusts of 300,000 pounds or more.

Two XLR-115 engines, each conservatively rated at 15,000 pounds of thrust, will power the Convair Centaur space vehicle, as an upper stage of an Atlas missile. This will make a system capable of putting a 7,500-pound satellite in a nominal 300-mile-high earth orbit, or sending a 2,000-pound payload on a deep space probe, or "soft-landing" 750 pounds of instruments on the moon. The Centaur space vehicle is a project directed by the National Aeronautics and Space Administration.

In another space project for which the XLR-115 has been chosen, Centaur will serve as an upper stage of the huge Saturn missile atop a cluster of rockets delivering nearly 1,500,000 pounds of thrust, and aimed to lift payloads in the range of

35,000 pounds for a 300-mile orbit or 12,000 pounds for a deep space probe. The Saturn project is being carried out for the Defense Department's Advanced Research Projects Agency by the Army Ballistic Missile Agency, Huntsville, Alabama.

To produce the new engine, which represents a new concept in rocketry, unique and highly advanced tools were needed. The company built a rocket-engine testing complex, the first time a private company has made a contribution of this size to the rocket testing capabilities of the nation.

During the year the Navy's Bureau of Aeronautics awarded a contract of approximately $2 million to Pratt & Whitney Aircraft to develop nuclear aircraft engine hardware. It was the Navy's first such contract, and the components to be fabricated are linked with the Navy's requirements and authority to develop a secondary heat transfer system for an indirect cycle nuclear aircraft powerplant.

The new contract will not affect Pratt & Whitney Aircraft's basic nuclear studies and development work on advanced reactors conducted since 1953 under the Atomic Energy Commission's sponsorship. Work is being done by the company at the Middletown, Connecticut, Aircraft Nuclear Engine Laboratory, an Air Force-owned facility. The company's original nuclear engine program was sponsored by the Air Force in May, 1951.

In the commercial jet age, which began in October, 1958, planes using Pratt & Whitney Aircraft JT3 and JT4 Turbo Wasp engines, commercial versions of the J57 and J75, piled up records.

Jet airliners with P&WA engines initiated regular transcontinental and round-the-world service in 1959, and accounted for more than 25 percent of the seat-miles flown within the United States. By the second quarter of 1960 they were expected to increase their share of the load to about 50 percent of all domestic seat-miles.

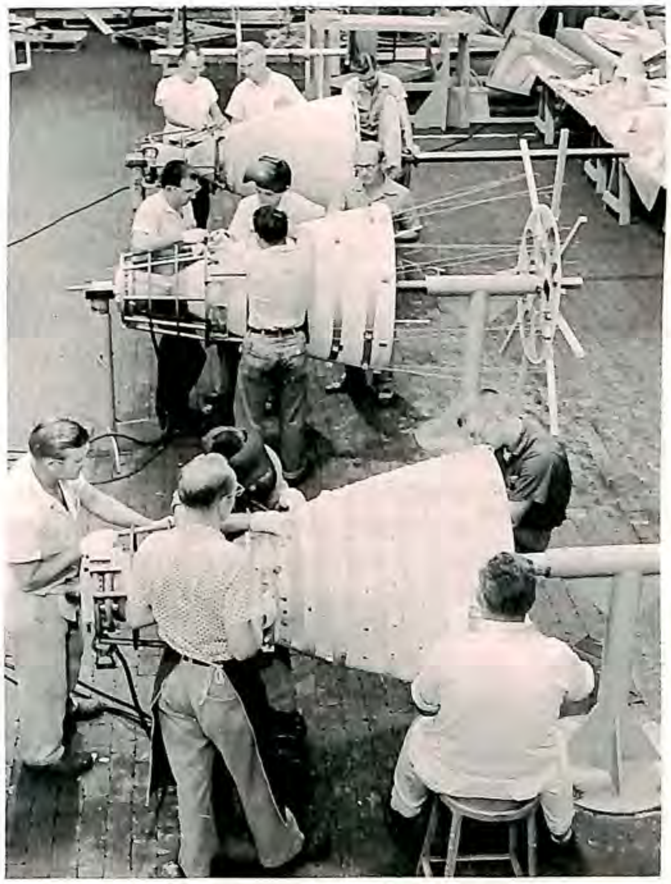
Since inception of commercial service the Boeing 707s and Douglas DC-8s powered by the Pratt & Whitney Aircraft engines had accumulated by year-end a total of approximately 420,000 engine hours. The combined total for commercial and military usage of the engines was nearly 6,500,000 engine hours.

On May 28-29, a Boeing 707-320, or intercontinental jet airliner using JT4 engines, flew from Seattle to Rome in a 5,830-mile nonstop flight which smashed a commercial jet transport distance record claimed by the Soviets for a 4,225-mile flight between Moscow and Khabarovsk, Siberia. The plane's time was 11 hours and six minutes.

In July of 1959 another Boeing Intercontinental powered by four P&WA JT4s flew from New York to Moscow in the unofficial time of eight hours and 54 minutes. The plane, carrying newsmen to cover Vice President Richard M. Nixon on his good will trip to Russia, bettered the record of nine hours and 48 minutes set by a Russian TU-114 propjet.

Air France's first Boeing Intercontinental completed a record-smashing 5,250-mile nonstop flight from Seattle to Paris November 6 in nine hours and 24 minutes, averaging 558 miles per hour.

Pan American World Airways, also using the Intercontinentals powered by JT4 engines, began



Thrust chambers of XLR-115 engines.

round-the-world service October 10, 1959, and cut flying time from 66 to less than 38 hours. A Pan American jet plane flew from New York to Paris November 10 in the record time of five hours and 44 minutes, eclipsing their old commercial record of six hours and four minutes set December 12, 1958.

The first Douglas DC-8 jet transports put into service September 18, 1959, by Delta Air Lines and United Air Lines also were powered by Pratt & Whitney Aircraft engines. Twenty five domestic and foreign airlines had ordered planes with P&WA powerplants.

By year's end a total of 566 JT3s and more than 400 JT4s had been delivered for use in the commercial Boeing 707s and Douglas DC-8s. A total of 453 JT3s and 558 JT4s were scheduled for delivery after January 1, 1960.

Performance data on the J75, the world's most powerful production turbojet, was disclosed for the first time in 1959 when the Department of Defense declassified the J75 and its commercial version, the JT4.

The J75 with afterburner, which powers the Republic F-105 fighter-bomber and Convair's F-106 interceptor, delivers 24,500 pounds of thrust. With water injection the engine will produce 26,500 pounds of thrust.

In 1959 a total of 1,757 J57s and 308 J75s were delivered to the military.

A main new product in the Pratt & Whitney Aircraft division of United Aircraft Corporation is the turbofan engine, which combines some features of the propeller with the thrust of a jet engine. It has already been selected for installation on 50 Boeing jets used or ordered by American Airlines, on five DC-8s to be operated by KLM Royal Dutch Airlines, and on three DC-8s ordered by Iberia Spanish Air Lines. United Air Lines has ordered the turbofan, known as the JT3D, on three DC-8s and plans to convert other planes in its big fleet. A P&WA turbofan engine also was chosen for the proposed DC-9 short and medium haul plane. An even bigger market potential for the turbofan exists in the military field. The Air Force already has picked the turbofan for the B-52H model of the long-range, eight-engined Boeing bombers. The turbofan engine is expected to stretch the bomber's "more than 9,000-mile" unrefueled range by a good margin.

The turbofan promises reduced fuel consumption, greater power at takeoff and cruising speed, and less runway length requirements. The Pratt & Whitney Aircraft JT3D-1 turbofan is rated at 17,000 pounds of thrust at takeoff and will be available beginning in July, 1960. The JT3D-3 is rated at 18,000 pounds, and will be available in June, 1961. The engine was flight-tested just 18 months after the start of design detailing.

The USAF selected the 600-mile-per-hour Lockheed JetStar for training future bombardier navigators. This plane is powered by the new 436-pound JT12, a single-spool, axial-flow turbojet introduced in 1958. The engine develops 3,000 pounds of thrust. This small but rugged engine also was picked to power two other advanced aircraft—the four-engined McDonnell 119 transport, and the twin-engined North American Sabre Liner, and it was selected to power two unmanned surveillance drones being developed for the Army by Republic and Fairchild, and the Canadair CL-41 trainer. A design of the engine, with afterburner, is capable of Mach 2.0 operation.

Pratt & Whitney Aircraft oadened its engine line in 1957 with the 8,000-pound thrust J52. The Navy's Bureau of Aeronautics awarded a $23.5-million contract for further development of the engine which has been announced as the powerplant for a new Navy attack plane, the Grumman A2F. It also was picked for the North American Hound Dog air-to-surface missile carried by the B-52G "missile platform" bomber.

The PT6, a small, lightweight free turbine engine weighing only 250 pounds, was introduced by Canadian Pratt & Whitney Aircraft. It is designed for turboprop use in light planes and turboshaft installations in helicopters. It develops 500 equivalent shaft horsepower. At the other end of the P&WA power spectrum is the J58, a big single-spool turbojet in the 30,000-pound thrust class and intended for operation at high altitudes and high Mach numbers.

Production of the T34 propeller turbine, which delivers more than 6,000 equivalent shaft horsepower, continued for the USAF's four-engined Douglas C-133 transport.

The Patterson-Moos division of Leesona Corporation of Cranston, Rhode Island, and Pratt & Whitney Aircraft during the year entered into an agreement for a joint research and development program on the Hydrox fuel cell. Under a license from Great Britian, Leesona Corporation had been engaged in the development of the fuel cell for more than three years. The cell is a new type of power producing plant which converts the chemical energy of hydrogen and oxygen directly into electricity without the need for conventional engines or electric generators. The agreement covers the joint development of fuel cell plants for space and military applications.

In cooperation with Cooper-Bessemer Corporation, a J57 was being modified to drive a Cooper-Bessemer gas turbine, converting the turbojet's thrust into rotative horsepower. The first unit, being produced at Mount Vernon, Ohio, will have 10,500 horsepower available for such jobs as pumping natural gas through cross-country pipeline systems. Natural gas direct from the pipeline on which the new unit is installed will substitute for conventional jet fuel. The engineering staff of

Cooper-Bessemer conceived the idea of harnessing the J57's massive thrust into industrial horsepower. In addition to use in the natural gas pipeline application, the companies see the device as opening up new sources of lower cost power in chemical and petro-chemical processing.

Six new test cells were added to the Willgoos Turbine-Engine Test Facility at East Hartford, where jet engines and components are tested under a wide range of simulated flight conditions.

Employment at the year-end was approximately 36,500.

REPUBLIC AVIATION CORPORATION

The year 1959 was one of marked progress in several areas for Republic Aviation Corporation. Highlights were the increased production of the F-105 Thunderchief and the introduction of the all-weather 'D' model, construction of a Research and Development Center as part of a multi-million dollar expansion program, and the receipt of important new contracts in the missile and special product fields.

In October, two squadrons of the Tactical Air Command's 4th Fighter Day Wing were brought to full strength when delivery of the F-105 nuclear-carrying, Mach 2 fighter-bomber filled the complement of the 334th and 335th fighter squadrons.

A few months earlier, the F-105D, all-weather version of the Thunderchief, was completed and successfully flown ahead of schedule. A plan was proposed for the European production of the automatic 'D', which has a completely integrated bombing-navigation-search electronic system.

Four Republic F-105 noses in tactical huddle.

Republic was still providing maintenance and service on the F-84F Thunderstreak and RF-84 Thunderflash aircraft. The 'F' with a primary mission of fighter-bombing and the 'RF' with its mission of photo-reconnaissance, were in service with 14 allied and NATO nations. The earlier F-84 Thunderjet was in service with Thailand and Formosa in the Pacific.

Intensifying its efforts in the Research and Development field, Republic advanced in many areas as part of last year's implementation of a multi-million dollar program to increase development of the advanced forms of aircraft, missiles and spacecraft. Included in this program is the modernly equipped Research and Development Center, a $14-million structure which houses scientific laboratories. The facility was to become fully operational in the spring of 1960, enabling scientific specialists to make investigations into specific disciplines comprising the multi-faceted problems in aeronautics, ballistics and astronautics.

Advancing on work started last year in the area of high temperature hydraulics, Republic verified the existence of a fluid capable of operating satisfactorily from 20 degrees to 1,000 degrees Fahrenheit. A follow-on contract, the result of two years research work, was awarded the company to develop and test components required for an aileron power control system capable of operating smoothly at all temperatures within this same range.

In August, Republic received from the Air Force's Wright Air Development Center contracts for trajectory studies of space probes. The research projects call for the establishment of scientific "ground rules" for the best system for computing space trajectories, plus an analysis of data handling techniques and guidance requirements for changing the orbit of a satellite. Earlier, Republic received a contract from the Air Force's Cambridge Research Center to determine the best method for predicting the orbit characteristics of a man-made earth satellite using data gathered from the Russian Sputnik II.

It was announced early in 1959 that Republic had received contracts from the Office of Naval Research and the Air Force Office of Scientific Research for experimentation in development of a magnetic pinch plasma engine to be used as an interplanetary propulsion system. Later, Republic announced plans to expand its Plasma Engine Laboratory and began construction of a second experimental engine.

The rapidly growing Research and Development program concerned itself with various projects for the support of life in space including plant growth under reduced pressures, water recovery, the design of a completely closed ecological system, and the design of a vehicle capable not only of landing on the Moon, but returning to Earth.

The Alouette jet-powered helicopter, designed by Sud Aviation of France and assembled and marketed in North America by Republic, continued to perform diversified missions in varied climates. Northern Airways of Fairbanks, Alaska, where the temperature drops to −35 degrees Fahrenheit, used the Alouette for forest service work and salvage hauls. Petroleum Helicopters, Inc., the U. S.'s largest operator of rotary-wing craft, used Alouettes to ferry passengers and supplies to off-shore oil rigs in the Gulf of Mexico, where the warm, moist climate raises temperatures to 105 degrees Fahrenheit. The sale of the Alouette to the Ontario Hydro Electric Commission, established the first government purchase of the craft in North America.

The Missile Systems Division (known as the Guided Missiles Division previously) continued production of the Swallow advanced combat surveillance drone and ground control system under a $30-million contract from the Army Signal Corps. The medium-range drone employs advanced observation equipment such as photography, radar and infrared to "spy" on enemy battlefield installations behind the lines. Jet-propelled, zero-length launched and recoverable, the drones are capable of all-weather operations.

In October the Division was advised by the Air Force that it had been selected to perform two nuclear physics research programs under contract. This work supplements the six anti-ICBM contracts being performed. Earlier, Missile Systems announced it had received con cts from three agencies for study of highly-sophisticated ballistic missile defense systems. The contracts called for investigation of such long range approaches to the problems as an invisible destructive curtain in outer space and the harnessing of radiation to cause internal damage to missiles. One program was studying missile defense systems for 12 to 20 years into the future.

The Division also received its third Navy contract for manufacture of a Practice Bomb Container. The device is used in training pilots in the delivery of nuclear weapons. Under sub-contract, the Division continued in the manufacture of Atlas ICBM and Thor IRBM nose cone structures.

Among the items being manufactured by the company's Special Products and Services department, established in the beginning of the year to provide engineering, development and manufacturing service to other aviation companies and allied industries and to market Republic-developed commercial products, were automatic circuit analyzers which reduce the time for electrical circuit checks from hours to less than five seconds for every 100 circuits; and a compact, automatic silver zinc battery charger capable of charging five aircraft batteries and discharging another simultaneously. A contract for the production units of a huge plastic antenna to be mounted aboard Navy ships for tracking and guiding missiles was received in the beginning of the year. The contract calls for a number of antennas to be used with the Tartar shipboard missile.

For the nine months' period ending September 30, 1959, a net income of $2,640,254 on sales totaling $152,952,050 was reported.

RYAN AERONAUTICAL COMPANY

New concepts in propulsion related to VTOL capability, and in metallurgy adaptable to extremely high altitude flight and to the tremendous stresses of rocket motor cases were advanced by Ryan in 1959.

Meanwhile, the plant geared for quantity production of its new airborne electronic automatic navigational systems and the most advanced version of the Firebee jet target. At the same time, established assembly lines continued to produce huge fuselage sections for the KC-135 jet tanker and jet pods and pylons for DC-8 jetliners, as well as Corporal rocket engines, Marquardt ramjet combustion chambers for the Bomarc missile, and numerous high-temperature components for jet and piston engines.

Successful ground launchings of Ryan Firebees began in 1959.

Ryan's rapidly expanding research and development activity encompassed such widely varying projects as its Vertifan, a fan technique of combining vertical take-off and landing characteristics with high speed forward flight; a unique new type jet engine tailpipe; application of ultra-thin gauge, high-strength materials to an extremely high altitude vehicle; and fabrication of cylinders of strip-wound paper-thin steel capable of withstanding stress more than five times greater than structural steel used in skyscraper construction.

An aircraft design study contract awarded by the Air Force crowned four years' development of principles of the Ryan Vertifan system, featuring a fan, or set of fans, horizontally submerged within the wing and powered by a turbine, driven by jet engine exhaust, to provide VTOL lift. The jet engine also provides conventional thrust for normal flight.

For Grumman Aircraft Engineering Corp., Ryan began construction of an unusual tailpipe to enable the new Navy A2F-1 carrier-borne attack plane to make extremely short take-offs and landings.

The Air Force assigned Ryan the task of determining feasibility of applying thin, high strength materials to a vehicle expected to operate at extreme altitudes to determine environmental conditions affecting functoning of unique propulsive devices.

The award of a contract to fabricate chambers for the solid rocket propellant of the Navy's Polaris missile disclosed that Ryan had developed a unique welded "strip-winding" technique, utilizing paper-thin steel alloys of great strength wound around a mandrel, tackwelded, and then spotwelded to create the desired wall thickness. The resultant cylinders showed capability of withstanding stress to 305,000 pounds per square inch static tension ultimate stress.

Widespread interest throughout the industry was shown in Ryan's successful experiments in the revolutionary new method of high energy forming, utilizing explosive charges lowered through a water container into a die containing the part to be formed.

When it was determined that many hours of time and expensive tooling could be saved in some projects previously utilizing the more conventional drop hammer, punch press, stretch press and rubber forming methods, high energy forming was specified for an increasing number of production jobs.

Ryan jet Firebees continued to occupy a major role in evaluation of the nation's air defense by serving as the sole targets for the second consecutive year in the Air Force world wide weapons meet, Project "William Tell II", at Tyndall Air Force Base, Florida, and as the targets for missiles in Operation "Top Gun", the Navy's fourth annual Naval Air Weapons Meet based at the Marine Corps Auxiliary Air Station, Yuma, Arizona.

Due to enter quantity production for the Air Force in 1960 is the newest version of the Firebee, the Q-2C, which set world's records in its 1959 testing program at Holloman Air Force Base, New Mexico. Among the Q-2C achievements: altitude of 59,800 feet; Mach .96 speed endurance in a remote-controlled flight, 96.8 minutes; uninterrupted flight above 50,000 feet altitude for 77.5 minutes; glide of 9.3 minutes and 45 miles after shut-off of jet engine.

Firebees also tested the Army's Nike-Hercules missile system during the winter of 1958-59 at Fort Churchill, Manitoba, Canada, in the coldest weather, ranging to 47° below zero, in which jet targets have ever been employed.

Successful ground launchings in a test program which began in 1959 at the Army's White Sands Missile Range, New Mexico gave the Firebees a new operational potential for surveillance and reconnaissance with the Army's ground troops. The tests also showed that Firebeees may be given greater flexibility as targets by freeing them from aircraft launching in regions lacking air strips and during periods of bad weather.

New Firebee bases were established during the year at Roosevelt Roads, Puerto Rico, to provide targets for the Atlantic Fleet, and at Naha, Okinawa, to operate with Navy and Marine units in the Far East.

Ryan's first electronics production line at its Torrance, California, plant went into operation during 1959, first turning out Model 114 ground velocity indicators for the Norden-Ketay Corp. as a vital unit of the Navy A3D Douglas Sky Warrior jet attack bombers. Assembly lines also were organized for the continuous wave APN-122 (V) Doppler automatic radar navigation equipment ordered by the Navy for use in six major types of planes in a \$20-million contract, the largest electronics order in Ryan history. First units to reach full production status in this contract—electronic control amplifiers—were delivered before mid-year.

Meanwhile, other large-scale contracts were received by the expanding Electronics Division, including \$5.3 million in business from Sikorsky Aircraft for APN/97 helicopter hovering and navigation sets. The Army ordered Model 120A electronic navigators for its new Grumman Mohawk turboprop observation plane in a contract for nearly \$3.5 million, and the Navy tested an application of the APN-122 (V) for its A4D Skyhawk carrier-based night attack jet bomber.

As Electronics Division personnel grew from 775 in January to more than 1,800 t year's end, physical plant facilities kept pace, with construction of an advanced test facility at the Kearny Mesa (San Diego) plant, containing more than \$300,000 worth of equipment in a certified environmental test laboratory. Other new facilities, including two free-standing reinforced concrete towers designed for development of antennas for Ryanav automatic navigation and guidance systems, were being constructed.

The flight test program of Ryan's revolutionary new VTOL Vertiplane for the Army continued at Moffett Field, California.

Disclosure was made in 1959 that Ryan built huge scrolls for the General Electric X-39 test engine which was tested with a nuclear reactor at the Atomic Energy Commission's site at Idaho Falls, Idaho.

Ryan stock was listed on the New York Stock Exchange for the first time September 1 after 19 years on the American Stock Exchange and 23 years on the Pacific Coast Stock Exchange.

Estimated business volume for the fiscal year 1959 was expected to approximate the near-record total of \$73,706,411 for the previous fiscal year.

SCHWEIZER AIRCRAFT CORPORATION

Schweizer Aircraft Corporation during 1959 produced complete Ag-Cat crop duster bi-planes for Grumman Aircraft & Engineering Corporation and began production on complete tail sections and ailerons of the Grumman Gulfstream G-159 executive type airplane.

The company also continued production of its line of sailplanes including the 1-26—including the 100th unit of this model—the 2-22C and the 1-23G. The prototype of the 1-23H, a modification of the 1-23G, also was built. Schweizer started work on a two place version of the light plane, the 1-30.

Schweizer had its biggest year in sailplane pilot instruction when nearly 300 students attended the Schweizer Soaring School. Commercial glider pilot licenses were given to more than 50 students, and private glider pilot licenses were earned by about 70 students.

For the first time since before World War II, the majority of manufacturing by Schweizer in 1959 was non-military. Also, the company continued production of magnetic booms for the Navy S2F; doors for Bell helicopters; and spare control surfaces for the Fairchild C-119 and C-123.

SIKORSKY AIRCRAFT DIVISION
UNITED AIRCRAFT CORPORATION

The first flights of two revolutionary new helicopters—the HSS-2, powered by twin gas turbine engines, and the S-60 flying crane—highlighted the year's activities at Sikorsky Aircraft.

The HSS-2, which has a flying boat hull and is being developed for the Navy as an anti-submarine warfare system, was flown publicly for the first time March 24. It is the Navy's first all-weather helicopter. The HSS-2 also gives the Navy its first helicopter that can both search out and destroy enemy submarines. Present fleet helicopters can perform only one of these functions during a single mission and still achieve maximum designed range.

The HSS-2 is in the weight class of a medium transport helicopter and can alight on and take off from water in an emergency. It also has the capability to take off, land or fly on a single engine at low gross weights, and is the first helicopter produced under the Navy's weapons system concept. The HSS-2 is the second Sikorsky turbocopter built with a boat hull. The first was the smaller S-62, powered by a single engine gas turbine, which was first flown in May, 1958. The Navy awarded $32 million in contracts to Sikorsky for development and manufacture of the HSS-2, and production was under way. Both the HSS-2 and S-62 are powered by General Electric T58-6 gas turbine engines.

The S-60 crane helicopter, a research vehicle built in cooperation with the Navy to demonstrate a new concept in direct lift aircraft, made its first public flight April 13. The S-60 is a literal "sky-hook." Instead of the conventional passenger or cargo cabin, the fuselage consists of a bridge-like boom extending from the cockpit to the tail rotor. A reversible seat enables the co-pilot to fly the helicopter from a rearward-facing position in which he has a clear view of the load at all times.

The crane is described as a "prime mover"—the aerial equivalent of railroad locomotives and truck tractors—and "a universal tactical and strategic vehicle." The S-60 prototype is intended to demonstrate the ease and efficiency with which an almost endless variety of loads—ranging from trucks and cement mixers to missiles and utility poles—can be carried externally by a hoist or from hard points.

The crane also frequently demonstrated an experimental "people pod" section—a 20-passenger, detachable structure suspended from the fuselage. Similar pods could be outfitted as communications centers, emergency hospitals and many other types of units.

The S-60 has two Pratt & Whitney Aircraft R-2800 piston engines. Future cranes will be powered by gas turbine engines.

The helicopter airlines also moved during the year to acquire aircraft powered by gas turbine engines. Los Angeles Airways and Chicago Helicopter Airways each announced that they had signed agreements to purchase Sikorsky S-61s. Los Angeles ordered five and Chicago six. The S-61 is a further development of the HSS-2 and will carry from 25 to 28 passengers. Deliveries were expected in 1960-1961.

Sikorsky S-58 sets huge power line poles.

Although Sikorsky Aircraft began production of turbine-powered helicopters with the HSS-2 and S-62, the company continued to produce its piston-powered S-55, S-56, and S-58 helicopters. The Navy awarded Sikorsky approximately $60 million dollars in contracts for further production of the Navy and Marine Corps versions of the S-58. The Coast Guard purchased six S-58s for search and rescue work. These were the first medium size transport helicopters obtained by the Coast Guard, which thus joined the Army, Navy and Marines in flying the S-58s.

The Army's twin-engine H-37 (Sikorsky S-56 also flown by the Marines as the HR2S-1) made its first appearance in Europe with the arrival there of the 4th Helicopter Transportation Company, an all H-37 unit.

The Federal German Republic (West Germany) ordered 25 S-58s. Including spare parts, the order had a value of $8.7 million. This will give West Germany a fleet of 51 S-58s.

Chicago Helicopter Airways purchased a sixth S-58, giving it the largest passenger fleet of the country's three helicopter passenger airlines.

The Puerto Rico Water Resources Authority purchased an S-58 for use in power line construction throughout the island. This was the first time a helicopter had been sold for such work. Once the technique was perfected, the helicopter set upwards of 50 poles in a single day. Puerto Rican officials said the $450 cost of setting a pole by conventional methods was slashed to approximately $130 through use of the helicopter.

President Eisenhower continued to be the world's most famous helicopter passenger, making frequent use of the Army and Marine versions of the S-58, both when in this country and in Europe. His guests on flights from the White House Lawn included Premier Nikita Khrushchev of Russia and former British Prime Minister Winston Churchill.

Sikorsky Aircraft embarked on an intensified and accelerated research program in all areas of direct lift aircraft. In addition to continuing its multi-million dollar research work in advancing the development of the helicopter, the company placed added emphasis on research into other concepts of VTOL and STOL. Advanced research personnel are looking ahead to the development of the type of vehicles that will meet the needs of modern military mobility, fast inter-city transportation and a wide variety of cargo-carrying and construction jobs.

The Sikorsky S-62 made an extended tour of Europe. It was demonstrated in France, Belgium, Denmark, Sweden, Norway, Germany, Switzerland, and Italy. Another S-62 demonstrator was taken to Japan, and from there will go to India and Australia.

The year marked the 20th anniversary of the first flight in the Western Hemisphere of a practical helicopter, which was Igor Sikorsky's VS-300. This also was the 50th year in aviation for Mr. Sikorsky, now 70 years old and retired engineering manager of the company. He continues in a very active role as consultant to the firm.

L. B. SMITH AIRCRAFT CORPORATION

The development and production of a newly designed executive version of the Douglas B-26, designated Tempo II, and the continuing emphasis on diversification of company operations, keynoted L. B. Smith Aircraft's 1959 activities.

Tempo II is the entry of L. B. Smith Aircraft Corporation into the advanced executive aircraft market. Designed to fill a gap between the many models of present business aircraft and the newest turbine powered models, the pressurized, high performance Tempo II was in production at L. B. Smith's Miami Facility.

For many years a leading conversion center for C-46 aircraft, the company, in 1958, received a supplemental type certificate certifying their new 60 passenger, 50,650 pound gross takeoff weight Smith-AEF Super 46-C for transport category. By mid 1959, L. B. Smith Aircraft had converted and delivered 26 of these aircraft for airline use throughout the world. More than 90 C-46s were converted through the use of kits, parts and components supplied by L. B. Smith Aircraft.

Early in 1959, L. B. Smith's production, overhaul and conversion capabilities were demonstrated when the company completed the production line overhaul of 14 Grumman built SA16, twin engine Albatross amphibians for the Brazilian Air Force, completing more than 100 technical orders on each. In addition 14 five man crews were trained in the operation and maintenance of the amphibians.

The overhaul and modification of 12 C-45H Beechcraft airplanes for the FAA became another production line project for the company later in the year.

Aerosmith Products, a division of L. B. Smith Aircraft Corporation, specializes in the design, engineering and manufacturing of business and commercial seats, galleys and lavatories. At the end of 1959, more than 67 airlines operating throughout the world were equipped with seats and galleys manufactured by Aerosmith. The division designed and produced passenger and crew seating for 34 of the 47 Fairchild F-27s delivered during 1959 for airline use.

A Plastic and Fiberglass Manufacturing Division was inaugurated in mid year; thus, L. B. Smith Aircraft became one of the few companies in the conversion field capable of designing and producing fiberglass and plastic products within its own shops.

Initial activities of the new division included development and production of the fiberglass seats used in the interior of the JetStar mock-up that was executed by L. B. Smith and shown at the NBAA show in October of 1959. Fiberglass production was begun on the seat-shells to be used in Tempo II. The new division produced radomes, spinners, air scoops and cabin accessories for the industry at large and for aircraft in L. B. Smith's own conversion shops.

Boeing B-52 fuselage section nears completion at Temco's Dallas plant.

Successful flights by test versions of the Corvus air-to-surface missile and substantial growth in electronics capabilities were among highlights of 1959.

Follow-on contracts and new business in the air-frame manufacturing areas kept activity at a high level in those fields.

First flight of the Corvus system came on July 18 at the Pacific Missile Range. The highly-successful first flight was the climax of an intensive research and development program by Temco, prime contractor on the new weapon.

Another Temco prime product, the TT-1 Pinto primary jet trainer, continued to score firsts in the Navy's pioneering all-jet training syllabus being evaluated at Saufley Field, Pensacola, Florida. First jet solo flights in Navy primary history occurred in March. In August, the first night solo flights were recorded, extending type of training given in primary.

Diversification of Temco products was accentuated during 1959 by creation of new divisions which mirrored growth of the company into new fields. By the end of 1961, Temco expected to have at least 50 percent of its sales in electronics and missiles. The new divisions are:

TEMCO MISSILES AND AIRCRAFT

This division has responsibility for major airframe subcontract work and for such prime products as the Corvus and the TT-1. Airframe production ranged in size from 58-foot aft fuselage sections of the Boeing B-52H to smaller missile and aircraft parts. Wings and ailerons were being manufactured for the Raytheon Hawk Army Missile, aft fuselage sections for McDonnell's F-101 Voodoo; wings for the Lockheed F-104; wings components for the Lockheed C-130 and Electra, and wings for the Lockheed P2V.

Metallurgical research programs, especially into metal-bonding techniques, resulted in new contracts. Components for the Boeing 707 and KC-135, the Convair B-58 escape capsule and the Bell Helicopter HU1-A were added, along with missile shipping and storage containers, rocket engine casings and other space-age metal work.

TEMCO ELECTRONICS

This division was making major contributions on classified programs of other divisions, including the Corvus missile, and was developing and producing electronic systems of its own design. One of the new products brought 10 separate contracts from military customers and offered possibilities for commercial sales. Systems under study were in the fields of automatic controls, instrumentation, radio frequency and antenna systems, radar devices.

TEMCO OVERHAUL AND AEROSYSTEMS

Major overhaul and modification contracts, along with classified electronics refitting of aircraft, caused employment to increase sharply at this division, located at Greenville, Texas. Work in progress included systematic maintenance of C-97s, IRAN (Inspect & Repair as Necessary) contracts on KC-97s, and modification and overhaul of C-121Gs, all for the Air Force. Follow-on contracts on this work totaling more than $10 million were announced in August. The division also was a member of a team, headed by Airborne Instruments Laboratory, for design and development of a classified airborne electronics system, and was engaged in other classified programs.

TEMCO INDUSTRIAL

This division was created in September primarily to utilize skilled men and the machinery not readily adaptable to new space-age programs. Because of the decline of airframe manufacturing, this division will fabricate metal and other products for commercial firms needing a southwestern facility.

FENSKE, FEDRICK & MILLER, INCORPORATED

This firm, an 80 percent owned subsidiary of Temco, was in production on the Iconorama, a multi-channel air and sea traffic plotting system which provides commanders with a graphic picture of combat situations almost instantaneously. Iconorama receives inputs from radar tracking networks and displays the information on a large screen or map in either two or three dimensions and in color. Contracts were signed with North American Air Defense Command and Strategic Air Command Headquarters for installation of the equipment. In addition, more than 20 other contracts were received for use of FF&M devices, including Iconorama, in various systems now under development.

THIOKOL CHEMICAL CORPORATION

Thiokol Chemical Corporation continued a rapid expansion of facilities and an increase in the number of missile propulsion systems which the company was furnishing prime contractors and the military services.

The Utah Division, which was established in 1957, was increased to a total of 85 buildings with 2500 employees. The first and second stages of the Minuteman were being developed at this division, as well as large rocket motors for some of the other space programs.

Approximately $7.5 million in facility expansion was completed this year at the Longhorn Division to enable production of large rocket motors for the Army's missile program. These included motors for the Nike Hercules, Lacrosse and Sergeant, as well as the possibility of propulsion system for the Pershing.

A new rocket engine production plant was staffed and equipped adjacent to the Bristol Headquarters for the production of the Navy's new concept of liquid rocket engines. Engines in production at this plant were for the Sparrow III and Bullpup systems.

Thiokol's Elkton Division was actively engaged in production of Recruit, Cajun, Subroc and space engines for the NASA space programs.

New activities evidenced in the Specialties Division included the development for Stanley Aircraft of escape capsules for the B-58 supersonic bomber.

Lacrosse uses Thiokol rocket engine.

Delivery was made by the Reaction Motors Division of Thiokol of the XLR99-RM-1 engine for North American's X-15 project. Successful flights were made during 1959 for the smaller XLR11 engine with the large engine flight scheduled for the early part of 1960. The Reaction Motors Division also completed delivery of the engine for the Navy's Corvus missile.

The Chemical Division expanded its Research and Development facilities at Trenton with the addition of new laboratory and chemical processing equipment. The company was producing urethane, as well as polysulfide liquid polymer, crudes and rubber chemicals.

Thiokol was operating four solid propellant rocket engine plants; two company owned and operated at Brigham City, Utah, and Elkton, Maryland, and two Government owned, operated under contract at the Redstone Arsenal and Longhorn Ordnance Works.

TRANSLAND AIRCRAFT

Transland, a division of Hi-Shear Rivet Tool Company, continued during 1959 as a supplier of aerial applicating equipment to the agricultural aviation industry, and was active in further design and development of the Ag-2 agricultural airplane.

The Ag-2 underwent a series of tests at the Department of Agriculture Research Station, Forest Grove, Oregon, and another series of field tests at Bakersfield, California, during the year. Transland was evaluating several manufacturing proposals which would place the Ag-2 in volume production during 1960.

UMBAUGH AIRCRAFT CORPORATION

During 1959, Umbaugh Aircraft Corporation completed flight tests on a single place model and made the decision to continue designs and prototype building of a two-place aircraft to be known as the Umbaugh-18.

Production was scheduled to start in October at the Fairchild Engine and Airplane Corporation Plant, Hagerstown, Maryland. Fairchild subcontracted to manufacture the Umbaugh-18.

Ray Umbaugh, president of the Umbaugh Aircraft Corporation, reported that even before the start of production 5,000 firm orders had been placed. Initial schedules call for 10,000 aircraft to be completed during 1960-61.

The Umbaugh-18 is a two-place rotary-wing aircraft that can take off and land vertically. It is a low cost personal transport selling for $9,995, and operation and maintenance costs are approximately six cents a mile when the aircraft is flown 300 hours a year.

Umbaugh appointed a number of distributors and dealers both in the U. S. and overseas. More appointments were to be made later.

The plane, which cannot spin or stall, has many potential uses in the industrial, agricultural, marine and transportation fields. It can be converted for dusting, spraying or cargo and also can be fitted with floats.

UNITED AIRCRAFT CORPORATION

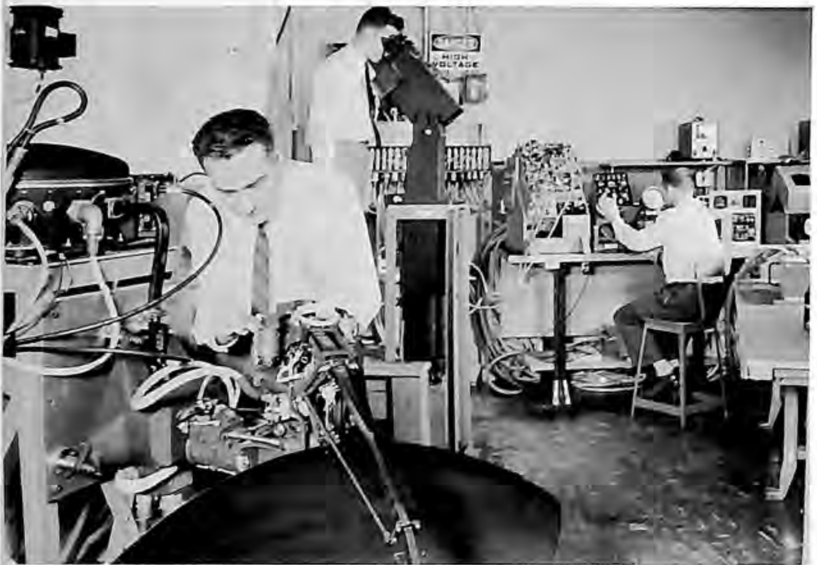
United Aircraft Corporation continued to broaden its flight dimensions in 1959 with an accelerated program of research, development, and expansion.

The corporation announced in July that it is spending $68 million to enlarge and modernize production and experimental facilities. All four operating divisions of United—Pratt & Whitney Aircraft, aircraft and rocket engines; Hamilton Standard, propellers and modern missile and turbine accessories; Sikorsky Aircraft, helicopters; and Norden, electronic guidance and navigation equipment —are included in this program as well as the Missiles & Space Systems division, United's Research Laboratories in East Hartford, and United Research Corporation of Menlo Park, a wholly-owned California subsidiary.

Because each division functions autonomously, reports of the company's technical and manufacturing activities for 1959 are found under the names of the individual divisions.

In June, United Aircraft Corporation was selected as the contractor for a new high-speed automatic aviation weather service designed to provide a national system for the combined use of military and civil aviation. United was working with a team of seven associate companies to establish a test facility which will include a data processing center and nine stations along the Atlantic Coast. The basic task is to integrate available equipment and techniques into a single system, called Weather Observing and Forecasting System 433L. The system can eventually be expanded into a common national weather system and a global Air Force weather system.

United Research Corporation of Menlo Park, working in the fields of aircraft and spacecraft with initial interest and priority in advanced propellants, planned to construct a new development and test facility in California. This facility and others, including two new major plants for Norden, one in



Norden's bomb director systems.

Norwalk, Connecticut, and another in Orange County, California, will be company financed.

A high level of development and production during 1959 was maintained by United Aircraft's divisions. In 1958, the last year for which figures are available, United Aircraft reported a net income of $42,294,728 on sales totaling $1,200,427,387. Total current assets at December 31, 1958, amounted to $334,684,568, compared to total current liabilities of $187,038,883 at that date. Contracts, orders, and government letters of intent at December 31, 1958, amounted to $1.4 billion. The corporation's employment at October 1, 1959, stood at approximately 55,000.

MISSILES & SPACE SYSTEMS DIVISION

Missiles & Space Systems, the only non-manufacturing division of United Aircraft Corporation, was engaged in a number of military studies and designs for the Air Force and Navy. The establishment of the division in July, 1958, followed several years of research conducted in the technologies related to the missile program.

The technical staff of Missiles & Space Systems comprised about 80 percent of the division's personnel, with specialists in virtually all of the technologies involved in the missile and space programs. This division's efforts were devoted to the system management concept, using the capabilities of the other divisions of the corporation, as well as outside firms, for production.

Missiles & Space Systems, with headquarters in East Hartford, Connecticut, has grown steadily from a nucleus of technical personnel assigned to the division when it was founded, to an organization of more than 200 people. Expansion of the technical staff was continuing.

HAMILTON STANDARD DIVISION

Hamilton Standard during 1959 expanded its product diversification program into new fields, including ground support and electronics. Separate departments were established within the company for these groups. Meanwhile, production of aircraft equipment and propellers continued.

The field of environmental conditioning was particularly active during the year and was marked by the receipt of contracts to provide the systems for the North American B-70 and Lockheed JetStar. The system for the North American aircraft will represent the most advanced system in the free world. It will be the follow-on to the modern systems now being produced for Mach 2 aircraft such as the Lockheed F-104, Republic F-105, Chance Vought F8U-1, Convair F-106 and Convair B-58—all of which use Hamilton Standard systems. In the commercial field, the air conditioning and pressurization system for the Convair 880 continued in production and performed satisfactorily during the flight test program.

Engine control deliveries continued in substantial volume during the year, with controls for the Pratt & Whitney Aircraft JT3 and JT4 leading the list. Hamilton Standard main controls were on all commercial P&WA engines and the reliability of these units was proven by the outstanding service record of the Boeing 707 series and the Douglas DC-8 aircraft. Other engines using Hamilton Standard controls included the military Pratt & Whitney Aircraft J57, J75, J52, and J58; General Electric J79, Continental J69, and among the smaller turbines, the General Electric T58 and Lycoming T55.

The company was awarded a contract for development and production of the air inlet control for the North American B-70 bomber. This control, which will regulate the flow of air into the engines of this 2000 miles-per-hour bomber, will be the most sophisticated of its type yet developed.

Deliveries of advanced fuel-air and pneumatic starters continued during 1959, with the pneumatic types for the Convair B-58 and Boeing B-52 and the fuel-air type for the Convair F-106 reaching a high point in production. The USAF Thunderbird flight demonstration team retrofitted its F-100 aircraft with Hamilton Standard fuel-air starters during 1959 and, within six months, had put over 1000 starts on its aircraft without missing a performance. In addition, the team obtained tactical mobility and independence of ground operation.

In the hydraulic pump field, deliveries continued on the radial piston types for the Convair 880 and B-58. Meanwhile, development was completed on a knee-type axial piston pump which was qualified and moved into prototype production near the end of the year.

Hamilton Standard entered the field of cryogenics during 1959 with the development of a small cooler for infrared detector cells. The system represented a major advance in the field permitting the cells to be cooled to as low as minus 350 degrees for greater efficiency and sensitivity.

The ground support equipment department formed earlier in the year, succeeded in acquiring several production contracts during 1959. These contracts included a motor to impart spin to the Little John rocket prior to launching; a periscope-type probe for the inspection of the barrels of artillery pieces; electrical check-out carts and mobile ground air conditioning carts.

In electronics, the production of helicopter flight controls continued, as did production of a constant speed device for helicopter engines. Also temperature controls were in production for the North American T-39 and B-70, Grumman A2F, Convair 880 and Grumman YAO-1. In prototype production were a take-off monitor for jet aircraft and static inverters for aircraft and missiles. A printed circuit facility was organized and began operation. Several contracts had been received at the end of the year.

In the propeller field, production continued on the 54H60 model for the Lockheed Electra and C-103B, and the 53C51 for the Grumman AO-1. These aircraft were flown extensively during the year and the Hamilton Standard propellers were performing up to all expectations. Limited production continued on propellers for the Douglas DC-6 and DC-7, Lockheed Constellation and other piston-engined aircraft.

Hamilton Standard's overhaul and repair department, organized two years earlier, made rapid strides during 1959. A contract for the overhaul of propellers for the Air Force's KC-97 tanker was undertaken during the year. Several other contracts for the overhaul of both Hamilton Standard products and the products of other manufacturers were received during 1959.

NORDEN DIVISION

Progress in advanced product development, increased production of widely-accepted electronic components and further consolidation and extension into new facilities marked the past year's activities of United Aircraft's Norden division.

On September 17, the division announced it had acquired an 80-acre tract in Norwalk, Connecticut, where it is building a new, multi-million dollar engineering-research and manufacturing facility. Construction of the new building, which will house operations now carried on in plants and laboratories at Milford and Stamford, Connecticut, and White Plains, New York, began October 23. Completion was scheduled for the early fall of 1960.

Norden also was negotiating for approximately 45 acres in California's Orange County to accommodate research, development and manufacturing operations it now has in Gardena, California. A new, 50,000-square-foot plant was contemplated which will replace the present leased facilities at Gardena. Norden will continue its development and manufacture of rotating components at its modern plant and office facilities at Commack, Long Island, New York.

Among the achievements of Norden in 1959 was the development and manufacture of a unique electronic vote tallying system for Los Angeles County, to be delivered for use in the county's 1960 election. The system uses mark sensing principles and is designed to bring about substantial savings in election costs by removing the burden of tallying votes from precinct workers, reducing the number of precincts needed, and by providing earlier election returns. The system's large ballot handler tabulates and sorts all sizes at rates of more than 600 a minute.

Also in the mark sensing field, the division was developing for the Educational Testing Service, Princeton, New Jersey, an automatic scoring machine capable of grading more than 20 different, randomly-mixed college entrance examinations at the rate of 6,000 an hour.

The APQ-71 bombing radar was delivered to the Navy during 1959 for flight evaluation, and two Air Force projects were completed: the APQ-70 radar ceilometer and a photographic overlap computer. The bombing radar is a variable sector-scanning type of antenna. The photographic 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.

Developments in Norden's industrial control program resulted in two numerical positioning systems for controlling machine tool operations such as drilling, reaming and milling. Although initially designed to control individual machine tool operations, the basic techniques developed by the division can be used to automate complete production lines of automatic machines in a variety of industries.

In 1959, Norden also completed and tested prototype models of its miniature all-attitude inertial platform. This provides a basic module around which a diverse line of guidance, navigation and attitude control systems will be built for missile, aircraft and drone applications.

Other developments included a unique method for acquiring and presenting terrain clearance information which enables all-weather operation of aircraft. For industrial and military applications, a small fully-transistorized and self-contained television camera was developed and evaluated. Also engineered and developed was a cathode-ray display (contact analog) which presents coordinated information in symbolic form (pathways, speed markers, compass-oriented grids). This device provides a submarine's helmsman with command and situation information and is applicable to aircraft and helicopters.

Also in 1959, Norden note increased production and usage of its line of components, including analog-digital-converters, synchros, potentiometers, resolvers, tachometers, and gyros. Many of these units are important parts of the guidance systems of today's jet aircraft and missiles. Increased engineering effort resulted in new components which are more precise and smaller and designed to meet more stringent environmental conditions.

VANGUARD AIR AND MARINE CORPORATION

Vanguard Air and Marine Corp. was formed in February, 1958, to do research and development in the field of vertical lift aircraft. Work on the first development continued through early 1959 and culminated in the testing of the Vanguard "Omniplane." This airplane, the so-called "fan-in-wing" type, was developed at company expense to provide a full scale flying test bed for future development of the fan-in-wing VTOL airplane concept.

The basic features of the Vanguard fan-in-wing type aircraft are the installation of two horizontal ducted rotors laterally disposed inside a low aspect ratio wing and the closures on top and bottom of the ducts which convert the ducted rotors into wings for high speed forward flight. In addition, a ducted pusher propeller is used providing forward propulsion as well as airflow over the tail surfaces to give pitch and yaw control during low speed or hovering flight. In August, a ground and full scale wind tunnel test program on the Omniplane was started under the sponsorship of the Air Force's Air Research and Development Command. The full scale wind tunnel tests were scheduled at the Ames Research Laboratory of the NASA.

Work was started on a four-place executive VTOL airplane for the commercial market and plans were being made for the design of a 40 passenger Short Haul Transport version.

VERTOL AIRCRAFT CORPORATION

During 1959 Vertol Aircraft Corporation began engineering and production activities on more advanced versions of its multi-turbine powered Model 107, expanded its scope of interests in VTOL/STOL aircraft designs, more firmly established the company's total capabilities in the general products field and intensified its efforts in the international markets.

In March, the Army announced that Vertol had been selected to build its new two- to three-ton capacity transport helicopter, designated the YHC-1B "Chinook." This aircraft, which followed the functional design concepts of the company-developed Vertol Model 107, eventually will replace all the Army's "obsolescent piston-powered transport helicopters." By mid-year, engineering and tooling for the production of an initial quantity of these aircraft was underway, with roll-out for the first Chinook scheduled in the fall of 1960.

In May, Vertol introduced the Vertol 107 Model II multi-turbine powered commercial helicopter and later in the year New York Airways signed an option agreement for the right to purchase the first five airline versions of this aircraft to be produced by the company. The Model II, equipped to carry 25 passengers, will be available in early 1961.

August 27 marked the first flight of the Army YHC-1A light tactical transport at the Vertol plant in Morton. A service test quantity of this 1½-ton payload version of the Model 107 was originally ordered by the Army in July, 1958.

A practical demonstration of battlefield mobility using the light tactical transport was conducted at Aberdeen Proving Ground, early in October. The Vertol Model 107, prototype for the YHC-1A (and YHC-1B) carried an entire Little John weapon system internally, unloading the crew and its

Vertol 107 delivers Little John rocket and crew to firing position.

weapon at a pre-arranged firing site. The entire operation from unloading, through firing the rocket and redeploying the crew, took 11 minutes and 27 seconds. This demonstration was the climax to several months of touring, for the Model 107 prototype. Beginning with the Salon L'Aeronautique, in Paris, in June, the twin-turbine powered transport covered 2,500 miles in ten weeks, visiting key military and commercial operation bases in northern Europe. During its tour, the tandem-rotored Model 107 partly demonstrated the newest concepts of multiturbine powered helicopter transports, which embody high performance, quietness in flight, lower vibration levels and functional design features applicable to a wide range of military and civil transport missions.

Along with continuing flight test programs of the Vertol 76 (Army VZ-2) tilt-wing VTOL aircraft in cooperation with the National Aeronautics and Space Administration, Vertol expanded its activities and interests in the broad field of VTOL and STOL aircraft. Wind-tunnel and design studies were underway to evaluate the feasibility of such principles as unloaded rotor, ducted fan and ground effect. During the American Helicopter Society Forum, held in May 1959, Vertol's engineering staff was presented the Grover E. Bell Award, in recognition of its achievements with the Vertol 76 tilt-wing VTOL.

The company's diversification program, begun two years ago, continued to expand and strengthen the product base. In October, it was announced that 21 separate contracts, covering diverse fields, had added more than $3.5 million to Vertol's sales volume during the past two years. Included in its general products programs were production of components for the Army's Hawk missile system and a 50-ton, 104-foot long radar antenna for a new USAF early warning system.

Allied Research Associates, Inc., wholly-owned subsidiary of Vertol, continued to expand its activities during 1959. The number of personnel increased by 20 percent bringing the total of 226 of which over 50 percent were of the professional level. Sales increased approximately 20 percent. Programs underway at this basic research engineering organization were in such areas as GLIPAR (Guide Line Identification Program for Anti-Missile Research), which is part of Project Defender being conducted for ARPA; development of a system to interpret data transmitted from meteorological satellites, development of a new concept in vibration isolation for gyroscopes and other delicate navigation equipment.

With an increasing interest in helicopters being actively pursued by both the government and military services in Canada, initial steps were taken to expand Vertol's subsidiary company. In line with this, the name of the Company was changed to Canadian Vertol Aircraft, Ltd., in October.

Vertol sales of $29,568,110 for the first nine months of 1959 were closely comparable to 1958 sales of $29,668,815 for the same period. Net earnings for the first nine months of 1959 were $109,558 compared to $345,711 for the same period of 1958. These lower earnings reflect a loss of $248,625 for the third quarter which is the result of non-recurring special charges amounting to $659,000 before taxes. Earnings for the remainder of 1959 were expected to return to the level experienced during the first half of the year. Backlog of business as of September 30, 1959 was $29 million.

WESTERN ELECTRIC COMPANY

During 1959 the Western Electric Company continued to play a major role in security projects. The armed forces called upon the company to fulfill major national defense responsibilities on the basis of the unique abilities developed by Western Electric in doing its job in the telephone industry, and on the strength of its past performance in accomplishing highly technical, complex projects encompassing a broad scope and involving large-scale operations. It was estimated that Government sales would be approximately $650 million.

Continuing its work in the guided missile field, Western Electric performed considerable work toward the mechanization of products for the Nike-Zeus system, the latest member of the Nike family. Much of this work involved development of new transistors and deposited carbon resistors.

The latest addition to the "family," the Nike-Zeus anti-missile missile system, was in active development. Bell Telephone Laboratories was assigned the research, development and design responsibilities for the system whose objective will be to intercept and destroy invading intercontinental ballistic missiles. Western Electric Company, the manufacturing and supply arm of the American Telephone and Telegraph Company, was to continue as the prime contractor for the research and development of this anti-missile device.

In addition to the Nike work, activity continued on a number of important projects for the Army, Navy and Air Force. These projects included data transmission systems, weapons direction equipment, underwater sound operations, guidance systems for ground-based Terrier missile and the Titan intercontinental ballistic missile.

During 1959, Western Electric continued to play a key role as the prime contractor for the communications system of the BMEWS project. This Ballistic Missile Early Warning System involved Western Electric in the fields of design, installation, and testing. This system, as the name implies, is an electronic system providing detection and early warning of attack from enemy intercontinental ballistic missiles.

In May 1959, the company completed the Aleutian Extension of the DEW Line, the westward segment of the communication and warning facilities of the Distant Early Warning Line. Work continued on the eastern segment, DEW East, which will extend the chain of radar warning stations to Iceland, 1200 miles east of the terminal on Baffin Island in Canada. As an adjunct to the Early Warning System, Western Electric was awarded a contract to design and install a communications network in support of the Air Force facilities in the Aleutians. This project called for greater spacing between stations and will require advances in the state of the art of "forward propogation tropospheric scatter" radio techniques, so called because the radio waves are reflected off the troposhpere. This network will expand existing communications facilities in the completed Aleutian extension, and also in the Alaskan White Alice communications system.

Other government communications projects included the coordination of work for the SAGE system of continental air defense, engineering and implementation projects under BMEWS in connection with Operation Polevault, communication and testing for TEXAS TOWERS and a contract for an Army communications system which will involve a world-wide network.

WESTINGHOUSE ELECTRIC CORPORATION

During 1959, Westinghouse Electric Corporation continued to expand its activities in fields relating to the aircraft and missile industry. New advanced-technology groups, new products and new systems were developed to satisfy the rapidly-changing requirements for electrical and electronic equipment.

Plans were announced for the creation of a centralized research and development center in the Pittsburgh, Pennsylvania, metropolitan area. The center will bring together on a single site in Churchill Borough, 10 miles from downtown Pittsburgh, all the key personnel associated with the company's broad centralized program of basic and applied research. Ground was to be broken early in 1960 for two new buildings to be constructed on the 100-acre site now occupied by the Westinghouse research laboratories. Full occupancy of the facilities was scheduled for 1961. The Westinghouse materials laboratories, the new products laboratories, the manufacturing planning and controls laboratories and the patent department will join with the research laboratories to make up the new research and development center. An estimated 1750 scientists, engineers and supporting personnel will occupy

Westinghouse Helisphere, radar antenna.

the center. The new center will comprise a total of 712,000 square feet of floor space and will contain some 450 individual scientific laboratories. In addition, 35 general service functions that support the work of the scientists and engineers will be combined and housed on the site.

A new space technology section was formed in the aircraft equipment department of Westinghouse in Lima, Ohio. The space technology section will be responsible for the development of advanced electrical systems. These systems may include special auxiliary power units which can be powered by turbine, nuclear or solar means. This section will also have the responsibility for devices and other products for flight vehicles associated with the space age.

An astronuclear laboratory where scientists will undertake the development of nuclear energy for outer space was also announced by Westinghouse. The laboratory will be located in the Pittsburgh, Pennsylvania district and will be part of a new Westinghouse atomic power division. This division does not include the Bettis Atomic Power Laboratory of the U.S. Atomic Energy Commission which is operated by Westinghouse.

An important forward step in the development of thermoelectric materials for the direct conversion of heat into electricity at high temperatures was made by scientists at the Westinghouse research laboratories in Pittsburgh. They developed a thermoelectric material—the most efficient of its type yet discovered—for use in the temperature range from 850 to 1500 degrees Fahrenheit. This top temperature is well above the melting point of aluminum, magnesium and many common thermoelectric materials. Development of the new material fills a gap in the substances which up to now have been available for thermoelectric power generation. It was expected to find immediate use in thermoelectric devices operating at temperatures well above those previously considered practical.

Also during 1959, engineers from Westinghouse and Boeing unveiled a space age thermoelectric generator.

The operable thermoelectric generator which, by itself, weighs three pounds and measures 20 inches in length, is capable of converting the energy of the sun into 2.5 watts of power—enough to operate a radio transmitter broadcasting a strong signal back to earth.

A sun powered thermoelectric unit shows considerable merit as a source of auxiliary power for space missions that may take months or even years to complete.

A thermoelectric generator at least ten times larger in electrical output than any similar device ever constructed in the United States was built by Westinghouse. The new 100-watt generator is known as TAP-100 (terrestrial auxiliary power, 100 watts). It represents major progress in the search for compact power sources required for remote sites.

The generator was developed for the Air Research and Development Command (ARDC). Westinghouse efforts were sponsored by ARDC's Rome Air Development Center, Griffiss Air Force Base, Rome, New York.

About the size of a medicine ball and weighing 40 pounds, the Westinghouse TAP-100 generator delivers three times as much power per pound of weight as any previously announced generator, and it transfers into a comparatively large-scale device the advantages of thermoelectric power generation previously attained only in smaller units. TAP-100 operates at a temperature of 850 degrees Fahrenheit —higher than the melting point of zinc.

Westinghouse scientists were also developing an advanced version of TAP-100 which will be fired by nuclear fuel in the form of an efficient, long-lived radioactive isotope.

In the field of "molecular electronics" a $2 million development contract was awarded to Westinghouse. The contract was issued by ARDC's Wright Air Development center as part of a broad program effort in this new electronic area.

TAP-100 themoelectric generator.

The Westinghouse development centers on a revolutionary method of "growing" germanium crystals as thin, uniform, flat ribbons instead of round ingots. Research results indicated that the new method may lead to the development of outer-space electronic equipment 1,000 times smaller and lighter than anything now in existence. Westinghouse air arm division in Baltimore has management responsibility.

New Westinghouse semiconductor products for aircraft and missile applications included a series of light-weight high-power silicon rectifiers (Type-300). They are available in nine peak-inverse-voltage ratings ranging from 50 to 500 volts. The hermetically-sealed cells can be used to provide up to 70 amperes of forward direct current.

The high-current units weigh less than three ounces. They feature rugged ability to operate in high ambient temperatures—up to 190 degrees C junction.

The Army Signal Supply Agency, Fort Monmouth, New Jersey, awarded the Westinghouse electronic tube division, Elmira, New York, a research and development contract for a receiving tube envelope capable of operating with an ambient temperature of 932 degrees F.

The program consists of evaluating the ability of PYROCERAM—one of Corning's crystalline materials made from glass—to maintain a high vacuum even when operating at such elevated temperatures. The study will include the ability of the material to perform satisfactorily at high temperatures, as well as methods and materials for joining and means for making electrical connections to electrodes inside the envelope.

A new Westinghouse product was the "Permachon"—a small size pickup-storage tube for high resolution, long-storage continuous-readout applications.

Called the WX-3989, it has optical pickup capabilities comparable to a vidicon and will operate in a standard vidicon camera. It incorporates a new storage material which will retain a stored charge pattern while it is scanned by an electron beam. Resolution of the stored image is exceptional. This tube will store an image written either optically or electrically, then scan out the image many times without significant degradation.

Another tube available is a new high-power triode, type WL-7413, for radar pulse modulator service. It is capable of handling eight megawatts of peak power. The tube, which requires only 40 kw of peak driving power, can be used without a high-power pulse transformer because of its 50-kv plate voltage.

A light image intensifier tube, Type WL-7257, was another new product developed by Westinghouse. Light images at levels as low as 10^{-7} foot-candles can be intensified over 1000 times.

A new seven-inch-diameter nine-pin display tube (Type 7AUP4) designed for airborne and monitor applications features a small ⅞-inch-diameter neck for decreased deflection power. The over-all length of the tube is 8⅜ inches and is of the electrostatic focus, magnetic-deflection type. Deflection angle of the 7AUP4 is 70 degrees.

For radar applications, a new high-resolution low-video-drive cathode ray tube (WX-3798) for use with transistorized video amplifiers was developed by Westinghouse. Drive requirement for the WX-3798 is from five to ten volts for peak brightness, as compared to 35 to 40 volts required for conventional tubes. The new tube produces a scanning line of only 0.0015 inches wide. Video bandwidths up to 20 megacycles can be achieved.

A family of three new radar display tubes, Types 10WP7A, 10KP7B and 12ABP7A was being produced.

The 10KP7B is a 10-inch magnetic-focus, magnetic-deflection, long persistence radar display tube of round-glass construction. This tube features a metal backed screen to improve light output, prevent ion spot blemish, and reduce undesirable screen charging. The faceplate is made of neutral gray glass to minimize reflections and improve contrast. In addition, the tube employs an improved resolution electron gun.

The 10WP7A has an aluminized screen for increased brightness and has a no-ion-trap gun. The gun features improved resolution capabilities.

Employing a low-voltage electrostatic focus giving high definition, the 12ABP7A is a 12-inch round display tube which has a metal backed screen for improved contrast and greater light output. This tube employs a low-voltage electrostatic focus gun having high definition. The faceplate is of gray-filter glass.

A new search radar developed for the Navy by Westinghouse departs from previous radar designs in that it is crystal controlled, thereby achieving extremely high stability. Also, instead of the usual rectangular pulse, a shaped pulse was designed to decrease the required bandwidth for operation: this allows the high-power system to work in crowded environments without interfering with other electronic devices. To simplify maintenance, the necessary testing equipment is built into the unit.

Also, in the radar field, a new magnetic-core memory system with extreme speed was being developed for a computer system that will be used in a target-sorting capacity for airborne radar operation.

Development of an airborne device, called a polarization switch that will filter out radar images of storms and heavy clouds and thus permit all-weather jet interceptor pilots to see their targets more clearly was announced by Westinghouse.

The development will increase radar range between five and ten times the present maximum in storms. This is possible because it eliminates much of the "clutter" on the radar scope reflected from storms and clouds. Thus, the radar signal bouncing back from the target aircraft shows up proportionately better.

A computer that was originally developed for improving radar operation was also made an aircraft navigational aid by Westinghouse. In a moving aircraft, the radar signal frequency hitting the ground is changed due to Doppler effect, and shows up in the radar system as unwanted noise, or "clutter."

A computer was designed to constantly determine the approximate ground speed from air speed, wind speed and direction, and trigonometry. Then, knowing the approximate ground speed, the computer calculates the clutter frequency and filters it out for improved radar reception.

The new application of this computer is to use the clutter frequency's Doppler effect to compute the actual ground speed. Hence, the total system uses the airborne fire-control radar for both Doppler navigation and fire control.

Another Westinghouse Electric Corporation computer under development will be a hybrid of two basic computing techniques, digital and analog. The standard analog computer uses one element to perform a single function in a fixed-wired design; digital computers on the other hand use only one basic arithmetic unit, with some elements for adding, others for multiplying. Consequently, the digital computer has considerable flexibility, and need be merely programmed to handle all types of problems.

Design engineers were also finishing work on an analog computor that will also be programmed. The computer will accept inputs in analog form, be directed to a basic arithmetic unit that can add, multiply, etc., as instructed; the outputs are in analog form, ready for use in the system. Errors per operation are only about one-tenth of one percent, and the computer will operate in ambient temperatures from minus 55 to plus 100 degrees C. An immediate application for the new computer is in Westinghouse track-while-scan radar equipment, where multiple targets are involved.

A new radar antenna that may be the forerunner of antennas for powerful, long-range, antimissile radars of the future was announced. An important characteristic of the antenna—known as a Helisphere—is that it scans the sky throughout a complete circle without any motion of the antenna structure itself. In contrast, a conventional radar antenna must rotate continually as it sweeps the sky in search of flying aircraft. In addition, the Helisphere antenna is extremely effective in concentrating high-frequency radar waves into an intense, narrow, moving beam.

Experimental versions of the Helisphere included both rigid and inflated balloon-shaped models. The inflated version offers the additional advantage of a large structure that is light in weight, portable, and quickly and easily erected.

The Corporation's Air Arm Division in Baltimore was developing a defensive system for the Air Force B-70 Valkyrie. The system will act as an electronic shield to protect the intercontinental bomber from enemy attack. Award of the multi-million dollar contract was announced jointly by North American Aviation, Inc., B-70 weapon system contractor, and Westinghouse.

The defensive system will make use of electromagnetic and other techniques to make it difficult if not impossible for enemy aircraft or missiles to successfully attack the B-70. This system with its advanced technical developments will greatly increase the manned aircraft's capacity of self-defense.

The Westinghouse aircraft equipment department in Lima, Ohio was awarded a production contract approximating $11 million to manufacture electrical power generating systems for the Air Force B-58 Hustler. The contract was awarded by Convair Division of General Dynamics Corporation, prime contractor for the B-58. Delivery of the power systems was scheduled for completion in 1960.

The contract also included responsibility for supplying spare equipment, training of personnel and other phases in support of the B-58 program.

For the Lockheed Jetstar, Westinghouse received a $250,000 order for static inverters using silicon transistors. These units are each rated at 3 kva.

A new model of the J34 jet engine was being produced. Designated the J34-WE-48, the "hot end" of the engine is a basically new design and features a single-stage turbine. Each of the seven previous J34 models used a two-stage turbine.

The single-stage turbine engine has fewer parts, weighs less, operates at increased speed, and provides easier access for maintenance service. It also has improved heat distribution for higher operating temperature possibilities, a greater potential for extended periods between overhauls, and better reliability and durability. The Navy Bureau of Aeronautics officially approved the new model for production after the engine had undergone almost 1600 hours of tests, including in-flight tests and a 150-hour military qualification test. The J34 jet engine is used to power the T2J "Buckeye" jet trainer aircraft being built by North American Aviation in Columbus, Ohio. The T2J was being used for training Navy instructors at Pensacola, Florida, and Memphis, Tennessee.

Westinghouse received an $11,355,000 order for production of the new-model engine through August of 1961. It will become effective on completion of an existing Bureau of Aeronautics production contract. Another contract for $4.8-million covered an engineering development program on turbojets at the Westinghouse plant.

New orders totaling over $7.5 million for jet engine spare parts for the Navy were also received by Westinghouse. The orders cover additional parts to support flight operations of the Westinghouse J34 turbojet engine. Parts will be made at the company's Kansas City plant and shipped to Naval air stations at Pensacola, Florida, and Patuxent River, Maryland. Various quantities of some 160 individual spare parts and subassemblies were included in the orders. Shipments were to be on a monthly quota basis throughout 1960.

Goodyear Aircraft Corporation awarded contracts totaling almost $1-million to Westinghouse for electrical equipment to power and guide Atlas missile erectors. A control system makes it possible to store the missile horizontally and erect it to a firing position in two minutes at the push of a single button.

An additional $5,250,000 order was awarded Westinghouse under a Navy contract for initial work on launching systems equipping four nuclear-powered submarines to fire the ballistic missile Polaris. These four craft, belonging to the Navy's second generation of Polaris submarines, are the Ethan Allen, Sam Houston, Thomas A. Edison and John Marshall.

This order brought to approximately $45-million the total Navy awards to Westinghouse for the development and production of Polaris launchers. In addition to the four Polaris submarines of the latest class, these contracts included funds for handling and launching equipment in the first five Polaris submarines – The George Washington, Patrick Henry, Theodore Roosevelt, Robert E. Lee and Abraham Lincoln.

Test launchers were built at Westinghouse Electric Corporation's Sunnyvale division for underwater, surface and land-based launchings. Using compressed gas, the underwater test launchers ejected dummy missiles successfully many times from beneath the waters off the southern California coast at San Clemente. On August 27, 1959, the Navy announced that a Polaris test rocket had been fired successfully from a surface ship off Cape Canaveral, Florida.

The Westinghouse Sunnyvale division held the prime Navy contract for the Polaris Launching and handling system. Lockheed Missiles and Space division in Sunnyvale is Polaris missile system manager.

The nation's second missile-firing nuclear submarine, the Patrick Henry, was launched on September 22 from the shipyards of Electric Boat Division, General Dynamics Corporation, Groton, Connecticut.

The Patrick Henry will be powered by an atomic reactor similar to other Westinghouse-designed nuclear reactors which have driven Navy atomic submarines to new speed records and which made possible voyages beneath the North Pole.

The Westinghouse air arm division in Baltimore, Maryland, was awarded a contract for more than $10-million to build additional terminal guidance systems for the Bomarc area defense missile. Production of additional target seekers was to run through 1960 on the basis of existing contracts and the new award from the Boeing Airplane Company, prime contractor to the Air Force for the supersonic ground-to-air missile.

This brought the total value of Bomarc contracts awarded to the air arm division to approximately $60-million. The air arm division was manufacturing terminal guidance systems for the BOMARC IM-99 in production quantities. Westinghouse also was working on a development contract from Boeing for a terminal guidance for the advanced IM-99 which will have increased capacities.

SYSTEMS AND COMPONENTS MANUFACTURERS

Main plant of Aeronca shows new brazing facility (left) completed in 1959.

AERONCA MANUFACTURING CORPORATION

Aeronca Manufacturing Corporation had an eventful year in 1959. It expanded its facilities at Middletown and merged with Longren Aircraft Corporation creating the Aerocal Division for all West Coast activities. The former Baltimore Division was reorganized, adding many outstanding scientists and executives in the field of space science.

During the year the company achieved a leading position in the field of production of brazed honeycomb structures and the development and production of other high-temperature structures.

Aeronca completed over 62,500 square feet of manufacturing floor splace to provide a completely integrated facility for the manufacture of brazed honeycomb structures. This facility houses some of the largest, most modern furnaces and supporting equipment in the industry, including a completely original process for inspection and test of large and complex panels.

The former Baltimore Division became the Aerospace Division and its technical staff was strengthened with the acquisition of a group of top-level scientists having broad experience in space flight. This divison was scheduled for additional expansion and will become the focal point for corporate planning for participation in space and missile systems and sub-systems development and production. Research and development continued on a family of low cost Mach 1.2 and Mach 3 target missiles.

The former Longren Aircraft Corporation was merged with Aeronca in April and was being operated as the Aerocal Division of Aeronca. The Aeronca-California Corporation was integrated with the Aerocal organization. These facilities were being used for the production of B-52 fuel tanks and pylons, KC-135 and 707 structural members, and a variety of aircraft and missile components. Research in the development of production methods for the use of molybdenum, Rene 41, Vasco-jet and other exotic materials was being carried out in the Aerocal facility.

Aeronca was awarded a major part of the B-70 weapon system requiring design, tooling and production of brazed stainless steel honeycomb wing structures under sub-contract to Boeing Airplane Company, Seattle, Washington.

In addition to production of elevon web panels for the Convair B-58, Aeronca contracted to produce pylon panels, nacelle panels and additional wedge and flat panels for this airplane.

Grumman Aircraft Engineering Corporation awarded Aeronca a contract to design, tool and produce the speed brake assembly for the Navy's A2F airplane. This structure, due to environmental requirements, is produced from A286 stainless steel honeycomb and facing sheets.

An entry into the missile ground support field was realized during the year when Aeronca was selected by The Raytheon Company to produce battery control and maintenance shelters for the Hawk Missile System. The ensuing design resulted in the development of a basic shelter unit which offers greater versatility for the installation of electronic equipment, greater payload capacity and a new concept of extremely light weight basic structure.

Another new field was entered when the company received contracts to produce several types of airborne antennas. These units were designed, tooled and produced incorporating the use of bonded aluminum and phenolic resin materials, making considerable weight savings possible without sacrifice of structural integrity and adding a longer service life to the components.

Production of major assemblies for the Boeing B-52G and H Missile platform continued during the year. These assemblies included rudders, elevators, spoilers and wheel wel' oors.

The Middletown Division continued to produce and deliver KC-135 and 707 wing center sections for the Boeing Airplane Company.

A continuing program of research and development in high-temperature structures, including ceramic bonding, improved methods of brazing and processing, improved techniques in welding and forming of exotic materials continued throughout 1959 at the Middletown Division.

In addition, the company was awarded a contract for the production of the Pogo-Hi target missile for the Army White Sands Missile Range. Aeronca's all purpose training target missile is presently under evaluation.

ALUMINUM COMPANY OF AMERICA

Aluminum Company of America, in 1959, announced: successful forging of record-size beryllium billet supplied by Brush Beryllium Company for the National Aeronautics and Space Administration's Project Mercury; development of all-aluminum solid propellant rocket motor cases that exhibit yield strengths greater than steels generally considered for the application; the Navy's all-weather attack bomber—the A3J Vigilante—will be the first craft to make use of X2020, Alcoa's lithium-aluminum alloy; reinstatement of construction on certain long-term phases of its 150,000-ton Warrick (Indiana) works smelter; resumption of work on a new die casting plant at Edison Township, New Jersey; installation of a 5,200-ton capacity extrusion press at its Vernon, California, works to supply larger shapes demanded by West Coast aircraft, missile and rocket industries; installation of a 14,000-ton extrusion press at its Lafayette (Indiana) works which will be twin to an Air Force unit now operated by Alcoa; installation of a new 2,500-ton vertical hydraulic press capable of producing large impact parts for aircraft and missiles; development of lateral impact extrusion, a new metalworking technique; casting techniques to produce extremely large, super-strength tubes and rings in highest strength wrought alloy compositions; supplying metal and engineering service for flying platforms; availability of aluminum sheet in alloy 5456, highest strength composition available in the readily weldable aluminum-magnesium series; production of closed die forgings for Lockheed Aircraft Corporation's new JetStar utility plane; production of world's largest aluminum ingots for Thiokol Chemical Corporation; delivery of pipe for an underground network of aluminum pipelines installed at the Atlanta, Georgia, Municipal Airport to deliver fuel to new jet airliners.

Successful forging of a huge, heat absorbing beryllium shield for NASA's man-in-orbit program was accomplished during the year. The dish-shaped piece—approximately 80 inches in diameter—was produced from a record-size beryllium billet supplied by Brush Beryllium Company. Forging was carried out on a 50,000-ton capacity press operated by Alcoa under the Air Force Heavy Press Program. Beryllium, one of the lightest metals known, is about one-fifth the weight of steel. It has unusual ability to absorb large quantities of heat. For these reasons, the metal is a prime choice for testing as a heat sink to withstand the tremendous heat generated by air friction during re-entry and descent through the earth's atmosphere.

In the field of solid propellant rocket motor cases, Alcoa conducted a year-long research program. All-aluminum cases recorded yield strengths greater than steels generally considered for the application. Early in the research program, hydrostatic testing of light metal cases in 7178-T6—highest strength commercial aluminum alloy—exhibited yield strengths equivalent on a weight basis to 224,000 psi in steel. The one-piece cases were fabricated by a combination of forging, extruding, sizing and machining developed by Alcoa.

In another approach to the problem, Alcoa fabricated cases wrapped with fine, high strength wire. The strength-to-weight ratio exhibited by these cases surpassed the magic million-inch mark sought for rocket motor case applications.

The A3J Vigilante, the Navy's newest, hottest attack bomber, became the first craft to have skin of a unique lithium-aluminum alloy developed by Alcoa. North American Aviation was utilizing more than 4,200 pounds of alloy X2020 plate to provide the Vigilante with strength and weight saving advantages not possible with standard aircraft alloys. The plate is milled into thin sheet to form skin for the inboard wing sections—from wing root to wing-folding joint—and the horizontal stabilizer.

Construction on certain long-term phases of Alcoa's 150,000-ton Warrick (Indiana) works smelter was reinstated late in 1959. Objective was to bring part of the operation into a state of readiness, so that one potline can be placed in production relatively soon after additional metal requirements arise. Construction also was resumed on a die casting plant at Edison Township, New Jersey. When completed the operation will represent a greatly expanded replacement for the 37-year-old Garwood (New Jersey) works, 12 miles northeast of the new plant site.

Alcoa also announced that installation had started on a 14,000-ton capacity extrusion press at its Lafayette (Indiana) works.

Intricate, close tolerance impacts—fabricated by a process combining extrusion and forging into one operation—were being produced by Alcoa in greatly increased sizes. Operation of a new 2,500-ton vertical hydraulic press at the company's Cressona (Pennsylvania) works, produced large-size impacts embodying such design features as flanges, stepped sidewalls, ribs, bosses, centertubes, and multiple sections. Sizes range up to two feet in diameter and five feet in length. Impacts, which are fabricated in an almost instantaneous, one-stroke operation, have properties similar to forgings and receive wide applications in aircraft and missiles.

In a field bordering on the realm of fantasy, Alcoa supplied metal and engineering service to Spacetronics, Inc., developer of a flying platform known as the Hydro-Air vehicle. The prototype, a tear-drop-shaped craft, is 32 feet long, 24 feet across at the widest point and two feet high. It was fabricated to prove the feasibility of cargo-carrying vehicles

Saucer-shaped beryllium disc.

intended to streak between ports while magically held above water by a cushion of air. A specially designed, horizontally rotating propeller housed in the bow of the craft pumps a huge volume of air into the space between the platform and water surface. The low air pressure, rated at only a few ounces per square inch, was sufficient to lift the vehicle about two feet.

To meet a sharply rising demand for strong, easily welded aluminum sheet in missiles, Alcoa introduced sheet rolled in 5456, highest strength composition available in the readily weldable aluminum-magnesium alloy series. Mechanical properties, tempers and fabricating practices were established after extensive development work.

A unique wing-attaching system developed by Lockheed Aircraft Corporation for its new JetStar utility plane required key structural members made from closed die aluminum forgings produced by Alcoa. JetStar wings are joined to the fuselage externally by being bolted directly to the forgings, which span the fuselage between wing roots.

Two giant aluminum ingots, believed to be the world's largest, were produced at Alcoa's Vernon works for Thiokol Chemical Corporation. The metallic cylinders weighed 28,000 pounds and measured 283 inches long and 35 inches in diameter.

At the new Atlanta Municipal Airport, an underground network of Alcoa aluminum pipelines maintained rigid cleanliness standards for jet fuel used by Delta Air Lines' DC-8 aircraft. Fuel is transferred from storage and settling tanks to aluminum tank trailers. The JP-4 type fuel is pumped from the tank trailers through the underground aluminum pipelines into DC-8 wing tanks.

AIRCRAFT RADIO CORPORATION

During 1959, Aircraft Radio Corporation had increased sales of its lightweight airborne communications and navigation equipment that reached a new postwar high. Military and commercial sales increased proportionately in 1959 to maintain steady growth in both areas.

Aircraft Radio, pioneer in airborne electronic equipment since 1928, introduced several new units to complement its product line during 1959. A major addition was the Type 15F VHF Navigation System using the R–34A, ARC's new crystal controlled VHF receiver. This receiver was also designed to be used in modernizing the many thousands of ARC Type 15 systems currently in use. Other products introduced in 1959 included the R–31A, an all channel glide slope receiver and the R–33A, a completely transistorized 3–light marker beacon receiver. Aircraft Radio also introduced the FES–1240 series of COM/NAV systems and the FES–1230 series of basic COM/NAV systems. The FES–1241 system is a prime example of ARC centralized control system. This system utilizes a control panel measuring seven inches wide by ten inches deep which includes frequency selectors and controls for two independent communications systems, dual crystal control [illegible]ni, ADF, glide slope frequency selection, marker beacons and audio selection switches.

Aircraft Radio's Type 21A automatic direction finder helped to set three lightplane records in 1959. Max Conrad in a Piper Comanche, made two record flights, first Casablanca, North Africa to Los Angeles, California, then Casablanca to El Paso, Texas. Peter Bluckman, flying a Meyers 200, in establishing the around-the-world light plane record, also used the ARC Type 21A ADF.

In February of 1959, Aircraft Radio Corporation became a wholly-owned subsidiary of Cessna Aircraft Company, Wichita, Kansas.

BENDIX AVIATION CORPORATION

CINCINNATI DIVISION

During 1959, the division was involved in industrial and research instrumentation, aviation electronics, nuclear instrumentation and radiation safety devices.

One instrument of particular significance was the Bendix Time-of-Flight Mass Spectrometer, which can perform 10,000 analyses per second of gases, liquids and solids. This includes such difficult analyses as analyzing plasma jets and rocket exhaust. The major problem in analyzing high temperature, high pressure flames is introducing the sample to the high vacuum region of the spectrometer in such a way that the chemical character of the sample will remain substantially unchanged. The Cincinnati Division was engaged in preliminary work on this problem.

ECLIPSE-PIONEER DIVISION

During 1959 Eclipse-Pioneer Division continued to expand and realign its manufacturing facilities to meet increasing commitments for automatic flight control systems, flight director systems, navigational computers, specialized aircraft instrumentation, inertial guidance equipment, and precision components. Concurrent with this expansion were significant achievements in research and development and the application of advanced concepts in electronics to airborne and ground support equipment.

Production of highly precise inertial navigation systems was accelerated through the completion of two ultra-modern facilities—a beryllium machine room and a super clean room for production assembly work.

Beryllium because of its high strength to weight ratio and extremely stable characteristics over wide ranges of temperatures had rapidly come to the fore as a valuable space age metal. It was extremely difficult to machine, however, and its dust was toxic. Eclipse-Pioneer research and engineering combined to build and put into operation a facility wherein beryllium could be machined with complete safety to personnel. Keys to the removal of injurious levels of toxicity were a huge air conditioning system which effected a complete change of air every five to six minutes, and a powerful exhaust system which, through manifolds was linked to every machine and work bench in the room. Constant checks of air contamination never revealed a beryllium content any greater than 20 percent of the allowable safe limit. For working the highly abrasive and somewhat temperamental beryllium to the millionths of an inch required, specially designed machines, some with temperature control spindles, and carbide tools were used. Machines that would hold tolerances only to within 10 millionths of an inch were rejected for use in this facility.

Joining the beryllium room in 1959 as another unique facility was the super clean production assembly room, 99.95 percent free of dust specks larger than 5-millionths of an inch in diameter. It was used essentially for assembling highly accurate gyros destined for missile guidance systems.

During the year the Air Force's Convair-built Hustler airplane phased out of the test stage and into production. The Division's automatic flight control system followed suit, and with equipment design stabilized saw the emphasis shift to a program of greater reliability. Coincidental with the appearance of tactical aircraft, Eclipse-Pioneer also delivered its "electronic crew chief," a flight line computer tester, which in 90 minutes was capable of making 750 tests of the B-58s intricate automatic flight control system—a job previously requiring two days for a three man crew. The computer-tester simulated actual flight conditions and commands and measured the aircraft's response to them, in effect making "in flight" tests while the plane was on the ground. This item of tactical ground support equipment was the forerunner of a line of universal automatic test equipment that was being made available for commercial and other military operations.

Major advances in the application of solid-state circuitry to automatic flight control systems were made by Eclipse-Pioneer's advanced research and development department. These significant developments, covered by sixteen patent disclosures, eliminated all moving parts within the computing and switching components of flight control systems, decreasing weight, volume, and cost, increasing service life and serviceability, and providing greater efficiency and response through a wider range of operating characteristics.

Also in the field of automatic flight control and flight director systems, sales of the Division's PB-20 system climbed to 1,252 and production continued on earlier commitments for the Boeing 707, Convair 880, Lockheed Electra, the Douglas A4D-2 and C-133A, the Canadair CL-28, and DeHavilland-built CS2F-1.

In conjunction with Elliott Brothers, England, a Bendix Aviation Corporation affiliate, Eclipse-Pioneer developed the first complete dual autopilot installation. It included such unique features as separate control surfaces for each of the dual servo

Friez division's radiosonde equipment.

actuations, complete dual computation and sensing, and separate comparators for each autopilot. A contract was received from Lockheed to design, develop, and put into production the first transistorized Navy autopilot capable of stick-steering and radar altitude modes. Coincident was a contract for the first transistorized autopilot specially designed for a commercial cargo transport, the Canadair CL-44.

Contracts for roll stabilized compass systems were awarded to Eclipse-Pioneer by both the Air Force and the Navy. Continued expansion in vertical scale instrumentation was exemplified in the receipt of contracts for the F-105 and F-106 aircraft.

Utilizing advanced state-of-the-art concepts, the Divison, in conjunction with Litton Industries, undertook the development of air data sensing and computing equipment for hyper-velocity and upper atmosphere flight.

Contributing to the demands of missile flight, Eclipse-Pioneer developed the vertical sensor, a sensitive electrical plumb-bob, used to check that a missile is exactly erect on its launching pad. The unit can determine true vertical within three minutes of arc, which corresponds to an error in course of less than five feet at an altitude of one mile.

Development, production, and sales increased in the Division's extensive line of precision rotating components for servomechanism and computing equipment—synchros, low inertia servo motors, motor generators, and tachometer generators—as well as in miniaturized, modular components for amplifiers and computers. Outstanding was the development of an electrical two-speed synchro for accurate shaft position data transmission in the field of guidance and control systems. The new unit eliminates a synchro transmitter, control transformer, and attendant gearing presently required in such applications.

FRIEZ INSTRUMENT DIVISION

During 1959, Friez Instrument Division continued manufacture of an aircraft thermometer which directly measures the true ambient free air temperature. This thermometer, the Bendix-Friez Axial Flow Vortex Thermometer, was being supplied to Boeing for the Boeing 707 jet.

The vortex probe is mounted outside the plane at a static pressure point in the airstream. Air flowing through the probe is directed by a fixed spiral vane to create a vortex around the sensing element. The cooling effect at the center of this air vortex compensates for the dynamic heating, so that the temperature measured is equal to that of the ambient free air. The temprature-sensitive resistance winding in the vortex probe forms one leg in the bridge circuit of the temperature indicator.

Friez also continued to supply the Magnesyn Remote Indicating System to the aircraft industry.

The Magnesyn system is c posed basically of two units—a transmitter and an indicator—joined together by electrical wiring. By means of this system, aircraft instruments can be actuated without the need for long mechanical linkage or tubing connections. This system saves in weight, simplifies installation and maintenance, and greatly reduces fire hazard by eliminating the need for introducing fuel, oil, and hydraulic lines into the cabin of the airplane. Magnesyn instruments were being supplied to Fairchild, McDonnell, and other companies.

HAMILTON DIVISION

The Hamilton Division continued to expand its product line in 1959 with the introduction of precision bellows, assemblies and thermostats for missile, aircraft and industrial applications.

Materials included stainless steels, monel, phosphor bronze and beryllium copper. Standard sizes range from .180 to 3.5 inches root diameter.

Production at year-end included bellows, bellows assemblies and complete thermostat assemblies. Control devices including bellows are also manufactured to customer drawings and specifications.

Additional emphasis was placed on industrial applications with the introduction of industrial servo valves, motors and hydraulic power supply systems. The Hamilton Division had a "closed loop" Electro Hydraulic Servo Valve available for capacities ranging from one to six gpm. Designs were completed for a new valve designed for industrial use which will have capacity flexibility from approximately one gpm to 15 gpm when used on a 3000 psi system.

The Division continued to expand the family of lightweight, hydraulic pumps having fixed or variable displacement in sizes ranging from two to 40 gpm and having operating speeds to 18,000 rpm. The program included pumps for high temperature operation using advanced hydraulic fluids.

Other important developments underway at the Hamilton Division included further product expansion to include missile and aircraft heat exchangers, fuel supply and transfer pumps and the integration of components into complete integrated subsystems. With this expanded product line, the Hamilton Division added emphasis to a more complete sales and service organization to evaluate, market, ad-minister and service the growing number of diversified programs in progress at Hamilton.

MONTROSE DIVISION

The Montrose Division continued a planned expansion program during 1959. The Montrose Division product line included pressure switches and transducers; aircraft autosyn indicators and transmitters; D. C. position indicators and transmitters; high precision small D. C. motors; dynamotors; tachometer generators and indicators; military synchros; and angle of attack indicators. The Engineering Department was enlarged to carry on a schedule of product improvement and new product development.

Montrose expanded its line of integrally-lighted indicators and was offering both single and dual indicators with integral lighting. Quantities of these indicators were being supplied to the military for use on the latest model aircraft.

Several miniature, integrally-lighted D. C. position indicators were developed and put into production. These indicators were replacing the older, less accurate types previously used.

Several models of pressure transducers were designed and released to production for use on aircraft and missile telemetering systems.

The Montrose Division type 27400 angle of attack indicators were being manufactured in volume for use on Navy fighter and attack aircraft.

Montrose developed and produced a complete line of ordnance synchros including high temperature and radiation resistant synchros for atomic reactor applications.

PIONEER CENTRAL DIVISION

The Pioneer Central Division of Bendix made a number of developmental advances in aircraft instrumentation during the year.

Added to its products were miniaturized (two-inch) standby altimeters and airspeed indicators. These small lighted units are mounted near the electrically operated vertical display instruments and increase flight safety by providing accurate mechanical indication of these functions in the event of power failure. High fuel flow requirements of current aircraft designs have been responsible for the development of a small, highly accurate, mass type fuel flow system capable of measuring flows to 125,000 pph within one percent of the actual flow.

In an effort to provide protection for personnel working in hazardous atmospheres, Pioneer Central developed and produced for the Army Quartermaster Corps an environment controlled protective suit and back pack liquid air supply and regulation system capable of providing air conditioning and a breathing atmosphere.

The development and production of an optical liquid level sensing and switching device generated interest because of its small size and high reliability. The unit will function in fluids with widely divergent characteristics and has found application in missile launching and flight operation as well as industrial fields.

PRODUCTS DIVISION

Bendix Products Division continued to supply many of the major aircraft engine, airframe and missile manufacturers with complete fuel metering and landing gear systems and components.

At the same time research and development facilities were increased to meet the needs of the rapidly growing missile and atomic requirements of the future.

In the Aircraft Engine Equipment section major efforts were placed on "in house" developments of several engine control and fuel system devices for universal customer application. This provides standardized basic units to the customer at minimum cost and with a minimum expenditure of time.

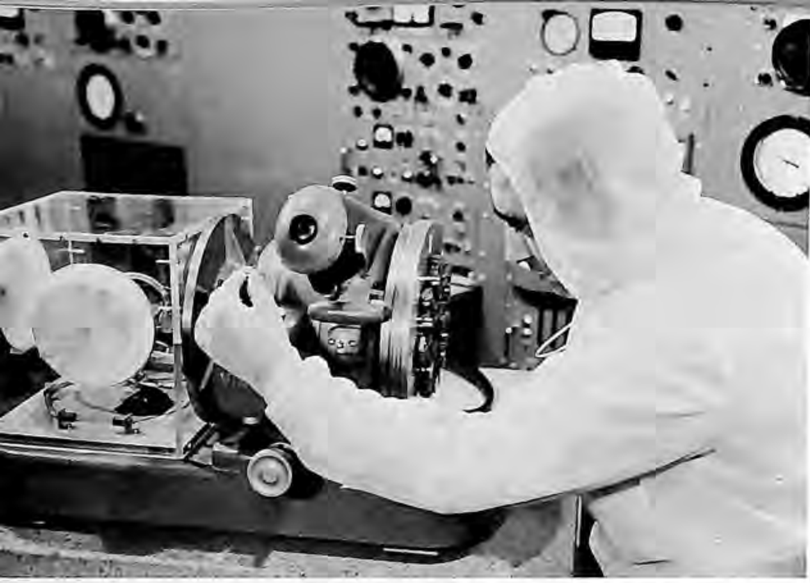
A Shaft Turbine Engine Control was developed for engines up to 750 horsepower for industrial, ground vehicle, fixed wing and helicopter application. Demonstration tests were completed in customer and Bendix engine facilities. System weights are as low as four pounds.

Hydraulic computer type Universal Turbojet Controls are adaptable to a wide range of engine sizes by changing simple main fuel bodies. A flexible, optimumly packaged light weight control is adaptable for engines from 1,000 pounds thrust upward. Development tests were completed and packaged controls were available.

A series of low cost, extremely reliable magnetic/amplifier, temperature controllers were developed. This basic design can be adapted for use in direct temperature control or limiting gas turbine temperatures for all size engines. Component qualification testing was completed.

Other interesting developments included liquid rocket engine controls of the hydromechanical type for direct operation with rocket fluids and combination hydromechanical—magnetic amplifier types. These were tested and available.

Another field included injection systems for light aircraft reciprocating engines. Developments com-



Eclipse-Pioneer specialist tests part for missile guidance system.

pleted were on two types which were made available for field testing.

Fundamental work was done on high temperature sealing materials, springs, bellows, etc., for advanced control application; on construction of light weight steel units to cope with ambients of the modern aircraft and missile age; and on high temperature pneumatic circuits.

The Systems Development section completed studies in the field of mechanical and electromechanical ground support equipment. This included missile transporters, missile launchers, emplacement equipment, electrical and hydraulic ground power units, launch sequence and monitoring equipment, and missile precision emplacement euipment. Active programs were under way in the fields of ballistic missiles, tactical missiles and military aircraft. Emphasis was placed on high reliability ground support equipment having characteristics of air transportability and low cost. The work was being performed under nine direct government contracts and seven sub-contracts.

Work on an Anti-Intercontinental Ballistic Missile Target Study involved theoretical, analytical, laboratory, and firing range work in the fields of aerodynamics, plasma, shock tube, infrared, radar and other fields associated with missile reentry.

Designs of movable nozzles for solid rocket motors were conceived, analyzed, laboratory tested, and successfully test fired on solid rocket motors using the latest high energy propellants planned to be used in new high performance missiles. The perfection of a swivel joint that will withstand the high temperatures and highly abrasive rocket exhaust gases was completed using novel sealing methods requiring minimum power and weight for actuation and control.

The Bendix High Temperature Material scientists developed new cermets for rocket throats, jetavators, jetvanes, and insulating liners for use with the latest high energy propellants. Satisfactory methods were developed for fabricating refractory powder metals with extremely high temperature operating capabilities. Work was being accomplished for cermet protective coatings over structural plastics.

During 1959, Bendix wheels and brakes went into service on the Boeing commercial 707 jet transport. The DC-8, which started commercial service during October, 1959, and the Convair 600, which was scheduled to enter commercial service in 1960, also were equipped with Bendix wheels and brakes. Development work on a liquid cooled brake was in the advanced stage. This equipment, which was scheduled for flight test early in 1960, represents a substantial advancement over any equipment now available with safety and reliability on "hot" stops being its strong features.

In landing gear controls, Bendix became firmly established in the hydro-electrical, as well as the hydro-mechanical, aircraft steering systems field. A variety of military aircraft were operating with these systems.

Bendix Products adapted hydraulic shock absorbing principals to a completely new use in 1959: railroad car shock absorbing equipment. Field service tests proved this equipment to be highly effective, with practical application in solution of problems long associated with the handling of fragile commercial freight and in the solution of new problems created by a requirement for delicate handling of missile and space equipment. Bendix Products Division engineering was pursuing continued development along these lines.

Bendix Products was awarded the contract for the design and production of the control rod drive mechanisms for two of the major nuclear reactors currently under development. One was for surface ships and the other for submarines.

RADIO DIVISION

Bendix Radio Division's Avionics Group completed engineering on several new lightweight airborne electronic equipments in 1959. Two of the equipments, the MNA-21A VHF Navigation Unit and the MKA-23A Marker Receiver, were the first units to appear in the one-quarter ATR, half height ARINC form factor housings. The MNA-21A was designed to be used in conjunction with the standard Bendix RA-21A VHF Receiver to provide completely automatic VOR-LOC course information. The MKA-23A was designed to provide visual indications of fan, "Z," and station locator beacon signals. Both units are fully transistorized.

Outstanding among the Avionics Group's developments was the new DRA-12 Doppler Radar Navigation System. This highly-accurate long-range, self-contained navigation system which provides direct read-out of ground speed and drift angle were to first be used by United Air Lines on their Hawaii-to-California DC-8 Jet Mainliners in January, 1960. Weighing only 60 pounds, the Bendix system incorporates many new and unique design features: the antenna is completely passive (no moving parts are used) and it can be mounted in a very shallow recess in the fuselage; complete transistorization and maximum utilization of plug-in preassembled computer circuit boards provides a high degree of reliability, easy access for maintenance and permits packaging in standard airline configurations. A special navigation computer which reads-out distance-to-go and course deviation information was nearing completion in engineering and was to be available as a companion system for the basic Doppler Radar System early in 1960.

Airborne Weather Radar sales continued at a high level during 1959 with large numbers of production systems being delivered to business aircraft owners and overseas airlines. Bendix Weather Radar Systems were specified for the Douglas DC-8 by Eastern, Northwest, Panagra and KLM Royal Dutch Airlines. Significant in the weather radar field in 1959 was the development of a new 18-inch antenna which permits installation of airline systems in aircraft as small as the Twin Beechcraft.

A license agreement was concluded in mid-1959 with Cossor Radar and Electronics, Limited of London which permits Bendix to manufacture and market a U. S. version of the British designed Air Traffic Control Transponder. This ½ ATR airborne unit, working in conjunction with Air Traffic Control Surveillance Radar Systems, will provide instantaneous identification of a specific aircraft.

Airborne electronic equipment packaging was considerably advanced through Bendix efforts in cooperation with the Air Transport Association. Bendix made available a wide line of reusable containers which will greatly reduce maintenance cost for airlines when trans-shipping equipment from stations to overhaul shops for service. Reusable containers designated as Category I can be used as many as 100 times. Category II containers have a service life of up to 25 trans-shipments.

Advanced programs at Bendix Radio Division also included operation and test of a feasibility model of a multi-purpose long-range radar, employing phased array techniques, which was developed for the Air Force and the Advanced Research Projects Agency; development of an extended range communications equipment for space applications; participation in DYNASOAR; participation in Project MERCURY tracking and air-ground communications; and in the Air Force's polar orbit communications satellite, Task STEER.

In the components area, Bendix Radio began limited production of the sub-miniature emergency UHF communications unit, the AN/ARC-63(XA-1). This unit, which automatically switches to battery operation in event of failure of an aircraft's primary power source, was the first equipment completed to meet the Air Force Uniform Design Criteria. It was being used in the Convair B-58.

Also completed during the year was an experimental model of a panel that integrates radio control functions of all mission and traffic control equipments in high performance aircraft. It can be used with any combinations of equipments, reduces cockpit space requirements by half, and is human-engineered for touch operation without visual reference by the pilot.

RESEARCH LABORATORIES DIVISION

During 1959, several notable development programs were completed by Research Laboratories Division of Bendix Aviation Corporation in aeronautical and space technology fields.

First used to adjust the attitude of the Discoverer II satellite as it made its polar orbit of the earth, the Bendix Cold Gas Reaction Controller was developed by the Research Laboratories for Lockheed Aircraft Corporation under an Air Force contract. Weighing less than 18 ounces, this revolutionary type of reaction control can keep a satellite oriented in its desired orbit and prevent the tumbling end-over-end motion of satellites previously launched without such a control. Mounted on the periphery of the satellite, a set of these steering jets discharges compressed nitrogen in response to autopilot-controlled electrical signals. Thrust is continuously variable from 0 to 15 pounds and is proportional to the deviation from the desired satellite attitude relative to the earth or other reference point.

The Laboratories also developed small portable mass spectrometers using the same focusing principles as are used in the commercial models of the Bendix Time-of-Flight Mass Spectrometer, which were in production at the Cincinnati Division of Bendix Aviation Corporation. These portable spectrometers were designed for use in a variety of airborne applications and were intended for installation in almost every type of air vehicle including aircraft, rockets, balloons, satellites, and space probes. Full use was made in the portable models of the latest miniaturization and transistorization techniques to produce a compact and rugged instrument weighing only 17 pounds. This device can make over 10,000 chemical analyses per second and by integration techniques can measure a number of gases simultaneously.

Other contributions of the Research Laboratories to aeronautical sciences were the basic sensors developed for the AN/AMQ-15 Air Weather Reconnaissance System, a weather-sensing system designed to furnish new meteorological and geophysical data on a global scale to the Air Force, commercial airlines, the Weather Bureau, and various research organizations. Successfully flight tested at Seattle, Washington, the Bendix sensors will measure dewpoint, albedo, ozone, and pressure. A low-cost, expendable index of refraction sensor was also completed.

SCINTILLA DIVISION

During 1959, Scintilla Division developed the Temperature-Vibration Monitor to provide flight engineers of turbine powered aircraft with constant knowledge of temperature and vibration conditions on the engines of the aircraft. This instrument simultaneously displays on the aircraft flight deck, in easily read bar graph form on a cathode ray tube, the continuous findings of 40 temperature and eight vibration sensors strategically located on the four engines of the aircraft.

The Bendix Pygmy electrical connector made many contributions to the ever increasing programs of research into the ways and means of reducing weight and conserving space in the installation of electronic equipment and wiring on aircraft and missiles.

Scintilla Division also developed a versatile tester for both alternating and direct current operated jet engine ignition units of the capacitor discharge type. This equipment evaluates the ignition units at an applied voltage by measurement of the input current, spark rate and output voltage. This tester is easily and quickly connected to an aircraft. It speeds trouble shooting and eliminates the problem of possible removal of serviceable units.

SYSTEMS DIVISION

Highlights of 1959 included a number of new weapon systems and space systems contracts for the Bendix Systems Divisions.

During the year, Bendix Systems received the prime contract for a new Navy missile system concept called Eagle. Exceptional accuracy and vastly improved range will make Eagl(new generation air-to-air missile system. The speed and altitude capabilities of Eagle will permit building the system performance into the missile rather than into the launching aircraft. Eagle will be employed for Naval fleet defense and intercept missions. Major subcontractors included Grumman Aircraft Engineering Corporation, Sanders Associates, Litton Industries, Aerojet-General Corporation and Westinghouse Air Arm Division.

Bendix Systems Division also received the prime contract for developing the Communications system for the STEER Communcation Satellite, a polar orbiting satellite to relay voice from ground station to SAC bomber and return. STEER is part of the NOTUS project conceived as a global communication system.

A program underway for more than two years provided Bendix Systems with a capability in design, development, and test of electronic equipment for operation in a nuclear radiation environment. A complete file of components and radiation effects was established. Nuclear reactor tests were conducted on components and subassemblies to establish radiation effects. At the same time design studies were conducted toward the development of radiation resistant subsystems.

The year saw a successful execution of the development of a global weather reconnaissance system for the Air Force. The objective of this program was to provide new and timely meteorological and geophysical data on a global basis. The airborne system includes rocketsondes, dropsondes, aircraft probes, and sensors, cloud and storm radars, computers, recorders, and displays. Serving the Air Force, commercial airlines, weather bureaus, and research laboratories, the new system will be in multi-jet aircraft cruising at M. 95 at altitudes up to 50,000 feet, and gather weather data up to 170,000 feet.

CHANDLER EVANS CORPORATION

The year 1959 was marked by a sizeable increase in shipments of fuel pumps, main and afterburner fuel controls and new unitized fuel controls for the country's leading jet powerplant manufacturers. It was estimated that total shipments for 1959 would exceed 1958 shipments by more than 12 percent.

During the year, the company continued its program to acquire the most advanced types of auto-

Servo-control valve assembly for Sparrow III.

mated tape-controlled machinery for both prototype and production use. Inaugurated three years ago, this capital equipment modernization program is part of the company's effort to assure great accuracy, increase productive capacity and to hold manufacturing costs to a minimum.

Following the January opening of its new Thermo-Research Center designed for environmental testing of fuels and fuel control systems, Chandler Evans completed construction of a new hot gas unit and of an advanced type X-ray laboratory.

During 1959, some of the principal mechanisms that advanced to production status included main fuel pumps for J52, J85 and J12 powerplants and unitized fuel controls for J69 and T53 engines.

Throughout the year, production of servo-control valve assemblies for the radar-homing Sparrow III air-to-air missile continued.

For the new generation of air and space vehicles, Chandler Evans continued its development program embracing a variety of systems, sub-systems and components for use in the field of high-pressure pneumatics.

During the year, the company announced the development of six new hot gas system components that resulted from its extensive research in this field. These were made commercially available. They include a lightweight hydrazine reaction chamber; a reed-suspended, closed center servo valve; a propellant flow modulating and pressure regulating valve; a solid propellant hot gas filter; a hot gas pressure relief valve; and a hot gas reaction chamber for laboratory use.

Early in the year, the company announced the development of a new type cabin air temperature regulator installed in series 120 and 331 versions of the Boeing 707 Jetliner.

Employment during 1959 has remained at a constant level and Chandler Evans expected to complete the year with a backlog of orders equal to that of a year earlier.

COOK ELECTRIC COMPANY

During 1959, Cook Electric Company's activities included several new developments in the aerospace and ground-support fields.

Acquisition of meteorological data from the upper atmosphere will be facilitated in the future with a new parachute system developed by Cook during 1959. The system is capable of stabilizing a vertical platform from which a radiosonde rocket can be fired. The parachute system is designed for release at altitudes of 25,000 to 45,000 feet, from bomber or fighter type aircraft, at velocities from 270 knots to Mach 0.95.

With the increasingly complex modern aircraft, a new need has arisen for gathering and displaying flight data simply, and for making decisions and acting on them quickly. Cook made analysis studies of the problems connected with these complexities in modern aircraft, and made mockups of simplified control panels. Cook Electric Company also produced 16 millimeter, sound and color films dealing with flight control panels, including "Dial D for Design," which shows new methods of design and development of instrument dials and controls for modern aircraft and weapon systems.

A compact, self-contained system was designed by Cook during 1959 for the recovery of an instrumented data capsule ejected during the re-entry cycle of a ballistic nose cone.

Cook was active during 1959 in developing magnetic tape recording and reproducing mechanisms. One model is the Type DR-25-2 which was designed for gathering data during the re-entry phase of an ICBM nose cone flight. This miniature system is packaged in a container 5.34 inches in diameter by 7 inches in length. Another magnetic tape recording system is the Model MR 31G-1 designed for extreme environments. It has reliably recorded telemetry signals in recoverable nose cones of IRBMs during re-entry.

Aluminum wing panels for the B-52 are extruded on Dow's 13,200-ton press.

DOW METAL PRODUCTS COMPANY

The Dow Metal Products Company, formed during 1959 as a division of The Dow Chemical Company, was responsible for the operation of Dow's metalworking facilities and the sale of products from those facilities. Under the new company, Dow no longer devoted itself almost exclusively to magnesium as in the past but was working extensively with aluminum and other metals as well. Sales of primary magnesium metal and magnesium-alloy ingot was handled by a separate sales group in the parent company.

During 1959 the company's Madison, Illinois, plant supplied B-52 wing panels, missile panels and stepped wing spars in aluminum from its 13,200-ton extrusion press. Magnesium extrusions and sheet for aircraft and missile applications also were supplied. Particularly noteworthy was the growing use of magnesium-thorium sheet and extruded products in components requiring good elevated temperature properties. Cleared information at year-end showed magnesium-thorium utilization in the Titan, Bomarc, Discoverer satellite and the Vanguard launching vehicle.

Two new magnesium alloys were introduced by Dow during the year. HM11XA, a new member of the magnesium-thorium group, was a die-casting alloy in metal for service above 500 degrees F. EK31XA, a magnesium-base sand-casting alloy containing rare earth metal, combined good room-temperature tensile properties with excellent tensile strength at elevated temperatures up to about 600 degrees F.

Dow also introduced a cold-bending magnesium sheet from coil stock. Previously, all cold-bending magnesium sheet has been produced on hand mills.

FLIGHT REFUELING, INCORPORATED

The company's year was marked by additional diversification of its activities in the production of missile and cryogenic fuel handling equipment. New products, techniques and systems included positive sealing booster disconnects, fuel fill and drain disconnects, retro rocket chambers, fuel flow regulator valves and depot and shipboard missile handling systems, all of which were either being studied or manufactured at FRI during the year. In addition, research and development programs involving space refueling, controlling airborne nuclear reactors and ground support equipment for nuclear aircraft and missiles were being conducted by FRI's Missiles and Nuclear Group. New construction included an atmospherically controlled dust-free room.

GENERAL LABORATORY ASSOCIATES

During the year, GLA ignitions and harness assemblies saw service with a number of new American turbine transports. GLA equipment was operating on the Boeing 707, Douglas DC-8 and Lockheed Electra, providing ignition for power plants as well as several auxiliary units.

GLA equipment also provided ignition for rocket engines on the Martin Titan ICBM and several high temperature applications for high output jet and rocket engines were successfully qualified. Development of equipment for nuclear-powered aircraft reached the hardware fabrication stage and GLA equipment was also selected for several classified projects involving severe environmental conditions and high degrees of reliability.

Development and production of high-temperature capacitors for high voltage application continued at a high rate. Additions to the test laboratory for vibration, environmental and reliability testing were completed during 1959.

HARVEY ALUMINUM

Keynoting the 1959 activities of Harvey Aluminum, Torrance, California were the extrusion of large complex aluminum shapes, outstanding progress in the fabrication of containers, and continued development work on super steel alloys.

On the 12,000 ton press Harvey successfully extruded flat integrally stiffened wing panels measuring 28.08 inches in width. The company also produced the largest multiple hollow shape ever extruded. Fabricated into a modular cabinet assembly for a missile control system, the six-hole section measured 24.190 by 2.485 inches.

In the fabrication of aluminum containers for missile components, Harvey won first place for the best USAF-industry developed package at the 1959 Air Materiel Command Packaging and Materials Handling Conference. The company's entry was an aluminum container, pressurized and shock-mounted, for shipping missile engines.

For high-strength, high-temperature applications, Harvey performed developmental extruding of Vasco Jet 1000, PH 15 7 Mo, Rene 41, Inconel X, AM 355, Peerless 56, and similar super alloys.

Harvey's advancements during the year in the fabrication of zirconium tubing and other zirconium mill products were also proving valuable in the development of nuclear propulsion for aircraft.

In titanium, the company launched plans to expand its integrated facilities in Torrance, California.

JACK & HEINTZ, INCORPORATED

The year 1959 was a *significant* development year for Jack & Heintz, Inc., designer, developer and manufacturer of systems and components for the aero-space industry.

Among the more prominent achievements were: 1) entry into the hardware stage with the "synchronous-flux (vscf) system"; 2) entry into the development of seven SECSYN designs; 3) entry into development of a semi-conductor frequency changer package; 4) completion of development of a new, lightweight, high-temperature tachometer generator; 5) start of production on a new a-c transistorized regulator; 6) development of the starter-generator system for the JetStar; 7) entry into development and pre-production phase of an electromechanical actuating system for missile ground handling.

The synchronous-flux system (vscf) is aviation's first all-electric variable-speed constant-frequency system. The system is capable of producing a constant frequency from a variable-speed shaft and is capable of eliminating the hydromechanical constant-speed drives now in use aboard virtually all jet-engine aircraft. The system promises much higher reliability, has a much longer service-life potential and costs substantially less to overhaul than any contemporary CSD-Generator electric power system.

The SECSYN (Stationary-Exciter-Coil SYNchronous) machine, introduced by J&H during 1958, underwent seven distinct developments during 1959. A 1.5-kva 400-cycle, self-air-cooled machine was built and tested. A 2.5-kva 400-cycle self-air-cooled machine was designed and was under construction. A 3.0-kva 800-cycle mercury-vapor-cooled machine for continuous duty at 600° F was designed and under construction. A 4.5-kva 1333-cycle mercury-vapor-cooled machine for continuous duty at 500° F was under construction. A 3.5-kva 1167-cycle special-cooled machine was built and tested. A

5.5-kva 1837-cycle mercury-vapor-cooled machine was tested. A 60-kva 400-cycle, Class C continuous-duty air-blast-cooled machine was under construction.

An off-shoot of the J&H vscf development, a new frequency changer "black box" is capable of taking a 60-cycle input and converting it to frequencies of several kilocycles. The unit was being studied for application to naval sonar and commercial equipment power needs.

A new, small, lightweight, two-pole, three-phase a-c tachometer generator was developed for use on jet aircraft. The unit weighs 0.8 pound compared to 1.3 pounds for the previous standard, larger unit. The tach is rated at 350° F. continuous operation.

One of the smallest and lightest regulators in its rating yet developed, the Jack & Heintz a-c transistorized regulator incorporates solid-state advances to achieve the size and weight reductions. It uses the gain and switching characteristics of the transistor to eliminate bulky magnetic amplifiers. A zener diode is used in place of a tube to provide a voltage reference level for comparison with the sensed signal.

The regulator, entering into wide use aboard helicopters such as the Kaman HU2K1 and Vertol YHC-1A, can incorporate a reactive load division circuit for paralleling generator systems.

J&H increased the number of starter-generator systems in the production stage. Systems by the company include ratings to 750-amp d-c, with systems available for the entire spectrum of turbojet, turboprop and turboshaft engines. The systems were proving particularly adaptable to the new-smaller jet engines rated to 4000-pound thrust. Most recent of the J&H starter-generator systems applications was the Lockheed JetStar. This jet transport, powered by four Pratt & Whitney JT-12 engines, will use a 400-amp system.

The missile ground support system developed by J&H is electromechanical, performing functions of transporter-leveling, launch-pad-positioning, missile-erecting and missile-rotating prior to launching. The system is very compact and lightweight to permit air transport.

KOEHLER AIRCRAFT PRODUCTS COMPANY

During 1959, Koehler Aircraft Products Company increased production of its cryogenics control valves for missile and ground support applications.

These valves included: a blade valve for cryogenic liquids control in the –320°F to –250°F range; a ball valve capable of handling liquid oxygen or gaseous oxygen to 450 psi; and a pneumatic valve which performs dually as a pressure relief valve and as a check valve.

Koehler/Dayton units are used in the fuel system of the Douglas DC-8.

During the year, Koehler had many other components in pilot production or service testing.

LEAR, INCORPORATED

Lear, Incorporated, entered its thirtieth year in avionics with a 1959 sales volume of approximately $90-million and a backlog of $85-million as of November, 1959. This compared with a 1948 sales volume of $63.6-million and a backlog of $71.9-million at the end of that year.

The expansion and development programs of 1959 were highlighted by a series of major accomplishments including new product development, new production facilities, intensified research in new fields and re-alignment of operating divisions to increase their production potential.

In September, 1959, Lear dedicated its new aerospace manufacturing facility in Grand Rapids, Michigan. This new facility of the Lear, Incorporated Instrument Division is a 172,800 square foot manufacturing plant built expressly for the production and assembly of precision components and systems for manned and unmanned flight vehicles. The positively pressurized plant contains a complex of "white rooms" which have a higher degree of clinical cleanliness than is to be found in ultra modern hospital surgeries.

As it moved into its new facility, the Instrument Division announced that Lear, in 1959, became the first company to develop and build a complete Geocentric Pendulum Control unit, the heart of the company's new Geocentric Vertical Reference System undergoing flight tests at year-end. The GVR system consists of the Model 7425A Geocentric Pendulum Control tied into any Vertical gyro. The Geocentric Pendulum Control unit of the GVR system functionally replaces the conventional vertical gyro gravity-sensing device, which is affected by flight accelerations.

Other 1959 developments of the Instrument Division included:

Production delivery to the Air Force of a new Lear two-gyro master reference for the F-105 and F-106. Lear was investigating the potential application of this new primary reference system for commercial airline use;

Introduction of a new two-inch remote vertical gyro indicating system for standby use in the event of a malfunctioning primary system;

Introduction of the Series 1080 gyro, a compact, lightweight, low-cost gyro specifically designed to take the extreme shock and vibration encountered in missiles, drones, helicopters and high performance aircraft;

Development of a Series 4060 three-axis flight control director-altitude indicator, very similar to the Lear indicator used in the North American X-15 experimental flight vehicle, to be installed on the North American B-70 chemically-fueled bomber;

Announcement of participation of Lear as the gyroscopic guidance team member of the Nike-Zeus, anti-ICBM weapon system and construction of an ultra-clean Nike-Zeus laboratory-test facility for assembly and testing of prototype systems.

At Grand Rapids, the Instrument Division continued to explore cockpit designs for manned space vehicles for the Air Force Flight Control Laboratory at WADC.

In its overall functions, the Instrument Division has responsibility for the development, manufacturing and marketing of flight indicators, gyro-stabilized platforms and compasses, automatic bombing systems, displacement and rate gyros, resolvers, synchros and ground support equipment.

During 1959, Lear operations in Grand Rapids were revised by the creation of the Electro-Mechanical Division and its separation from the Instrument Division. The E-M Division designs, manufactures and markets electric fractional horsepower motors, clutches, electrical hydraulic and pneumatic actuators and control systems and precision servomechanisms.

In the missile market, the E-M Division obtained initial production contracts for elevon and throttle actuators for McDonnell's GAM-72 missile and for fin positioning servo actuators for the JPL/Sperry Sergeant missile. E-M also will supply servos for several space research rockets.

In another field, E-M continued large volume production of air inlet systems and landing flap systems for the Republic F-105. Air Force health and safety officials recommended that Lear's E-M

Instrument workers in Lear's "white rooms."

Division remote jet engine fuel trimmer be standard equipment on every military jet aircraft. In the commercial field it was also specified for the Boeing 707, the Douglas DC-8, the Lockheed JetStar and the McDonnell 119.

For further diversification the Electro-Mechanical Division entered the industrial field with the production of actuators, remote positioning systems and powdered metal clutches for industrial use. During 1959, the Division received its first production orders for rod positioners to be used in atomic reactors.

The Astronics Division, with headquarters in Santa Monica, California, reported major progress in production, engineering and development for 1959.

In production were:

Complete maneuvering autopilot with stick-sensor for Swedish supersonic SAAB J-35 Draken jet fighter;

Stability augmentation systems for the NATO G-91 fighter;

Transistorized, modularized command maneuvering control system for the Ryan Q-2C target missiles;

Missile command guidance receivers designed and built in production quantity for the Boeing Bomarc ground-air missile;

Two-axis stability augmenter system for the Northrop T-38 Talon;

Production of Lear L-102 and L-5B autopilots now used on such jet transport and corporate aircraft as SUD Caravelle, McDonnell 119, Grumman Gulfstream and Fairchild F-27 was expanded.

In engineering and development Lear Astronics was designated System Manager for electronic guidance of the Navy DASH program. For the Gyrodyne DASH vehicle, Astronics developed a "millimin" packaged complete drone control that stabilizes the remotely controls the vehicle.

Astronics also moved into hot gas stability and flight control systems by participating in team proposals with the Kidde and Batelle organizations.

In electronics the Astronics Division was building low cost receivers, Versa-tel data transmission equipment and beacons. It also teamed up with other companies in developing a missile nose cone recovery system.

Also based in Santa Monica was the LearCal Division, which in 1959, produced over 2,500 flight proven NAVCOM-100 systems for private and executive aircraft.

Slated for production in 1960 was the all-transistorized L-3 autopilot which represents a significant advancement in light plane automatic flight control. Lear was also producing a new light weight three-axis data generator (gyro reference) and the NAFLI Jr., an attitude indicator featuring natural flight reference for the easiest and quickest attitude reference yet available. In 1960, Lear was to begin production of the ADF-47, an all-transistorized direction finder.

Integrated functionally with all Lear divisions was the Transport Sales Organization activated under the Astronics Division in 1959 to expand Lear's role in the commercial transport market.

Utilizing 30 years of experience gained in aircraft navigation and communications marketing, Lear designed an all new, sophisticated system for transport aircraft known as the ADF-200 system. Using subminiature tubes and transistors for optimum performance, the ADF-200 is the most advanced automatic direction finding system yet conceived.

Another system projected for the transport market was the NAVCOM-200, an advanced version of the flight-proven NAVCOM-100. NAVCOM-200 is a crystal-controlled navigation and communication system with optimum perform ance and reliability.

At Elyria, Ohio, on the o skirts of Cleveland, the Lear-Romec Division continued development of its standard product lines, including centrifugal fuel boost pumps, lub/scavenge pumps for jet engines, pressurization and desiccator assemblies for radar units, servo valves for missile hydraulic guidance.

New contracts obtained during 1959 included component orders for the Convair B-58, Lockheed JetStar, McDonnell 119, Republic "Swallow" drone, "Eagle" and "Nike-Zeus" missiles, and many others.

A few of the new products developed in 1959 included the RG-18500 and RG-18530 camera vacuum pump, the RG-13360 integrated hydraulic power package, the P-1272, the P-1272A and the P-1279 coolant units as well as the RR-12160 fuel booster pump.

Lear established a Solid State Physics Laboratory in Santa Monica in 1959. The SSP Laboratory was conducting research in electroluminescence, metallic oxide films, infrared detection, plasma technology, semi-conductors, ultrasonics, photo-conductors, thermoelectricity, and gyromagnetics.

Overseas, Lear, Incorporated, continued its expansion, particularly through Lear Electronic GmbH of Munich, Germany, a wholly owned subsidiary, and the Lear sales offices in Geneva, Switzerland, and Wiesbaden, Germany.

MB ELECTRONICS DIVISION
TEXTRON ELECTRONICS, INCORPORATED

During 1959, MB Electronics continued to supply completely integrated vibration test systems for use by major contractors in the missile, aircraft, electronics, and associated industries. These are used for the vibration testing of components and systems for missiles and high-performance aircraft. Such testing must meet government or industry specifications for generating, controlling, and measuring vibration under precise conditions of temperature, humidity, pressure, and/or other environmental forces.

Three major contracts for vibration test systems were awarded MB during 1959. Aberdeen Proving Ground awarded MB a $254,460 contract for a special vibration test system consisting of three exciters in force ratings of from 1750 to 28,000 pounds and two electronic amplifiers (17.5 and 100 KVA). This equipment will be used for all types of vibration testing at Aberdeen. A new feature is that it will be able to use tape-recorded vibration data taken from the field, amplify this electronically, and apply it to an electromagnetic shaker. Thus, field conditions can be simulated accurately in the laboratory.

The Air Force awarded MB a contract for approximately $230,000 for special vibration calibrating equipment.

On August 20, one of the largest single orders ever placed for complex motion vibration test equipment was given to MB by Aerojet-General Corporation, Sacramento, California. This equipment will involve special advanced electronics and electro mechanical systems, and will be used to improve testing techniques on that company's rocket engines for missiles and space applications. This test system should play a prominent role in improving the operational reliability of high-performance aircraft and missiles, since it will duplicate precisely in-flight vibration conditions which are the cause of 40 percent of all service failures.

MINNEAPOLIS-HONEYWELL REGULATOR COMPANY
MILITARY PRODUCTS GROUP

During 1959, Minneapolis-Honeywell completed an addition of nearly 40,000 square feet to its inertial guidance plant north of St. Petersburg, Florida. The addition was being used for manufacturing and assembling of inertial guidance systems and components for missiles and other vehicles.

In January, Honeywell began delivery of production "spike positioners" that permit maximum utilization of thrust for the Air Force's supersonic B-58 bomber under a $1.6-million contract awarded by Convair of Fort Worth, Texas. The inlet diffuser control system automatically controls the position of the shock wave produced by faster-than-sound flight as it enters the B-58's four jet engines.

Throughout the year Honeywell was engaged in the design and production of attitude control systems for both orbiting and re-entry versions of Project Mercury, the National Aeronautics and Space Administration man-in-space project. The company was also conducting human engineering studies for Project Mercury.

Honeywell's Inertial Guidance Center in St. Petersburg was awarded a multi-million dollar contract to develop an inertial guidance system for an Army Signal Corps drone being built by the Fairchild Aircraft and Engine Corp. The Honeywell system will be a variation of its "MIG" inertial guidance system, smallest and lightest pure inertial system yet devised. The drone is designated AN/USD-5.

In February, the Ordnance Division of Minneapolis-Honeywell was awarded a $2.9 million contract to continue development started at the Army's Picatinny Arsenal for the adaption of a nuclear warhead for the Sergeant missile. The contract called for further development of the fuzing mechanism, arming devices, safety mechanisms and nose cone structural assembly.

Also in February, the employees of Minneapolis-Honeywell's Aeronautical Division received congratulations from President Eisenhower on the successful orbiting of the Vanguard II weather satellite. The Honeywell division designed and manufactured the guidance reference system that enabled the Vanguard rocket to launch the weather-reporting satellite.

M-H scientist examines beryllium sphere.

In March, Honeywell announced receipt of $8 million in new orders for automatic flight control systems for the Air Force's F-101B Voodoo supersonic interceptor. The new contracts brought the total awards made to Honeywell for the F-101B autopilots during the past several years to $28.3 million. Orders for the F-101A version of the McDonnell Voodoo amounted to about $20 million.

Again in March, Honeywell's Aeronautical Division was given the assignment to develop guidance and stabilization systems for the "Scout" multipurpose space vehicle. Honeywell's system includes new ultra-accurate gyroscopes, servo control systems, a programmer, and hydrogen-peroxide reaction controls.

In June, Honeywell announced that it was producing autopilots for the Navy's WF-2 "Tracer" and S2F-3 "Tracker" airplanes under nearly $4 million in contracts from Grumman Aircraft Engineering Corp. Development and prototype production work on the systems was conducted by Honeywell for one and a half years at the company's Aeronautical Division in Minneapolis. Honeywell also announced receipt of a $5.4 million contract to develop and produce inertial guidance systems for Centaur, the first U. S. high-energy space vehicle.

From May through October Honeywell's Aeronautical Division flight tested a three-axis version of its Adaptive Flight Control system in an F-101A airplane. Dynamic performance was exactly as predicted over the flight envelope of the F-101.

Honeywell's Aeronautical Division announced that it had proven the feasibility of an electrically suspended gyroscope with the potential of far greater accuracy than present forms of gyroscopes. The gyro contains a beryllium sphere rotor machined to tolerances more accurate than 15 millionths of an inch. The sphere is electrically suspended in a vacuum and rotates at high speeds unassisted for long periods of time. Honeywell had been conducting research in electrically suspended gyros under contract to the Navy Bureau of Ordnance since 1956 and in 1959 received a contract from the Air Research and Development Command of the Air Force for a study of airborne feasibility.

In September, the National Aeronautics and Space Administration successfully fired a Big Joe Test Capsule which was controlled and stabilized in space by a Honeywell system. The stabilization and control system was programmed to take control of the capsule at separation, stabilize its flight, then turn the capsule completely around and at the point of re-entry start the capsule revolving slowly. The company was building a more complicated but similar system for Project Mercury's manned flight.

Receipt of a $2.6 million contract to produce miniaturized inertial guidance systems for Army surveillance drones being built by Republic Aviation Corp. was announced in September. The inertial guidance units, in conjunction with an airborne computer, will be able to guide the drone over several target areas on each flight without radio or radar commands and return the drone to safety.

The Honeywell-Atkins Maximum Safety Light, new airborne lighting system designed to reduce sharply the possibility of mid-air collisions, was certified by the Federal Aviation Agency. Acting on the FAA approval, Honeywell's Aeronautical Division announced that it was stepping up production plans to make the flight safety device available for all civilian and military aircraft.

Early in October the company's Aeronautical Division completed the nation's first long-term two-man space cabin simulator. The seven-ton device, which was designed to explore man's reaction to 30 days of simulated space flight, was shipped to the Air Force's School of Aviation Medicine at Brooks Air Force Base, San Antonio, Texas. To approximate closely conditions imposed by space travel, the space cabin was designed to be virtually self-sustaining. As a result of developments at Honeywell, the astronauts in the cabin will breathe and re-breathe the same air and drink and re-drink the same water for 30 days.

During 1959, Honeywell's Aeronautical Division worked on the navigation and guidance system for one version of Dyna-Soar, the Air Force manned and pilot-controlled semi-orbital vehicle.

For the Army-Navy Instrumentation Program the Research Department of Honeywell's Aeronautical Division conducted studies to determine human ability to control everything from a single push-button to a complete space ship. Both men and aircraft were simulated on digital and analog computers in a technique referred to as "robot psychology."

THE NEW YORK AIR BRAKE COMPANY
WATERTOWN DIVISION

The Watertown Division of The New York Air Brake Company continued to expand the existing product line of "STRATOPOWER" constant and variable delivery, axial piston hydraulic pumps and motors during 1959.

The "STRATOPOWER" Overcenter Hydraulic Pump offered a brand new degree of versatility and several advantages over previously available pumps. The most significant advantage to the overcenter type of design is the fact that once a pump of any given size is developed, the companion motor is well on its way to being developed. The New York Air Brake design shows only a subtle difference between a pump and motor.

The company had in production several of these new hydraulic motor and pump sizes and other sizes will continually be made available.

The sizes available at year-end as pumps or motors with ratings in cubic inches displacement per revolution included .05, .1, .2, .25, .6, .68, 1.6, 4.5. These were available in both fixed and variable displacement versions. It is significant that these hydraulic motors can utilize any of the presently known fluids.

PACIFIC AIRMOTIVE CORPORATION

During 1959, Pacific Airmotive Corporation continued its work on overhaul of jet engines. Schedules for deliveries of JT3 jet engines to Continental Air Lines called for two overhauls a week. This workload was supplemented by a support program on the JT4 engine, with output averaging an engine a week.

Commercial jet engine overhaul supplemented the company's volume in the overhaul and servicing of military J57, J75 and T34 engines, with the overhaul of Rolls Royce Dart engines scheduled to begin in January 1960. PAC also continued to overhaul piston engines and accessories ranging in size from the smallest Lycoming and Continental engines up to the largest Pratt & Whitney engines.

Pacific Airmotive was the only aircraft maintenance facility in the United States currently certificated by the Federal Aviation Agency to overhaul both JT3 and JT4 jet engines.

Eleven Grumman Gulfstream turboprop business transports were sold by PAC and its wholly owned subsidiary, PacAero Engineering Corporation. Eight of the aircraft were delivered during 1959, with the balance scheduled for early 1960. The company received orders to outfit 10 of these Gulfstreams, which are delivered by the manufacturer in bare-hull condition.

Convair 340s and 440s were being modernized to high perfromance propjet aircraft under a joint program with the Allison Division of General Motors. Conversion of the Convairs involved removal of the original piston engines and installation of Allison 501-D13 propjet engines. Through PacAero Engineering Corporation, PAC is responsible for the engineering, tooling, manufacture and installation of the conversions as well as flight test and FAA certification. PacAero had orders for 10 conversions, with nine additional aircraft being scheduled.

The distribution phase of the company's operations was broadened with the addition of new franchise lines for parts and equipment installed on the turbine-powered airliners and business transports now going into service. Supplementing the major engine and accessory manufacturers that PAC has represented for many years, the company signed distributor agreements with the following manufacturers during 1959: Cooperative Industries, Minnesota Mining & Manufacturing, Meletron, Marvel Schebler division of Borg Warner, Airborne Accessories, Sonotone, and Holley Carburetor.

At Chino, California, the company was performing a small overhaul program on Venezuelan Air Force C-47s and had an IRAN contract to overhaul 67 Navy R4D transports.

Flight Support, Inc., PAC's subsidiary engaged in the manufacture of aircraft test and ground support equipment, was responsible for the design and production of accessory test units for American Airlines' new jet test facility at Tulsa.

Golden Gate Aviation, Inc., was incorporated as a subsidiary of PAC in 1959. Headquartered at Oakland International Airport, Golden Gate Aviation is the authorized distributor for Beechcraft private and executive airplanes in Northern California and Northern Nevada.

PACKARD BELL ELECTRONICS
TECHNICAL PRODUCTS DIVISION

In a year of advances and developments, Packard Bell Electronics' Technical Products Division experienced four major events: the award of an initial subcontract for Polaris Fleet ballistic missile automatic checkout equipment from the Lockheed Aircraft Corporation, Missile and Space Division; the acquisition of a majority interest in Technical Industries Corporation of Pasadena; the listing for trade of Packard Bell Electronics' stock on the New York and Pacific Coast stock exchanges; and ground breaking ceremonies for an eventual 350,000 square foot electronic center in Newbury Park, California.

The Division concentrated on research, design, development and manufacture of electronic control and test equipment, avionic equipment and components, electrical, electronic and electromagnetic devices and systems.

With an experience based on engineering development and production of electronic ground support equipment for the Thor program, the Snark missile, and the Falcon missile, the Division was awarded in 1959 an initial subcontract totaling approximately $1.5 million from Lockheed for the development and manufacture of factory automatic checkout and readiness equipment for the Navy Polaris Fleet ballistic missile.

Another important contract received during 1959 was a $239,918 award from the Rome Air Material Area, Griffiss Air Force Base, calling for UHF radio sets for ground-to-air communications.

Packard Bell, leading supplier of IFF communications equipment, continued delivery of radar identification sets AN/APX-6 and received a new contract for radar recognition sets AN/APX-7.

Two major developments of the Computer Corporation were the TRICE (transistorized real time incremental computer expandable) and the Multiverter. The TRICE is a differential analyzer which evaluates a missile's performance as fast as the missile operates. Several contracts were received from the Army for this device. A later development, DAFT (Digital/Analog Function Table), was an outgrowth of TRICE techniques and provides accurate and repeatable arbitrary function generation for analog computers.

A DAFT installation at Holloman Air Force Base in 1959 was slated for flight simulation, substituting for expensive experimental flights.

The Multiverter is an analog-to-digital and digital-to-analog converter. This mechanism can translate information to digital form, such as data received from a missile in flight, at a speed equal to the rate received. The company received contracts for this device from the Naval Ordnance Test Station, the Air Force Missiles Development Center at Holloman Air Force ' ise in New Mexico, and from the Army Ballistic Missile Agency at Redstone Arsenal in Alabama as well as Cal Tech and Stanford to translate Explorer radio signals to digital form for evaluation. The Multiverter also found commercial uses, notably in high speed data processing systems for petroleum, chemical and petro-chemical plants.

Another development of the Technical Products Division was the Missile Impact Prediction System, which was installed at Vandenberg Air Force Base in California as part of the Pacific Missile Range. The unit will "lock on" and track the missile automatically as it is being fired.

Other developments from the Division's research and development group included the CNI test set and the ATC Transponder test set; an Airborne Tape Recorder-Reproducer for ITT; and a "fog sensor" for air pressurization and air conditioning systems on commercial airliners.

Durock, a flexible ceramic insulation capable of withstanding intense temperatures up to 1000 degrees Fahrenheit under continuous operation, was also developed by Technical Industries.

REEVES INSTRUMENT CORPORATION

The year 1959, the thirteenth since the incorporation of Reeves Instrument Corporation, was marked by intensive activity in the fields of missile guidance and ground support equipment.

Reeves designed and produced an inertial reference package (IRP) for Lockheed Aircraft Corporation used in the current Discoverer satellite program. The package comprised three single axis floated gyros, two floated accelerometers, and fourteen individually encapsulated, fully transistorized amplifier modules. The units are mounted to a magnesium casting of twelve inch diameter, and the entire assembly weighs less than forty pounds. The IRP is used for guiding the missile during its ascent phase, and for maintaining proper attitude and trajectory while in orbit.

For Philco Corporation, Reeves designed and produced a high precision three axis pedestal which is used as a mount for the tracking radar for the Discoverer program. Complete servo instrumentation is supplied with the pedestal, which stands eleven feet high, and has a base diameter of seven feet.

During 1959, Reeves delivered, under various Navy contracts, a considerable number of Inductosyn repeater systems to the Sperry Gyroscope Company for the Polaris program. Employed as an integral part of the Ships' Inertial Navigation System (SINS), the system makes possible the transmission of extremely low-level Inductosyn outputs to remote stations of the navigation computers.

Reeves was also working on a multi-million dollar contract for the production of depot test equipment for the Rome Air Materiel Area, Griffiss Air Force Base. The equipment will be used in the depot test of systems and components employed in the MSG-1 and 1A close support and guidance radars which Reeves designed and manufactured for the Air Force.

A continuing program of research and development on improved design and production techniques for single axis floated integrating gyros led to further improvements in performance characteristics.

A high precision gyro test table was developed during 1959 to meet production test requirements. The table, being marketed as a commercial item, has a position accuracy of two seconds of arc. Available with all necessary servo electronics, the table is driven by a direct drive torquer motor to eliminate gearing errors. An improved version of the standard gyro test set, consisting of a complete electronics console and table, was also placed into production in 1959.

A complete line of fully transistorized miniature computer amplifier modules were first placed on the market in 1959. An outgrowth of a mid-course computer system developed for the Regulus program, the modules are completely encapsulated, and occupy a total volume of four cubic inches.

Reeves systems and components were used in a number of current missile programs, including Atlas, Titan, Polaris, Regulus, Matador, Discoverer, Thor-Able, Bomarc, Terrier, and others.

REYNOLDS METALS COMPANY

During 1959 Reynolds Metals Company began production of sections for the modified Redstone boosters to be used in the Mercury project. The firm continued its fabrication of ballistic shells and fuel tanks for the Redstone and Jupiter-C rockets and Jupiter-C spin launchers at its Missile Plant at Sheffield, Alabama.

Also at its missile plant, Reynolds designed and built a unique gantry welder which saves time and provides flexibility in missile production. The unit, virtually automatic, is used for metal inert-gas girth welding by combining the stability of a fixed unit with the flexibilty of a movable unit.

A new type aluminum welding back-up bar, which reduces the costs of metal inert gas-arc welding, was developed by Reynolds and was expected to find wide application in the precision welding field. The bar, with a stainless steel insert, cuts in half the average cost of repairing the all-stainless back-up bars previously used.

In July, Reynolds unveiled what is believed to be the country's first all-aluminum airplane hangar at Richmond, Virginia. Aluminum V-beam roofing, which reduces the number of trusses and supporting perlins, was combined with 140-foot clear span bowstring aluminum trusses in an arch-type roof to provide lightweight, maintenance-free construction unavailable until now.

Reynolds Metals Company continued during the year as the leading supplier of aluminum powders to producers of solid fuels for various rocket programs.

ROHR AIRCRAFT CORPORATION

Rohr's product mix during 1959 continued to show increasing emphasis on commercial as well as military business.

Within the year commercial contracts rose to 64 percent of net sales. These included jet power pods, horizontal stabilizers and elevators, sound suppressors and thrust reversers and a 43-foot section of the fuselage for all versions of the Boeing 707. Similiarly jet pods were being manufactured for the Convair 880 and propjet pods and other major components for the Lockheed Electra. Rohr also contracted to produce jet pods and thrust reversers of its own design for the Lockheed JetStar.

In military categories, in addition to continuing production of jet pods and metal bonded panels for the B-52G, and jet pods for the KC-135 tanker, Rohr was planning for manufacture of power units for the new B-52H. Propjet pods for the C-130B, power packages for the P2V, and brazed steel honeycomb structural panels for the Convair B-58 and the McDonnell F4H continued in production. New military orders included engine pod assemblies and other components for the P3V Navy version of the Electra and wing components for the North American B-70, Mach 3 bomber.

Additional emphasis was laid during the year on the company's engineering and manufacturing development services. During 1959 Rohr developed and tested a prototype thrust reverser for the North American F-100F. In the field of nuclear energy, the company manufactured a series of reactor tubes for one of the Atomic Energy Commission's generating plants, and was also selected by the Army to process and rehabilitate artillery gun barrels in an experimental project successfully carried out for Watervliet Arsenal.

Both manufacturing and development effort was amplified in Rohr's adhesive metal bond structure for lower temperature range applications, as well as in high-temperature stainless honeycomb. Phenolic impregnated paper honeycomb core was bonded to metal sheets was utilized in construction of a prototype Arctic hut, designed to replace existing structures along the Distant Early Warning (DEW) line of radar stations in the far north.

Plant production facilities were expanded during the year, bringing to 2,070,930 the total square feet of manufacturing, warehouse and office space at the company's main plant in Chula Vista, manufacturing plant in Riverside, assembly plants in Auburn, Washington and Winder, Georgia, and other associated operations.

SOLAR AIRCRAFT COMPANY


Rocket motor case emerges from Solar furnace.

To house expanding projects in the gas turbine, missile and space and commercial product lines, Solar Aircraft Company began construction of a new 62,000 square foot engineering and research building at its San Diego bayfront property in September, 1959. Solar also doubled the size of its facilities for the manufacture of all-metal honeycomb core and brazed honeycomb sandwich during the year to handle production of components for advanced aircraft.

In the missile and space field several research and development projects involving new concepts were undertaken. A study contract was awarded Solar early in the year by Army Ordnance in the field of missile defense supporting research sponsored by the Advanced Research Projects Agency. The contract was awarded as a result of a new approach developed by Solar and proposed by ARPA.

A unique new rocket thrust chamber and injector was built by Solar for the National Aeronautics and Space Administration. The chamber is constructed of U-shaped channels instead of tubes giving greater design flexibility and more precise control of fluid passages, particularly in the throat areas. The chamber will be used by NASA for testing new rocket propellant combinations at NASA's Lewis Research Center, Cleveland, Ohio.

Two new facilities went into operation at Solar to give the company greater capabilities in the manufacture of products for missile and advanced aircraft components. A giant controlled-atmosphere pit furnace, the only facility of its kind in the nation, was constructed for heat treating large rocket motor cases. The furnace, built below ground level, is capable of heat treating assemblies up to nine feet in diameter by 30 feet long at temperatures up to 1950 degrees F. Another new facility developed at Solar was a traveling furnace designed for brazing long panels of all-metal honeycomb sandwich material. The furnace moves over assemblies of sheet metal faces and honeycomb core, brazing them into a single, lightweight, rigid structure. The traveling furnace went into production in October, 1959, brazing long wing components for the B-70 bomber.

In June, Solar announced the development of a new missile with a peaceful mission—the Firefly. The Firefly is a guided missile fire fighter that is launched like a rocket and hovers like a helicopter. Installed near an area such as an airport, its rocket motor can fire it to anywhere within five miles in 40 seconds. It is fired and guided by push buttons to an air crash or other site of potential fire. When it reaches the scene, the unmanned craft turns into a helicopter and hovers over the area. Then the remote operator can flip a switch releasing more than a ton of extinguishing liquid. The Firefly's body, exclusive of rotors and dispensing nozzle, is about 16 feet long and its wingspan is the same distance. It weighs about 5,000 pounds, including its payload of extinguishing fluid.

Probably the world's smallest aircraft propulsion engine, the Solar Titan gas turbine was installed in a one-man helicopter and passed initial flight tests in September, 1959. The tiny turbine, developed by Solar, is 21 inches long, 12½ inches in diameter, and weighs only 52 pounds. It is rated at 55 horsepower at sea level, and is capable of developing up to 80 horsepower. The versatile gas turbine engine is also being developed as a generator drive for missile support units and auxiliary power units for aircraft.

During 1959 one of Solar's larger gas turbines helped start two of the nation's newest commercial jet aircraft on their maiden flights. Ground support units powered by Solar Jupiter 500 horsepower gas turbine engines, were used to support the Douglas DC-8 and Convair 880 on their test flights.

In addition to missile and gas turbine operations during 1959, the company began development of ducting systems for the B-70 bomber, under contract with North American Aviation, Inc.

SPERRY GYROSCOPE COMPANY

Looking forward to its Golden Anniversary in 1960, Sperry highlighted its 49th consecutive year in the vanguard of navigation technology with major strides in aerospace system development and production. Although many truly significant achievements, particularly those in the research and development stage, were classified, systems for the B-58, X-15, B-70, and other inertial activity, plus the Sergeant program were among those that moved into greater prominence.

As early as 1950, less than a year after "inertial guidance" was accepted as feasible, Sperry undertook the difficult technical challenge of developing an extremely accurate, highly reliable, long-term operating, airborne system. During 1958, the first production model B-58 supersonic bomber was turned over to the Air Force. Hustler now carries the most studied, analyzed, tested, evaluated and "understood" inertial guidance system in being. More than 25 million man-hours were employed to develop and produce the system culminating in production of such systems for the B-58 and for the X-15.

One of the nation's most ambitious research projects, the X-15 manned rocket program moved closer to completion with delivery of Sperry's inertial system. The equipment will enable the X-15 pilot to control the craft as it rockets to the fringe of space, re-enters the earth's atmosphere and lands. Flight instruments developed by Sperry for the project include inertial altimeters, inertial velocity and vertical rate indicators. The system also will feed data to airborne and ground-based recorders for permanent charting of each flight.

Bomb-nav systems and ground support equipment for the first Strategic Air Command wing of 36 Hustler B-58 supersonic bombers were being produced by Sperry. Weapon system manager Convair reported that long-lead time items, including bomb-nav systems, for the second wing also had been authorized. Navigation accuracy in excess of specification requirements were achieved on flights of more than 1,000 miles.

During the year, Sperry received a go-ahead to design and manufacture a gyro platform for the B-70. Under contract to North American Aviation, Inc., Sperry was developing a lightweight Twin Gyro platform, differing in major respects from the conventional two and three-gyro platforms currently in use. Rugged new Sperry Rotorace (TM) gyros, themselves a notable advance in gyro art, will be employed in the system to achieve the accuracy required for B-70 missions while maintaining the bomber's readiness for rapid alert.

The JUNO shoot, which placed the first U. S. satellite in orbit around the sun, and the equally impressive accomplishment of returning monkeys alive from space, pointed out the advanced development of inertial guidance systems. These particular systems were produced jointly by Sperry Rand sister divisions, Sperry Gyroscope Company and Ford Instrument Company.

In the more conventional areas of civil and military aircraft navigation, Sperry had several innovations during 1959. These included a "master navigation system," the AN/APN-118, designed to meet the mission requirements of all types of Army aircraft for at least the next 10 years. Developed in conjunction with the Army Signal Research and Development Laboratories, system key components include an especially developed, lightweight, Doppler radar, radar altimeter, the most accurate Gryosyn[R] compass known, and an automatic navigation computer which "remembers" entire flights and solves complex navigational programs. Components of the system can be assembled in different combinations to meet varying mission requirements.

Also introduced was a unique "push-button" automatic pilot for the nation's upcoming fleet of utility jets. Adopted initially for the Lockheed JetStar, the system provides hands-off jet control at a total weight about one-half that of conventional automatic pilots. The SP-40 system provides exacting control during cruise and couples the aircraft to radio beams for automatic navigation and landing approaches. Where ground radio facilities do not exist, the system accepts Doppler radar signals which enable it to follow automatically any track across ground.

Aviation's first universal flight control system was developed by Sperry. The system will automatically control any type of Army aircraft—helicopters, fixed-wing planes, or pilotless drones. Unlike traditional flight control systems, which have been custom-engineered, or modified, for each type of installation, the Universal Automatic Pilot provides a set of electronic "building blocks" which can be installed in varying combinations to achieve any desired degree of flight automation. The system, developed by Army and the Sperry Phoenix Company, was to be flight-tested initially in H-21, H-34 and H-37 helicopters, L-23, YAC-1 and YAO-1 fixed-wing craft.

Sperry also introduced a low-cost light aircraft automatic pilot for civil aviation. The system, developed by Sperry Phoenix Company, weighs 27 pounds, including flight instruments. Designed so that a complete flight control system can be installed a step at a time, the Automatic Pilot lends itself to any light plane—from small single-engine aircraft to the larger twin-engine types widely used in commerce and industry.

An automatic flight control system expressly designed for jet airliners—the Sperry SP-30—made inaugural flights during 1959 as both United Air Lines and Delta Air Lines began regular service with the new Douglas DC-8. The system also has been adopted by Convair for its 880 and 600 series of jetliners. It provides hands-off control of jetliners at a relatively slow 100-miles per hour through nearsonic speeds and in combination with Sperry's Integrated Instrum t System gives pilots a pictorial display of navigat n information as well as "how to fly" instruction of maneuvering and landing.

In the areas of drone control and guidance, Sperry's SEE (Sperry Echo Enhancer) system was adopted widely during 1959. Designed for use with surveillance, air-intercept or tracking radars, the system makes miniature target drones look like giant intercontinental bombers during simulated air attack tests. SEE also could be used by ground controllers to locate and identify aircraft with greater certainty at greater distances.

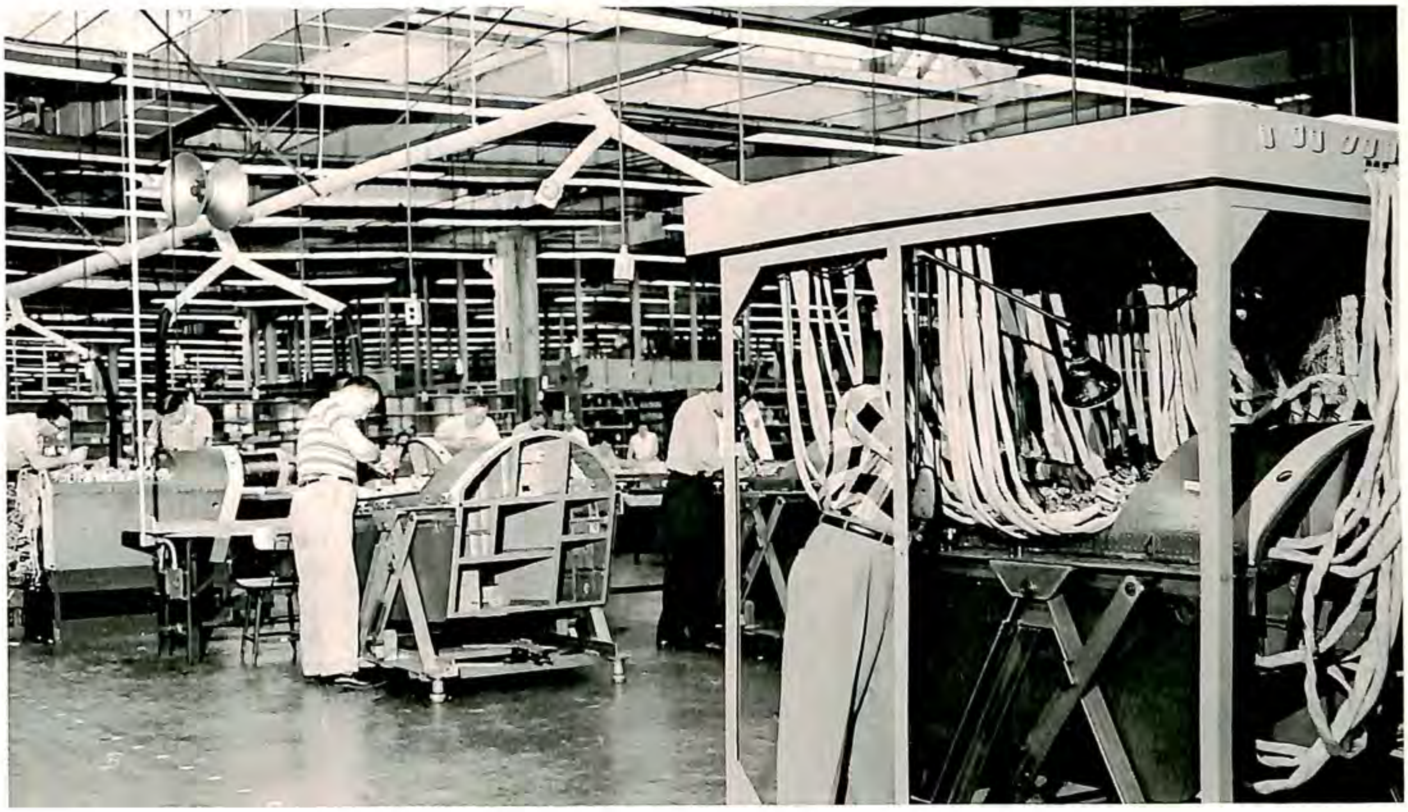
Under a joint Lockheed/Sperry Phoenix program, B-47 jet bombers—designated QB-47s—have been converted to pilotless drones. The Sperry guidance and control system utilizes high-frequency radio signals from a portable ground station during takeoffs and landings and from a DT-33 director aircraft during flight to command specialized flight controls.

Sperry also continued to deliver similar drone control and guidance systems for USAF's fleet of QF-80 pilotless jets and has designed and developed specialized equipment for remote control of Army's SD-2 surveillance drone.

Production of APN-59 radar equipment, used in USAF's C-130B, C-133B and KC-135A, continued at Sperry. The system, which was modified to obtain the first radar pictures from the edge of space during balloon tests, is used for search and surveillance, storm detection and other all-weather navigation procedures.

Sperry's production of electromagnetic countermeasures for USAF's B-52s was one of the company's most important and pressing defense projects. Under an avionics system managership assigned by the Air Force, Sperry marshalled the forces of a large segment of American industry to create an ECM system that renders the B-52 invulnerable to many forms of enemy action. Designed to jam and confuse enemy radars and to deceive missiles, the AN/ALQ-27 system is reported to be the most comprehensive ever developed.

In the area of guided missiles, Sperry's production of radars for Navy's Terrier and Talos missile systems continued in high gear. During the year,



Finishing touches are put on B-58 navigation units before shipment.

it was disclosed that a more compact radar system had been developed for the new, longer-range, Terrier missile. It was also revealed that the Army's Sergeant missile system had moved into the hardwar production stage. Initially developed by the Jet Propulsion Laboratory, Sergeant was being produced by the Sperry Utah Engineering Laboratory, Salt Lake City. The new solid-fueled tactical missile has greater range, accuracy and reliability than Corporal, its predecessor. Noteworthy for mobility and portability, Sergeant requires a minimum amount of ground support equipment. System maintenance requirements and ground handling procedures also have been minimized.

In respect to the Polaris program, Navy's first navigation management contract awarded a private contractor went to Sperry. The contract gave Sperry the authority to design, specify, integrate, deliver, install and purchase navigation equipment for new, second-generation Polaris submarines from other contractors. It supplemented existing contracts for integrating the complex systems in earlier 598-class submarines, such as the GEORGE WASHINGTON, PATRICK HENRY, and THEODORE ROOSEVELT, launched during 1959. The new 608-class submarine will advance the nuclear hull design over the earlier vessels and will increase size. Under the impetus of a speeded-up program to have Polaris operational by 1960, a new laboratory test center will enable Sperry to solve assembly and operating problems of a combined complement of advanced navigational equipment—before actual installation aboard a submarine.

SCAR (Submarine Celestial Altitude Recorder), a means by which submarines can take celestial fixes while submerged, was revealed. The exact altitude of a celestial body is computed automatically, giving the angle of sighting in degrees and minutes as well as time in hours, minutes and seconds. An exact fix can be determined from two or more sightings without the inherent danger of surfacing. SCAR, produced by the Sperry Piedmont Company, was demonstrated earlier during the historic submerged voyages of the NAUTILUS, SEAWOLF, and SKATE.

As a result of a study of measurement problems in American industry conducted by Sperry for the Aerospace Industries Association in cooperation with the Air Force and the National Bureau of Standards, corrective actions were being taken to head off a national "measurement pinch." The survey, which indicated the need for unified standards, included specific recommendations toward improving the national calibration program.

Gyrolube(TM) Flotation Fluid, which will permit all-latitude, all-weather storage and operation of floated gyroscopes, marked a technological breakthrough disclosed during the year by USAF and Sperry. The new gyro flotation material, which retains fluidity to less than −65° F without artificial heat, is of importance to operation of inertially guided bombers, missiles and submarines.

Several technical breakthroughs were disclosed by Sperry's Electronic Tube Division. These included development of the most powerful transmitter klystron ever built for high-frequency target tracking radars in missile defense systems. Developed for the Army Signal Corps, the new klystron will enable greater accuracy, speed, and certainty in tracking of small, fast-moving targets at much longer ranges than heretofore achieved.

Among other achievements in the division's laboratories was a new wide-band radar amplifier tube which produces more than 20 kilowatts of power at frequencies up to 40 billion cycles per second.

At Sperry Microwave Electronics Company, strides in applying new principles of "solid-state" physics to microwave circuitry yielded devices for more precise control of extremely high radar power. Recently developed ferromagnetic materials have fostered a completely new approach to microwave circuit elements and eliminated several mechanical problems of co entional microwave devices. The new line of devices include extremely fast microwave switches without moving parts, low noise amplifiers, modulators, attenuators, mixers, and isolators which enable important improvements in the technical capabilities of advanced radar systems.

Introduced by Sperry's Semiconductor Division were three new series of super-quality diodes and transistors designed to withstand rocket vibration, severe shock, and high temperature. Sperry also introduced the first series of silicon PNP military type transistors for switching and servomechanism circuits in missile and airborne equipment operating in extreme environments.

SUNDSTRAND CORPORATION

At the Annual Stockholders' Meeting held on April 28, Sundstrand's corporate name was formally changed from Sundstrand Machine Tool Company to Sundstrand Corporation. While the Machine Tool Division of the Company continued to expand, the corporate name failed to reflect the rapid growth of non-machine tool operations.

Sundstrand's growth in the Aviation and Department of Defense products area has been evidenced in recent years by the development of Sundstrand-Denver, and the acquisition of Sundstrand-Turbo, Pacoima, California. Following the corporate name change, sales efforts of these divisions were combined with Sundstrand Aviation, Rockford to form the Aviation and Defense Products Group. This consolidation assured maximum utilization of combined capabilities to better serve the aviation and defense markets.

In line with the new sales and marketing approach, Sundstrand in August opened a district office in Dayton, Ohio to serve AMD and WADD.

SUNDSTRAND AVIATION

Development of secondary power systems and components at Sundstrand Aviation reached a new peak during 1959 with the naming of the division as Secondary Power Subsystems Manager for both the B-70 and F-108.

Delivery of constant speed drive systems for commercial applications continued throughout the year with increased production for both the Boeing 707 and Douglas DC-8.

In 1959, Sundstrand developed a combination cartridge-pneumatic jet engine starter. The new starter weighs less than 55 pounds and provides safe, dependable, three-way starting: solid propellant cartridge starts; cross bleed air starts; and low pressure ground cart compressed air starts. Aerodynamic braking in all three starting modes provides inherent self-limiting to prevent overspeeding without requiring valves, servos, or other mechanisms. The unit is designed for use on either single or multi-engine aircraft. A further design advantage is a moveable breech, which allows the starter to be easily adapted to most airplanes.

Continuing its extensive research in high temperature accessory power systems and components, Sundstrand Aviation announced the successful development of a secondary power system capable of 600 F operation. A major portion of this program involved comprehensive evaluation and complete environmental testing of all mechanical, hydraulic and electrical components.

During the year, Sundstrand also announced the development of SUNDYNE pumps—a new design for fluid transfer. With initial application for water injection on turbofan models of the Boeing

707 jetliners, Sundyne pumps offer numerous advantages. They have high reliability and long life resulting from a negligible temperature rise during dry operation. Sundyne pumps are rated up to 90 gpm and are built to operate for 1500 hours between overhaul.

A further growth of Sundstrand constant speed drive activity was the design and development of a 120 KVA drive. The new drive represents a significant increase in secondary power capability for the increasing demands of new aircraft.

The Investment Castings facility continued to grow during the year with large scale expansion of both plant and equipment.

SUNDSTRAND TURBO

Sundstrand Turbo activities at both Pacoima, California and Denver, Colorado continued in advanced research for internal power on missiles and space vehicles during 1959. Three major state of the art projects in progress during the year were chemical open and closed cycle turbine power systems, solar regenerative fuel cells and quick response flight altitude control system.

The solar regenerative fuel cell was being developed for a closed cycle fuel cell system capable of being regenerated by solar energy. Operating life of the cell will be one year of continuous operation under environmental conditions encountered by space and orbital vehicles.

Another program started during the year involved the development of an orbital vehicle, high performance, open cycle, chemically powered turbine APU. In this system, power is derived from hydrazine through a pressure-staged turbine. The duty cycle of the unit will be 4.5 hours with a reliability objective of 1500 hours mean time to failure.

A program for development of a new hot gas reaction valve for application in flight attitude control requirements was also begun during 1959. Operating on hydrazine, the system has a response time from electrical signal to full thrust of 10 milliseconds. The system has three nozzles to control yaw, pitch and roll. The combustion chamber can be blocked for extensive periods of time without flaming out. The valve can be pulsed from a rate of one cycle per hour to a maximum of 30 cycles per second.

THOMPSON RAMO WOOLDRIDGE INCORPORATED

During its first full year as a corporate entity resulting from the merger of Thompson Products, Incorporated, and Ramo-Wooldridge Corporation in October, 1958, Thompson Ramo Wooldridge Incorporated made significant progress in new aircraft and missile projects as well as in the development of electronic systems for both military and commercial applications.

To handle expanding programs in these newer fields, the company added substantially to its facilities during the year. The role of the company's Tapco Group, within which the long-established aircraft product lines are operated, underwent a major transition from components maker to producer of highly engineered sub systems for advanced aircraft, missile and space vehicle applications.

While continuing as a leading producer of turbojet engine assemblies and aircraft fuel system components for the greatly reduced but still substantial aircraft market, Tapco moved forward with contracts to develop accessory-drive, hydraulic and liquid-cooling systems and high performance booster pumps for the B-70. Among other important new contracts was one to produce a Tapco designed and developed auxiliary power supply of advanced configuration for an important defensive missile, and another that calls for the development of a miniaturized auxiliary power supply for an undisclosed application.

A contract that presented an especially severe engineering challenge was one to develop a high pressure gear pump for an advanced turbojet engine in which fuel and environmental temperatures will be so high that conventional sealing materials and light metals cannot be used. It must be essentially an all-steel pump.

At the same time, Tapco made progress during the year in microwave components and the development and production of airborne telemetry equipment on an extremely tight timetable.

Tapco continued its work in highly specialized tubular structures for aircraft and missile applications, and to consolidate and prepare for expected growth in this area, began construction of a two-million-dollar plant in Anaheim, California, in which operations in smaller plants in Bell and Long Beach were to be combined. Additional facilities for high temperature metallurgical research and development were provided in Cleveland and a new high speed, large capacity digital computer system was added to the New Devices Computer Laboratory. Expected to greatly aid the Group's work in missile fuels and fuel systems was the acquisition during the year of Magna Products, Inc. of Santa Fe Springs, California, which has study contracts on solid propellants.

Activities of the Ramo-Wooldridge Division, which occupied new $14-million laboratories in Canoga Park, California, in November, were organized into two areas of major concentration. Research and development activities of the Systems Technology Division included communications systems, counter-countermeasures systems, infrared systems, penetration systems, reconnaissance systems, antenna research and design. Data processing and process control programs were also a part of a new organization: Intellectronics Laboratories. Areas of interest included electronic computers, data processing, automatic process control and other applications of electronics in the extending of human intelligence.

In its Intellectronics Laboratories, R-W Division assembled a combination of talents comprising physical scientists, electronics engineers, systems engineers, and social scientists and psychologists who together will be able to break down major intellectual tasks into properly compatible, separate efforts appropriate to the human intellect and the electronic machine.

Work underway in the Intellectronics Laboratories included novel approaches to automatic translation of languages, the design of electronic information processing systems to aid the military, design and production of complete installations for process control in industry, and new intellectronics systems for air line navigation and traffic control. R-W's combined commercial and military research and development business in Intellectronics was running at a rate of approximately $25 million annually.

Pacific Semiconductor, Inc., a subsidiary, continued to show a record rate of growth during the year, and with further expansion of facilities to meet customer requirements being completed and scheduled for early construction, growth was expected to continue.

VICKERS INCORPORATED

In 1959 Vickers research and development work covered a wide range of projects for various commercial and military aircraft and space vehicles. These projects included extensive studies of fluid mediums such as hot gases and exotic fuels. High-temperature and high-speed studies resulted in several product improvements and new products which are important contributions to the science of space exploration. Auxiliary power systems were designed and built to meet the space, weight and performance characteristics of various missiles and rockets.

Early in 1959 Vickers announced a new series of miniaturized motorpump packages for missile applications. The first models of the vane-pump electric motor combination were used for low pressure circulation of coolant-oil around the high output tubes of missile electronic gear. Other applications for this motorpump include missile skin cooling, electronic chassis cooling, fuel and lubricating pumps, small radar and computer drives and remote power supply.

A 60 kva differential type constant speed drive for aircraft alternators was developed and manufactured. This drive maintains close output speed regulation while accepting input speeds varying from 3800 to 7000 rpm. It maintains steady state speed plus or minus 0.25 percent over 200° F temperature range, plus or minus 0.5 percent for 400° F temperature range and 0.5 second maximum full load transient recovery time.

Designed for both aircraft and missile applications the Vickers Servo Valve, handles 3.5 to 5 gpm at 3000 psi. It weighs only 8.5 ounces.

Several self-contained auxiliary power units for operational missiles were in production. These self-contained packages have a wide variety of uses and are tailored to meet one or more missile requirements such as guidance, communications, environment control, pumping fuel, controlling fuel rates, etc.

Since missiles and space vehicles vary widely in their application and in their auxiliary power requirements, no single source is applicable to all of them.

Vickers auxiliary power units in production included proven power sources such as hot gas systems, battery systems, turbine systems, etc., and unusual power sources were being investigated. These include sun power, nuclear energy and ionic energy.

One of the newest additions to the Vickers line of aircraft products was a new series of fixed displacement vane-type fuel pumps for jet engines. These new pumps provide significant weight savings up to 10 to 25 percent.

Important and significant advancements in forging technology were made by Wyman-Gordon Company in 1959.

In the field of forging supernickel alloys to meet ever increasing demands for forgings to withstand greater pressures and higher temperatures, Wyman-Gordon produced larger and heavier components than previously available. Forgings from such alloys as Waspaloy, Rene '41 and WG-500, previously attainable in small components ranging from ½ to three pounds in weight, became available in varying configurations and weights up to 1,000 pounds as regular production items.

The techniques used in producing these forgings were evolved from a development effort undertaken by Wyman-Gordon Company in anticipation of the need for components for advanced jet-engines, rockets and aircraft.

Space travel was brought a step closer to realization in 1959 by the breaking of an important materials roadblock: the first successful large closed-die forging of the exotic metal, beryllium, at Wyman-Gordon.

In announcing his company's achievement in overcoming the one critical impediment to the use of beryllium in space flight—its brittleness—Robert W. Stoddard, president, said that ". . . beryllium may now be truly considered a structural engineering material for future space flight. It is anticipated this will have far-reaching effects in propulsion systems, missile applications and space vehicles."

The importance of this forging development of beryllium use in space travel derived from the fact that beryllium's lightness, in addition to its other unusual space-travel qualities, reduces the ratio between the weight of a vehicle and its power with the result that it affords added fuel load and increased range of a missile, rocket or airplane.

The beryllium forging met a Government need for a space metal which must withstand high and low temperatures, severe demands of nuclear compatibility, thermal shock, corrosion resistance and radiation damage.

Also during the year, more power and greater payload in missiles and jet engines were made possible as the result of the first successful large closed-die forging of the world's highest strength—high temperature superalloy, Astroloy.

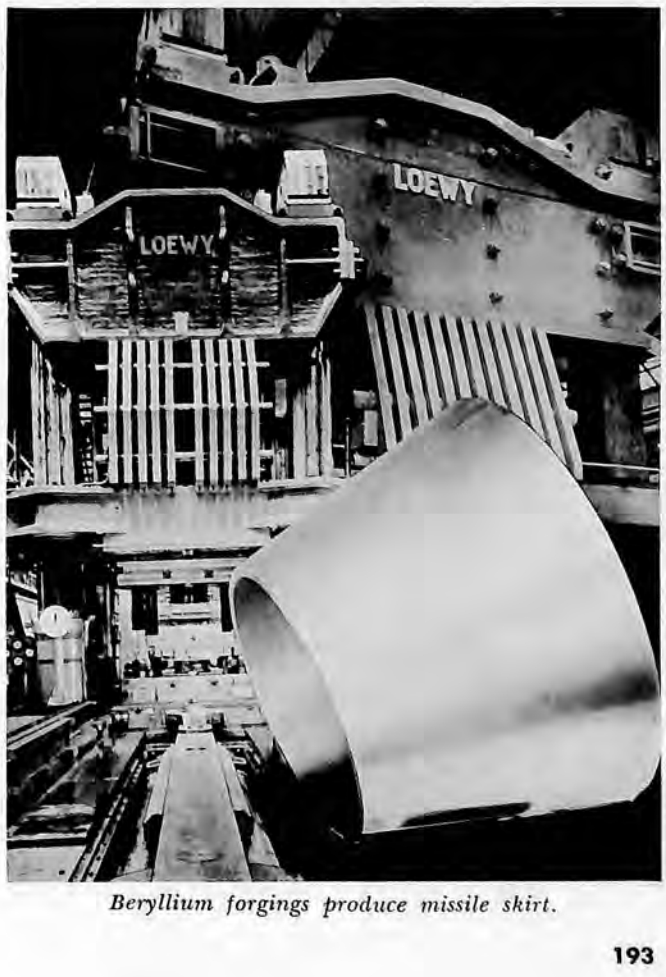
Sufficient development was accomplished to enable the company to guarantee minimum properties in forgings up to forty inches in diameter.

For the parts for which Astroloy can be used this meant that operating temperatures of missiles and jet engines could be increased by as much as 200 degrees, which in turn meant increased power and greater payloads for missiles and jet engines.

Another development at Wyman-Gordon during the year was closed-die forging B120VCA all-beta titanium missile motor casing closures.

In addition to titanium, B120VCA contains vanadium, chromium and aluminum. The forging on view weighs 441 pounds, has an outside diameter of 41.16 inches.

At present, this alloy as forged at Wyman-Gordon develops 180,000-200,000 psi yield strength with four to six percent elongation. At 180,000 strength level, B120VCA is equivalent to steel at 290,000 yield on a strength to density basis. The fact that this B120VCA is in initial stages of application, the strength growth potential is believed to exceed that for steels in the foreseeable future. The higher burst strengths available can be translated into various objectives sought by missile engineers, such as increased range, payload and speed.



Beryllium forgings produce missile skirt.

MILITARY AVIATION

★ ★

DEPARTMENT OF DEFENSE

The pattern for Defense's 1959 year was similar to the preceding year with Soviet technological gains dictating increased activity, particularly in the field of research and development. Military space programs were further accelerated and the shift to guided weapons became more pronounced as new types reached operational status. Although manned aircraft continued to be the mainstay of the Department's air strength, there was further de-emphasis in this area insofar as developmental projects were concerned.

The Department's expenditures for the fiscal year 1960, which started July 1, 1959, were estimated at $40.9 billion, about $300 million less than the amount spent in fiscal 1959 and almost $2 billion down from the 1958 figure.

Force levels dipped slightly during the year. In the Air Force, the number of strategic wings remained constant at 43, but tactical wings were reduced by one and air defense wings by two. At year-end, the USAF was operating a total of 102 wings, down from 105 at the end of 1958.

The Navy's first all-new guided missile destroyers were launched in 1959 and the 1960 shipbuilding program provided for six guided missile destroyers and frigates, four nuclear-powered attack submarines and eight other vessels. The first nuclear-powered surface ship, the guided missile cruiser *Long Beach,* was launched in July. The Navy was replacing its Essex Class carriers with Forrestal Class attack carriers.

Army forces were cut by about 20,000 troops during 1959, but at year-end the Army continued to support 15 divisions and 23 other major units including four missile commands, eight battle groups and three field artillery missile groups (heavy).

The Marine Corps continued to support three divisions and three air wings.

Top-level personnel changes in the Department of Defense in calendar year 1959 included:

January: Dr. Herbert F. York began work as the Defense Department's first Director of Research and Engineering. (He was appointed to this office on December 24, 1958.)

February: Garrison Norton resigned; the office of the Assistant Secretary of

Thomas S. Gates, Jr.
Secretary of Defense

Franklin B. Lincoln, Jr.
Assistant Secretary of Defense

James H. Douglas
Deputy Secretary of Defense

the Navy for Air was eliminated, and the Assistant Secretary for Research and Development became responsible for aviation as well as atomic energy and research and development matters; George W. Vaughan became Assistant to the Secretary of Defense for Legislative Affairs.

March: The President nominated Admiral Arleigh A. Burke and Generals Nathan F. Twining and Thomas D. White for new two-year terms on the Joint Chiefs of Staff.

April: Air Force Lieutenant General Bernard Schriever was named chief of the Air Research and Development Command; The Senate confirmed Cecil M. Milne as Assistant Secretary of the Navy for Materiel, and Philip B. Taylor as Assistant Secretary of the Air Force for Materiel; Vice Admiral John T. Hayward took over the newly-created post of Deputy Chief of Naval Operations for Development; Rear Admiral Ralph K. James was named chief of the Navy's Bureau of Ships.

May: Deputy Secretary of Defense Donald A. Quarles died, and Thomas S. Gates, retiring Secretary of the Navy, was nominated to replace him. William B. Franke, Undersecretary of the Navy, succeeded Gates; Defense Secretary McElroy appointed Admiral Arthur W. Radford, retired chairman of the Joint Chiefs of Staff, to serve as a consultant to the Secretary of Defense during the illness of the Joint Chiefs' chairman, General Twining; General Lawrence S. Kuter was named commanding officer of the North American Air Defense Command.

June: General Maxwell D. Taylor, Army Chief of Staff, retired June 30; his successor, General Lyman L. Lemnitzer, was sworn in on July 1; Dr. Joseph V. Charyk became Assistant Secretary of the Air Force for Research and Development; General Frank L. Everest was selected to head the Tactical Air Command; Major General William S. Stone was named superintendent of the Air Force Academy.

July: James H. Wakelin, Jr., became assistant Secretary of the Navy for Research and Development.

August: General George H. Decker was sworn in as the Army's Vice Chief of Staff; Dudley C. Sharp was sworn in as Undersecretary of the Air Force; Major General David M. Shoup was named commandant of the Marine Corps.

September: The Navy announced that the Bureau of Ordnance and Bureau of Aeronautics would be consolidated into a Bureau of Naval Weapons, effective December 1, 1959. Rear Admiral Paul D. Stroop was named chief of the new bureau; J. Vincent Burke, Jr., was sworn in as Department of Defense General Counsel; Defense Comptroller Wilfred J. McNeil resigned effective November 1.

October: Major General August Schomburg was named commanding general of the Army Ordnance Missile Command, Huntsville, Alabama.

November: Franklin B. Lincoln, Jr. was nominated as Assistant Secretary of Defense (Comptroller) to succeed Wilfred J. McNeil.

December: Neil H. McElroy resigned as Defense Secretary; Thomas S. Gates succeeded him; Brigadier General Austin W. Betts was named head of Advanced Research Projects Agency; on December 11, James H. Douglas, Jr. was sworn in as Deputy Secretary of Defense; Dudley C. Sharp was sworn in as Secretary of the Air Force.

AIR FORCE

During 1959 the United States Air Force made significant progress in modernizing its operating forces.

Intensive efforts were made to bolster the position of the United States in the field of astronautics (see Research and Development). In September the Secretary of Defense clarified responsibilities for military space systems, assigning to the Air Force the task of development, production, and launching of all space boosters and also the development of such specific satellites as Midas, for early warning against ballistic missiles, and Samos, a reconnaissance system.

In December, 1958, the Air Force had been assigned the development of systems and techniques for operating certain space vehicles Under Project Discoverer, ARPA-AF, the USAF Ballistic Missile Division conducted initial tests of the propulsion and guidance systems of satellites, followed by attempts to recapture satellite capsules carrying live animals. The recapture of these capsules will be a milestone in the progress of the man-in-space program, Project Mercury, NASA-AF. Between February and December there were seven Discoverer launchings, five of which were placed in polar orbit.

The X-15, a piloted aircraft designed to take man to the outer fringes of the earth's atmosphere, made its first flights during 1959. After a captive flight in March, its first powerless flight took place three months later. In September the X-15 made its first successful powered flight. Released at an altitude of 38,000 feet, it climbed to 50,000 feet, attaining a speed of more than 1,000 miles per hour. One month later, in a second powered flight, the X-15 climbed to 60,000 feet. An in-flight explosion late in the year caused a temporary delay in the program.

The Air Force relied on new and more powerful weapons coming into the inventory plus greater flexibility in their use to insure that reduced combat forces would not result in a loss of fighting strength. The number of manned aircraft wings dropped from 117 on July 1, 1958 to 104 a year later.

Modernization of combat forces could not be permitted to affect day-to-day readiness. Proven weapons were not replaced with those whose reliability and accuracy were still in doubt. The cardinal objective was to maintain the delicate balance between the forces in being and those under development.

Significant progress was made on the intercontinental ballistic missiles, which will be under the operational control of the Strategic Air Command. After an intensive flight-test program, the SM-65 Atlas was declared operational in September, 1959, when it was fired from Vandenberg Air Force Base, California, by an all-Air Force crew for the first time. The advanced SM-68 Titan missile made its first successful flight in February, 1959.

By November the Air Force had selected 12 USAF bases for the support of intercontinental ballistic missiles. Seven of these bases were chosen for Atlas missiles. The five sites for Titans were Lowry Air Force Base, Colorado; Ellsworth Air Force Base, South Dakota; Mountain Home Air Force Base, Idaho; Larson Air Force Base, Washington; and Beale Air Force Base, California.

Intermediate-range missiles were delivered overseas. In August, 1958, the Royal Air Force received missiles for its first SM-75 Thor squadron in the United Kingdom. Two months earlier, a RAF training crew had fired a Thor at Vandenberg Air Force Base. The United States also signed an agree-

Titan's first succesful firing was in February.

The X-15's first powered flight occured in September.

ment with Italy for the placement of SM-78 Jupiters in that country. The Strategic Air Command was responsible for the training of British and Italian missile units.

A noteworthy example of USAF progress in ballistic missiles was the number of successful firings that occurred during the six-month period beginning March 1. Of 43 launchings of Atlases, Thors, and Jupiters, either as missiles or boosters, 33 were completely successful.

SAC also had the air-breathing SM-62 Snark missile in operational status. In April, the first production version of the Snark was fired successfully down the Atlantic Missile Range. Later in the year, the 702d Strategic Missile Wing at Presque Isle Air Force Base, Maine, was in the process of attaining operational readiness.

SAC became an all-jet bomber force in February when its last B-36 was retired. During the same month SAC received its first B-52G, which has greater range and more speed and will carry the GAM-77 Hound Dog missile. In April, a Hound Dog was test-fired from a B-52 for the first time. SAC also increased the number of KC-135 jet tankers in its inventory. The majority of SAC wings were equipped with B-47 medium bombers, but the supersonic B-58 Hustler was scheduled to enter the strategic striking force in the near future.

The highly versatile Tactical Air Command is not only able to wage small wars but can supplement both SAC and the Air Defense Command in a general war. The major new plane entering the TAC inventory was the F-105 Thunderchief, which began to come off the production line in February. The 4th Tactical Fighter Wing, equipped with Thunderchiefs, worked with the Air Research and Development Command in the operational testing of the F-105.

The mainstay of TAC was the F-100 Super Sabre. Other combat aircraft in its inventory included the F-104C fighter, the RF-101 nd RB-66 reconnaissance planes, KB-50J tankers, and C-123 and C-130 transports. The B version of the C-130 Hercules entered TAC units in June. TAC also had F-84Fs and F-86s for training foreign pilots under the Military Assistance Program.

TAC's RF-101 Voodoos established two world speed records in April. They flew an average of 816.28 miles per hour over a 500-kilometer closed course and an average of 700.05 miles per hour for a 1,000-kilometer circuit.

The GAR-8 Sidewinder air-to-air missile proved a potent and reliable armament for TAC fighters. The Air Force also began equipping tactical fighters with the GAM-83 Bullpup air-to-surface missile developed by the Navy. This missile will augment other armament.

In January, TAC began launches of the TM-76A Mace for training purposes. Subsequently, one tactical missile group in Germany began converting from the TM-61 Matador to this newer tactical surface-to-surface missile.

The Air Force continued to stress the importance of air defense against manned aircraft and air-breathing missiles. A successful air defense requires a system of detection, control, and communication. An elaborate network was created to warn of attack, the Distant Early Warning (DEW) Line forming the northernmost outposts in this system. In April, the Air Force opened the Aleutian Island extension of the DEW Line, adding six new stations. Other warning lines, picket ships, offshore Texas Towers, and RC-121 aircraft complete the intricate network.

Control of this air defense system will lie in SAGE centers, each of which will contain two large digital computers. In March, the 26th Air Division (SAGE) became operational, controlling the air defense of the entire northeastern region of the United States. This first operational SAGE air division was made up of five air defense sectors.

The Air Force was building the Ballistic Missile Early Warning System (BMEWS) for timely detection of oncoming intercontinental ballistic missiles. During 1959 construction was in progress on BMEWS sites at Thule Air Force Base, Greenland, and Clear, Alaska. Negotiations were also under way for construction of a third site in the United Kingdom.

The Air Defense Command made rapid progress in the modernization of its interceptor aircraft. Advanced supersonic jets entering the inventory included the F-101B, F-102A, F-104A, and F-106A. The F101B and the F-106A were equipped with the MB-1 Genie rocket containing a nuclear warhead.

The IM-99 Bomarc interceptor missile was in the latter stages of testing. In January the first IM-99A training missile was fired from the new USAF Missile Employment Facility at Elgin Air Force Base, Florida. In September a Bomarc successfully intercepted a supersonic Regulus II drone that had been launched some 300 miles away. Also, in September, equipping of the first operational Bomarc unit began.

Operational readiness of aircraft and missiles depends upon the effectiveness of USAF supply and maintenance procedures. Between March and September, only one percent of the B-52s and one-half of one percent of the jet tankers were out of commission for lack of parts. In order to respond quickly to the demands of the combat commands, the Air Force eliminated depots in Europe and supplied bases on that continent directly from central points in the United States. This system was made possible by electronic requisitioning of items and by airlift.

The Military Air Transport System furnishes airlift both by military aircraft and by civilian carrier. Its basic mission is to meet military airlift requirements in the event of war or threat of war. The Air Force has a vital interest in the development of the civil air transports that will continue to fill a very large part of its airlift needs.

MATS is essentially a cargo fleet, although a number of its aircraft can be used to carry passengers or for air evacuation. The workhorse of the MATS fleet in 1959 was the C-124, designed to carry heavy equipment. Other MATS planes are the C-118, C-121, C-133 and C-97.

As fundamental as weapons for the Air Force are the officers and airmen who are trained in the skills needed for the aerospace age. As retention rates continued to rise, the Air Force made intensive efforts to improve the quality of its military and civilian personnel. The most notable event in the acquisition of new officers was the graduation from the Air Force Academy of the first class of 207 students in June. On June 30, there were 131,602 officers and warrant officers and 708,833 airmen, or a total of 840,435, in the Air Force. About 225,000 officers and airmen were stationed overseas. The number of civilians employed directly by the Air Force totaled 313,466.

ARMY

The high point of interest in Army Aviation and missile development for the year was the transfer of the Army Ordnance missile team under Dr. Wernher von Braun from the Army Ordnance Missile Command at Huntsville to National Aeronautics and Space Administration. About the same time that the President made this announcement, Major General John B. Medaris announced that he would retire. He was replaced by the Deputy Chief of Ordnance, Major General August Schomburg.

During the year, the Army made progress in achieving an increased degree of strategic mobility, the capability of moving forces wherever they may be required in the world. This program involved both readiness of personnel and their equipment, and weapons and other items which must be moved with them.

The concept was incorporated into the new Pentomic division reorganization, and it also influenced research and development of new weapons and supporting equipment, including engineering, communications and transportation items. Emphasis was placed on miniaturization and lightness without sacrificing fighting ability.

Major requirement toward carrying out the concept was expanding joint planning and training, since the Army depends on the Air Force for sufficient air lift to carry its Strategic Army Corps (STRAC) and on the Navy to provide tonnage to support overseas deployment of forces.

In Exercise Banyan Tree early in 1959, the assault echelon of the airborne battle group of the 82nd Airborne Division was loaded at midnight at Fort Bragg and, after a non-stop flight of 1,800 miles, made a parachute assault landing to seize objectives at Rio Hato in Panama at 0730 the following morning.

Increasing capabilities of Army aircraft brought the Army a new degree of tactical mobility. In STRAC units, there was further integration of Army aircraft into tactical organizations to give combat commanders mobility and flexibility scarcely dreamed of in earlier days. For joint airborne operations within 100 to 150 miles of friendly territory, Army aircraft can be expected to fly into the objective area in the early stages of the operation.

Additional progress was made in making equipment airtransportable. Among new flyable items

The DeHavilland Caribou was Army's newest and largest transport.

are a rubber-tired tractor; a seven-and-a-half cubic yard scraper; a seven-and-a-half ton crane shovel of one-half cubic yard capacity; a ballastable airborne tractor (BAT) which, using dirt as ballast, can convert to a 17-ton tractor; and a ballastable crawler (ABC) to dig emplacements.

For air defense of the field armies the Army depended on mobile Nike-Hercules units to provide defense from high altitude attacks. The Hawk, in production at year-end, is a mobile missile system capable of engaging high performance aircraft at medium and low altitudes. Also—a problem not present in continental United States defense—Army troops must be protected from the possibility of low-level attacks by medium performance aircraft, large numbers of which are still in service. This requirement called for a highly mobile, short-range air defense weapon which would be either a rapid-fire small caliber cannon or a rapid-fire missile system which has highly accurate fire control. Plans were announced for a new surface-to-air shoulder-fired guided missile system called Redeye. It is a non-transportable missile system designed to destroy low-flying jets or conventional planes. The weapons system is approximately four feet long, about three inches in diameter and weighs approximately 20 pounds. It is effective at altitudes and ranges commensurate with defense of field army positions and Marine Corps amphibious operations against strafing and bombing aircraft.

Redstone rises from its launching pad.

While the Army made a creditable start in providing itself with a missile atomic delivery capability, it was not completely satisfied with its family of three operational systems in troop use. These were the Honest John, with a range of some 14 miles, the Corporal with a 75 mile range, and the 200-mile Redstone.

Ideally, because obsolescence occurs faster in missiles than any other type of weapon, a three phase program is essential—a system in hands of troops, one under development, and another in early planning stage. Thus, the heavy, short-range Honest John was to be replaced with the Sergeant, a solid-fueled weapon easier to handle and maintain. The Lacrosse was to provide pin-point accuracy necessary for small-yield delivery close-in to friendly troops. The new Pershing, in development, was scheduled to replace the Redstone and provide the Army field commander with a missile of significant range capability and a relatively lightweight weapon that can be easily supported logistically.

Stress was being placed on Short-Take-Off-and-Landing (STOL) or Vertical-Take-Off-and-Landing (VTOL) capabilities for fixed-wing aircraft. Several types developed by commercial firms were in the flight test stage. Advantages of VTOL aircraft include ability to pick up and deliver men or cargo without regard to landing strips, to hover, to take advantage of terrain cover.

The helicopter is a VTOL craft, but its speed and weight limitations made research into VTOL fixed-wing types mandatory. Some of the new aircraft being developed for the Army included: "Iroquois," a turbine-powered utility helicopter capable of transporting small tactical weapons and equipment; "Chinook," a medium transport helicopter; "Mohawk," a fixed-wing aircraft that flies low and fast carrying necessary surveillance equipment for swift ground observation; "Caribou," in test status at year-end was the Army's newest and largest transport, capable of carrying 32 passengers or 22 litters or three tons of cargo. It needs only 1020 feet of runway. Its predecessors, the "Otter" and "Beaver" have been used successfully and are being flown in 58 countries.

Army Aviation was utilizing some fixed-wing aircraft, including the L-19, to proved aerial reconnaissance, target acquisition, fire adjustment capabilities. The L-19 carries a pilot and observer at 85 knots with a four-and-a-half hour fuel supply. There were also in service the L-20 utility and U1-A light cargo fixed wing aircraft utilized for personnel and resupply missions, wire laying, and evacuation of casualties.

NAVY

The year was characterized by refinements in the organization of the operating forces and by adjustments in administrative structure to meet the changing requirements resulting from technical and scientific advances.

Offices and bureaus, particularly those concerned with research and development, were under extensive reorganization. Many of the changes were a direct outgrowth of the recommendations of the Committee on Reorganization (Franke Committee) whose report was approved with minor modification by the Secretary of the Navy on May 15.

Changes most directly affecting the aeronautical organization included abolishment of the Office of Assistant Secretary of the Navy for Air and establishment of an Assistant for Research and Development, merger of the Bureaus of Aeronautics and Ordnance into a Bureau of Naval Weapons, and formation of a new Office of Deputy Chief of Naval Operations for Development.

Transfer of certain divisions from the Office of DCNO (Air) followed the general pattern of consolidating research and development functions into one central office and of returning the Office of DCNO (Air) to its original responsibilities for plans, programs, requirements and training. Responsibilities for planning and directing the Navy space program were assigned to an Astronautics Division, established within this Office in July.

The possibilities for extending the effectiveness of naval operations through utilization of specialized equipments stationed or orbiting in space were under careful study. Many exacting requirements in such areas as intelligence, surveillance, meteorology, communications, and geodetic survey, appeared capable of resolution through the development of specialized space vehicles. Operational requirements for some of these were formulated and presented to the Advanced Research Projects Agency (ARPA) for research and development. The navigation satellite, Project Transit, was under development and on September 17 its prototype was launched by a Thor-Able rocket from Cape Canaveral. Failure of the third stage to ignite, however, foiled the attempted orbit. A second shot was scheduled.

Clarification of the roles of the respective services in Space by the Department of Defense in September assigned specific responsibilities to the Navy for

First aerial view Chance Vought- Navy F8U-2 Crusader II.

the development of satellite systems pertaining to navigation, and for continued research in bio- astronautics, the science of keeping people alive in space.

The Navy was an active participant in other aspects of the nation's space program. Four naval aviators, three Navy and one Marine, were among the seven men selected as the prospective astronauts of Project Mercury. The Johnsville centrifuge and the facilities of the Naval Medical Research Institute, both of which figured prominently in the extended selection program, continued to be utilized in their respective capacities as the training of the selectees began and progressed. The Navy's modified Mark IV full pressure suit, developed by Goodrich and the Naval Aircrew Equipment Laboratory, was accepted by the National Aeronautics and Space Administration (NASA), for use in Mercury. Re-entry tests of the Mercury space vehicle, launched by an Atlas ICBM, were also given a Navy assist when naval air and surface units recovered the capsule about 700 miles from the predicted impact area.

In the operating forces there was a slight reduction in size that continued the trend of the last several years toward a balance between operating costs and effectiveness. The reduction was accompanied by changes in areas of special emphasis and of certain assigned missions.

There were fewer personnel in the aeronautical organization. The inventory of operating aircraft fell to approximately 8,000. Some shore facilities were closed but the opening of others more suitably located and physically equipped almost balanced the losses. A revised concept of aircraft maintenance went into effect and the gradual elimination of Fleet Aircraft Service Squadrons (FASRONS) began. The new system which returns responsibility for maintenance to the unit having custody of the aircraft, was not only expected to improve the overall maintenance program, but also to be more economical in the use of manpower.

There was no change in the number of operational aircraft carriers, but commissioning of the USS *Independence* on January 10 and recommissioning of the USS *Oriskany* after major conversion on March 7 added considerable strength to the fleet. Availability of these modern attack carriers permitted reassignment of two older ships to duties in antisubmarine forces for which they were better fitted. The availability of nuclear powered submarines to employ the Polaris ballistic missile, was assured on June 9 when the USS *George Washington* was launched at Groton, Connecticut, and two more of the same type were launched shortly after. The first two destroyers designed and built as missile ships, slid down the ways in April.

Three more guided missiles were put into full operational use. Sparrow III joined in the air-to-air category and alterations necessary to handle it were completed on ten attack carriers. Bullpup, a highly reliable and accurate air-to-surface missile, was assigned to attack squadrons deployed overseas in both major fleets. The versatile air defense missile Talos with capability for being effective against surface targets, attacking aircraft, and air breathing missiles, begain fleet operations in February when it was first fired at sea by the missile cruiser *Galveston*.

The bombardment missile Regulus I pioneered the delivery of mail by missile in a demonstration made in cooperation with the U.S. Postal Service on June 8. Carrying 3,000 pieces of official mail, the missile was fired by the submarine *Barbero* from a position about 100 miles off the Florida coast and directed to shore at Mayport, where its cargo was delivered safely after a 22 minute flight.

Six missiles continued under development. Corvus, a supersonic air-to-surface missile designed to attack heavily defended targets from long range, was first fired in air by an A4D in July. Tartar, with which missile destroyers will be equipped, completed several successful firings in which its ability to home on aircraft at extremely low altitudes was demonstrated. Developed of advanced versions of the Terrier and Sidewinder, of the antisubmarine missile Subroc and the air-to-air Eagle also continued.

Tests of the ballistic missile Polaris continued throughout the year and were marked by steady progress. In August, a significant milestone was passed when the missile was fired into the Atlantic Missile Range from the USS *Observation Island* at sea, seven miles off Cape Canaveral. Its satisfactory ejection from equipment similar to that which will be used aboard ballistic missile submarines, and its performance on a limited flight of 700 miles, were promising indications of its early availability for operational use.

New operational aircraft included the F8U-2 Crusader with improved power plant and fire control over its predecessor, and the T2J Buckeye jet trainer, delivered to the Basic Training Command in July. Development of lighter-than-air craft was marked by delivery of the first ZPG-3W at Lakehurst on June 19. These airships were specially designed and heavily instrumented for early warning patrol, and are the largest non-rigids ever built. Carrier aircraft under development included the F4H-1 Phantom II, which exceeded Mach 2.2 and zoomed to over 80,000 feet with its normal armament of four Sparrow III missiles; the high speed, long range, high altitude A3J Vigilante attack plane, the A2F low altitude attack specialist, and the WF-2 and W2F early warning planes. Both the F4H and WF-2 were scheduled for fleet use in fiscal 1960.

There was continued emphasis on antisubmarine warfare. The program begun last year with the establishment of specialized task groups to develop tactics, doctrine, and equipments, and to train air, surface and sub-surface units in coordinated attack, was continued in full force. Almost constant antisubmarine exercises, ranging from those staged by single units to the full scale fleet problem, were held in both oceans. This emphasis carried over into antisubmarine units of the Selected Air Reserve. In February, 55 air crews from Reserve units, with their P2V and S2F aircraft, took part in a submarine defense exercise with elements of the Pacific Fleet and the Canadian Navy.

Six carriers, four of which were inactive and one of which had been modernized in recent years, were reclassified to assume tasks for which they were better fitted, and two attack carriers of high capability were assigned in their place. All carriers assigned to antisubmarine warfare were of the angled deck type. Improved models of the HSS helicopter and the S2F twin engine aircraft used from these carriers made first flights during the year. Both embody significant advances in performance and in the quality of their electronics gear. A landplane under development, the P3V version of the commercial transport Electra, made its first flight in new configuration. The modernization of operational ASW patrol planes begun last year with P2V, was extended into this year as contracts were let to install more modern and efficient detection and destruction systems in P5M seaplanes.

The amphibious assault ship (LPH) came into being as a new class of ship. The carrier *Boxer* was the first to be reclassified to this mission. Two others, the CVS *Princeton* and CVHA *Thetis Bay* were similarly reclassified, and the keel for an entirely new ship of the class, to be named *Iwo Jima*, was laid in April. The LPH resembles an aircraft carrier in outward appearance, but there the similarity ends. The flight deck provides a platform for helicopter operations and below deck spaces house regularly assigned Marine assault troops and their combat equipment. For this mission, ships like the *Boxer* carry 40 helicopters and 1800 troops.

The first amphibious squadron built around these ships came into being in November, 1958, when the first Marine Aviation Detachment Afloat was organized aboard the *Boxer*. This squadron, which also includes four Thomaston Class LSDs equipped with helicopter platforms, operates under the Atlantic Amphibious Force. Similar organizations were subsequently activated in the Pacific. These provide the fleet with highly mobile units, able to land troops over shore defenses in helicopters, and send in formidable over-the-beach support, including tanks and artillery, without regard for beach gradients and terrain.

Not the least of the year's accomplishment was the continued reduction of the major accident rate and its concomitant saving in lives and costly equipment. For the year ending June 30, the major accident rate of 2.57 per 10,000 flight hours was achieved, the safest year in naval aviation history. When the Annual Safety Awards were made in September, the announcement carried the significant report that in addition to the 35 units receiving the Award, 377 air units of all types, including the Naval Air Reserve, had posted accident-free records for the entire year.


RESEARCH

AND DEVELOPMENT

THE MILITARY SERVICES

The military year in research and development was characterized by increased effort in the field of astronautics, including a number of successful satellite launchings and preliminary steps toward manned space flight. At the same time, however, there was increased activity in the less spectacular areas of military research.

The Air Force research and development program during 1959 progressed with major aircraft, missile, and space advancements. Research and development activities covered every field from aircraft instruments to social sciences, underground geophysical investigations to space studies vehicles and weapons beyond the orbit of the moon.

During the year significant progress was made in the high priority ballistic missile systems. The Air Research and Development Command launched 20 Atlas ICBMs, five Titan missiles, 32 Thor IRBMs and six ablation Thor-Able missiles. These firings included long-range tests to check guidance and re-entry characteristics and several short-range tests for sub-assembly evaluation.

The first intercontinental ballistic missile was assigned to an operational unit at Vandenberg Air Force Base, California. The Atlas ICBM thus attained its initial operational capability in 1959.

The Air Force marked a major milestone in the ICBM program when the Titan began its flight test phase two. The test program for the Titan was pursued actively during 1959 with several successful launchings.

Three full-size models of the Minuteman missile were fired from a test silo at ARDC's Air Force Flight Test Center in California.

Other milestones achieved in this program were the successful firings of the first stage in the spring and the first firing of the second stage. These firings were significant in the development of solid propellants for missiles, particularly because the first stage is the largest solid rocket engine ever fired.

In 1959, significant addition to the striking power of the Tactical Air Forces was the development of the Mace surface-to-surface missile. Mace is a much improved version of the older Matador and has a more accurate guidance system. The Air Force also completed the test phase of the Snark intercontinental missile and equipped an operational unit at Presque Isle, Maine, with the subsonic air-breathing missile.

In the general area of aircraft systems, development of the Republic F-105 was completed in 1959 and the first units of the Tactical Air Command were equipped with this Mach 2 airplane.

The test phase of the program to develop the world's first supersonic bomber, the Convair B-58, continued during the year. The B-58 has a speed of more than 1,350 miles per hour. Development and testing of the bomber was very successful and operational use was anticipated in 1960.

Another active program was the development of the North American Aviation B-70, an intercontinental, high altitude, supersonic heavy bomber. This concept aimed at the biggest step forward in the state-of-the-art of heavy intercontinental bombers. Late in the year the program was re-oriented to the development of two prototypes.

Several programs were quite active in giving more punch to the Strategic Air Command's B-52 intercontinental bombers. The Air Force began the flight test phase of the Hound Dog, an air-launched supersonic missile with a range of several hundred miles. The Hound Dog will enable the B-52 bombers to launch missiles long before they reach heavily defended target areas. As another way of increasing the effect of the B-52, the Air Force was developing the Quail, an air-launched decoy missile designed to cause confusion in the enemy's defenses.

The Air Force awarded a contract to Douglas for the design study of a new type weapon system which will mark a major advance in offensive striking power. A ballistic missile launched from strategic bombers, this weapon was called the GAM 87-A or Sky Bolt.

For the Tactical Air Forces the Air Force began adapting a guided air missile developed by the Navy called the Bullpup. Investigations were initiated to improve performance of the Bullpup so as to meet the specific needs of TAC.

On the Air Defense side of the research and development activities various tests proved the worth of SAGE, a Semi-Automatic Ground Environment System. During the year Sage centers controlled the firing of Bomarc missiles hundreds of miles away. They controlled simultaneous operation of Bomarcs and manned interceptors and the centers demonstrated their capability of intercepting drones.

To increase the active phase of air defense the Air Force introduced the F-106 supersonic manned interceptor into operational units. The F-106 is an almost automatic aircraft. ' has a speed of some 1,400 miles per hour.

A highly significant milestone was passed when the Bomarc "A" surface-to-air missile was introduced into the active air defense inventory. Testing of the advanced Bomarc called the Bomarc "B" was begun in 1959. Bomarc "B" will have a range of some 400 miles and will use solid propellants for the boost phase.

A major research and development problem in defense was a means to counter ballistic missiles. The Air Force made definite progress in the development of high powered radars with ranges in excess of 3,000 miles. These radars were under construction as part of the BMEWS, the Ballistic Missile Early Warning System. Construction of the first two sites continued on schedule during 1959 with anticipation of an early operational capability.

The application of nuclear propulsion to various types of weapon systems continued to be investigated during 1959. Nuclear propulsion for aircraft followed the previous lines of development of a reactor for a high-powered direct air cycle propulsion system with research on indirect cycle reactors as a secondary effort. In March, the Air Force announced that Convair was the winner of the competition for the design of an experimental prototype.

The use of nuclear power for space systems received wide publicity when the SNAP was demonstrated to the President. Significant advances were also made in the development of the Project Pluto, a nuclear powered ramjet. Project Rover, a nuclear powered rocket, was transferred to the National Aeronautics and Space Administration in 1959.

Research and development in support of space systems received major emphasis during the year. A major portion of 1959 Air Force activities were in support of either the National Aeronautics and Space Administration or the Advanced Research Project Agency. However, on November 17, major ARPA projects were transferred to the jurisdiction of the Air Force. These included the Discoverer, the Samos and the Midas. In addition the Air Force was given the responsibility for the development, integration, and launching of boosters for the military satellite systems. This included support of the

Navy Transit navigation satellite and the Army communication satellite. For the NASA the Air Force provided boosters such as Atlas and Thor for satellite launchings and space probes, including the Explorer VI paddle wheel satellite. The Air Force also provided support for Project Mercury, the man in space program.

As part of the Discoverer program the Air Force put six satellites in orbit. Two, Discoverer V and VI, were launched in one week.

Name	Launch Date	Approx. Weight (lbs.)
DISCOVERER I	Feb. 28	1,300
DISCOVERER II	Apr. 13	1,600
EXPLORER VI (for NASA)	Aug. 7	142
DISCOVERER V	Aug. 13	1,700
DISCOVERER VI	Aug. 19	1,700
DISCOVERER VII	Nov. 7	1,700
DISCOVERER VIII	Nov. 20	1,700

Atlas ICBM with Big Joe capsule leaves launching pad in Florida.

A program which received a great deal of attention was the X-15. The X-15 is an extremely advanced research aircraft which will operate on the outer edges of earth's atmosphere at speeds of 4,500 miles per hour. The flight test phase of the X-15 program began at Edwards Air Force Base, California, in 1959 and three powered flights were made after a successful glide flight program.

Another project in the near space area initiated by the Air Force was the Dyna-Soar, a manned boost glide vehicle. Dyna-Soar stands for Dynamic Soaring. Late in 1959 a contract was awarded to the Boeing Airplane Company to develop the glider and to the Martin Company to develop the boosters for Dyna-Soar.

In the general area of management of research and development program, several important changes were made. Within Headquarters, USAF, the Directorate of Requirements was transferred from DCS/Development to DCS/Operations. Within DCS/Development a new Control Systems Group was established to manage the complex programs for developing electronic environments, data processing systems and control systems. In keeping with the new responsibilities of space programs assumed from the Advanced Research Projects Agency, the Director of Advanced Technology was made the Assistant to the DCS/Development for Advanced Technology and was made the focal point within the Air Staff for all activities relating to the USAF space program.

The Air Research and Development Command began a reorganization to provide greater efficiency in physical and manpower applications. Lieutenant General B. A. Schriever assumed command of the Air Research and Development Command and started to apply the management principles he had used while directing the Air Force Ballistic Missile Division. Four new divisions were established with the goal of reducing lead times in weapon system development.

During 1959 the level of funding of Air Force research and development was approximately 2.5 billion dollars. Funding gave increased emphasis to basic research and reflected the changing emphasis from aircraft to missiles, illustrated by the fact the amount allocated to missiles was double that for aircraft.

Active Army concepts during 1959, some of which advanced to the research and development stage, include—the "flying crane" to carry large loads; powerful jet-driven helicopters that can be armed with machine guns and rockets; adaptation of the helicopter principle to an individual flying platform type of aircraft; and a vehicle that uses the ducted fan principle of flight.

Given sufficient funding, the Army felt that most of the aircraft under development could be put into production with little delay.

During the year, Army experimenters conducted research in the area of avionics, to provide electronic devices necesssary to assure flexibility of operation of Army aircraft. If aviation is to be utilized to the maximum, the Army must overcome present re-

The Doak 16 is Army's new VTOL aircraft.

strictions imposed by terrain and weather. Ideally, Army aircraft would be able to operate at low altitudes under any weather condition, from unprepared airstrips, with minimal support.

To meet such requirements, the Army had under development a self-contained inertial navigator and a terrain clearance indicator, the combination of which should allow the desired operations. These items were not expected to be available for test before 1962. Still to come were the rocket jump belt for the individual soldier, the aerial platform, and zero-ground pressure vehicle.

New developments in drones were under way in 1959. The RP-71 drone, carrying a small lightweight reconnaissance camera, will enable tactical commanders to observe enemy positions and movements at a distance. The drone is controlled by radio and tracked by radar. It fires a series of brilliant photoflash cartridges to expose film in the camera, then returns and is dropped by parachute.

In the missile field, the Army was studying for field unit protection individual air defense weapons with greater capability than existing .50 caliber machine guns, and defense systems against ballistic missile attack.

In all air defense systems, there were requirements for complex electronic computers to aim and coordinate area missile batteries. The brains of a system, they tie together all elements from target detection to destruction. The Missile Master, already installed in some locations, is the electronic brain for the coordination and control of Nike batteries in fixed defense to insure the most effective distribution of fires against a mass attack. Its field equivalent is termed Missile Monitor.

Perhaps the most significant development in the Naval aero-space field was managerial and administrative rather than technological. Navy effected the merger of the Bureau of Ordnance and the Bureau of Aeronautics into a single new Bureau of Naval Weapons. Among other benefits expected from the consolidation of two major "ardware" bureaus, the pulling together of Naval weapons elements which formerly crossed bureau lines was designed to make inroads on excessive lead times to produce weapon systems. Bureau of Naval Weapons was established on September 1, 1959, and subsequently the Bureaus of Ordnance and Aeronautics were phased out on December 1, 1959.

In Research and Development, a more unified approach to major weapons such as air/missile systems was anticipated from the Bureau of Naval Weapons. This would stem from the pooling of technological talent formerly in two separate bureaus, as well as from the greater "mileage" that can be expected from combined field and laboratory facilities.

Two major Naval air weapons completed their development programs and became operational. One was the all weather air to air missile, Sparrow III, deployed during the year to both the Atlantic and Pacific Fleets. The other was Bullpup, a close support missile, similarly deployed. Parent aircraft for Sparrow is the F3H-2, and the F4H-1 now under development. Bullpup operates from the A4D series and the FJ fighter-bomber configurations.

Several new Naval aircraft were still in late research or development phases and nearing production status. These included:

The P3V-1 Electra, a land based patrol plane chosen by the Navy to fill its requirements for an ASW airplane with short-field capability permitting operation from small advanced bases, and with a range long enough for mid-ocean searches. Electra was the first U. S. anti-submarine warfare plane to be turbine powered.

Electra was eventually to replace the famous P2V Neptune series of Navy ASW aircraft.

The T2J-1 Buckeye, the Navy's first all-purpose jet trainer being designed as a complete pilot training system, will provide the Fleet with a versatile aircraft which can meet the requirements of primary through basic pilot training, instrument work, gunnery training, formation and tactics, carrier pilot qualifications, and other diversified service operations.

The A2F-1, a carrier based jet attack plane designed for high and low altitude operation, is powered by two turbojet engines manned by a crew of two.

The A2F-1 will have particular capability in applying naval striking power in highly localized wars, and will be equally capable of participating in all-out nuclear wars. It will be a true all-weather airplane, and although intended for carrier operations, it also has land based short field capability.

It will carry a variety of sizes and types of weapons.

The GV-1, a Navy version of the Air Force C-130B, being procured for use by the Marine Corps as an aerial tanker and as an intra-theater assault transport. As a tanker, it is capable of transferring 28,000 pounds of fuel during multiple refueling of jet aircraft 1,000 miles from its take-off point. As a transport, the GV-1 can carry 92 combat-equipped Marines, 74 litter patients, or 35,000 pounds of cargo for 2,000 nautical miles in seven hours at 300 knots.

The W2F-1, designed to operate from aircraft carriers far at sea and patrol the extremes of fleet defense perimeters to detect impending attacks by enemy aircraft, missile and sea forces.

Carrying detection gear in a huge saucer-like radome atop its fuselage, the W2F-1 relays data on incoming attacks to the Fleet task force. The new airplane is also designed to control fighter and intercepter defensive measures.

As a highly advanced and more heavily instrumented replacement for the Navy's WF-2 Tracer, an interim early-warning plane now rolling off Grumman assembly lines, the futuristic new plane will substantially extend the distances from the fleet at which enemy aircraft and missiles can be detected and destroyed.

The HSS-2, a substantial advance over the HSS-1 helicopter which the Navy uses for ASW operations, is widely used by the Army and Marine Corps for utility work.

The HU2K-1, developed to meet the Navy's need for a high performance, all-weather helicopter to accomplish a great variety of missions dictated by widely dispersed modern naval operations. Included in its missions are rescue work, carrier plane guard, litter evacuation, transport of externally slung cargo, personnel transport, and observation-reconnaissance missions.

The HU2K-1 made its first flight on July 1, 1959.

The A3J Vigilante, a carrier-based, all-weather attack weapon system capable of delivering a wide variety of ordnance, including nuclear weapons, to sea or land targets. Its wide operational capability

North American's T2J will be trainer for Navy.

enables it to perform its mission at both extremely low and extremely high altitudes. It is a two place aircraft powered by two General Electric J79-2 engines, each of which develops more than 12,000 pounds thrust.

Although it includes the most advanced electronic and other components, the A3J will be lighter in weight than some attack planes now operating off Navy carriers. The A3J made its first flight on August 31, 1958.

The F4H-1 Phantom II, the Navy's first supersonic, two-seat, all-weather fighter. Powered by two J79 turbojets, the Phantom II is designed to fly at more than twice the speed of sound, and will be armed with Sparrow III air-to-air guided missiles partially recessed into the fuselage.

The F4H-1 was to replace present all-weather fighters, the McDonnell F3H Demon and the Douglas F4D Skyray, now in the Fleet.

First deliveries to Fleet squadrons were expected early in 1961.

A trend was developing in naval aviation which would see greater air defense performance built into an air to air missile and less performance in the airplane which fires it. This system will be hinged around the long range missile Eagle. The launch aircraft will not have the tremendous speed and altitude capabilities normally associated with fighter and intercept airplanes. Rather, the premium on the aircraft stresses endurance and load carrying ability rather than speed. Bureau of Naval Weapons bid requests for such an airplane to be part of the Eagle system were mailed in December. Although no popular name for the aircraft was formalized, it was tentatively named the "Missileer."

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Seven Mercury astronauts left to right: Alan Shepard Jr., John Glenn Jr., Walter Schirra Jr., Malcolm Carpenter, Leroy Cooper Jr., Donald Slayton, Virgil Grissom, and Mercury Space Task Group Director Robert Gilruth.

The National Aeronautics and Space Administration was one year old on October 1, 1959.

During 1959, the agency completed its internal organization, carried on space experiments with Earth satellites, space probes and sounding rockets, and prepared long-range space goals.

NASA's mission, as outlined by the President and the Congress, was to direct all United States aeronautics and space research and development, apart from military projects. However, the agency cooperated closely with the armed services, and its research centers worked on specific problems connected with military aircraft and missiles. In the aeronautics field, NASA confined itself to research.

On October 5, 1958, NASA initiated Project Mercury, the first step in the Nation's manned space flight program. The agency launched lunar probes, which will be followed by "hard" and "soft" lunar landings by unmanned, instrumented probes. NASA also carried out Earth satellite experiments in the fields of meteorology, navigation, geodetics and communications. In cooperation with the Department of Defense, NASA set in motion a national space vehicle program leading toward rocket vehicles in the six million pounds thrust range.

NASA absorbed numerous projects and organizations in 1958-59, all of which had to be speedily integrated as internal organization, space operations and planning moved forward simultaneously.

The nucleus of NASA was the National Advisory Committee for Aeronautics with its 7,966 scientists, engineers, and administrative personnel in its Washington, D. C. headquarters and five laboratories in Virginia, Ohio, and California. NACA was an independent government agency devoted for 43 years to aeronautical and rocket research in support of private industry and the armed services.

Other organizations and projects taken over by NASA included:

. . . From the Air Force and Advanced Research

Projects Agency of the Department of Defense: five space probes, three satellite projects, several engine research programs including development of nuclear engines, fluorine engines and a 1.5-million pound thrust, single chamber rocket engine.

. . . From the Army: the Jet Propulsion Laboratory of Los Angeles, California, operated under contract by California Institute of Technology. JPL has a staff of 2,700.

Also from the Army (subject to Congressional approval in 1960): the Development Operations Division of the Army Ballistic Missiles Agency in Huntsville, Alabama, with a staff of more than 4,000 (exact number of persons in transfer was under negotiation at year-end.)

Early in 1959, construction began on a new NASA research and development center in Greenbelt, Maryland, near Washington. Named for the late Dr. Robert H. Goddard, American rocketry pioneer, the $14 million Goddard Space Flight Center was to be ready for occupancy in mid-1960.

Completing the organization picture were the National Aeronautics and Space Council and the Civilian-Military Liaison Committee, each of which has nine members. The former, headed by the President, includes the Secretaries of State and Defense, Chairman of the Atomic Energy Commission, the NASA Administrator, the Director of the National Science Foundation, the President of the National Academy of Sciences (a private organization) and two other non-government members from private industry or educational and scientific fields.

The Civilian-Military Liaison Committee, headed by William H. Holaday, includes one representative from the Department of Defense, one each from the Departments of the Army, Navy and Air Force, and four from NASA.

Top priority at NASA in 1959, went to Project Mercury, which gained momentum during the year.

The project's immediate objectives were: 1) the study of human capabilities in the space environment; 2) the study of system requirements necessary to sustain the launch, flight and successful re-entry from orbital speeds.

On April 2, 1958, seven Mercury astronauts were selected from among hundreds of military test pilots. They were:

Navy Lieut. Malcolm S. Carpenter, 33 Garden Grove, California;

Air Force Capt. LeRoy G. Cooper, 32, Carbondale, Colorado;

Marine Lieut. Col. John H. Glenn, Jr., New Concord, Ohio;

Air Force Capt. Virgil I. Grissom, 33, Mitchell, Indiana;

Navy Lieut. Comdr. Walter M. Schirra, 36, Hackensack, New Jersey;

Navy Lieut. Comdr. Alan B. Shepard, Jr., 35, East Derry, New Hampshire; and

Air Force Capt. Donald K. Slayton, 35, Sparta, Wisconsin.

The astronauts were in training during 1959, each man specializing in a different aspect of the experiment and contributing his own knowledge and skills to the project.

NASA's Space Task Group at Langley Field, Virginia, directed the project, utilizing all the resources of NASA, with strong support from the Department of Defense and the Armed Services.

Numerous tests of the capsule, including its escape system, were carried out. On September 9, 1959, a model of the Mercury capsule, mounted on an Atlas missile, was successfully fired from the Atlantic Missile Range. The capsule was recovered in the South Atlantic after surviving re-entry temperatures of 3,000 degrees Fahrenheit. Although a malfunction in the Atlas caused the capsule to fall somewhat short of its goals, i.e., 100 miles altitude, 2,000 miles flight distance, and 17,250 miles per hour flight speed, the primary research objectives of the experiment were met.

On the operational side, four Earth satellites and three space probes were successfully launched between October 1, 1958 and October 15, 1959. The successful satellites: Explorers VI and VII, Vanguards II and III. The successful space probes: Pioneers I, III and IV.

NASA also fired numerous sounding rockets, including two sodium flare experiments, one successful, one unsuccessful. A NASA attempt to launch a 12-foot diameter inflatable sphere of aluminum foil and Mylar plastic failed because of a malfunction in the rocket vehicle, a modified Juno II. On October 28, NASA successfully launched a 100-foot diameter inflatable sphere of aluminized Mylar plastic from its Wallops Island (Virginia) Station.

A brief review of major satellite and space probe experiments includes the following:

. . . Vanguard II, meteorological "Cloud Cover Satellite," was launched February 17, 1959. The 20.74-pound sphere contained photocells to produce images of the Earth's cloud formations. Although the payload developed a precession (wobble) that scrambled the transmitted images, Vanguard II proved the feasibility of the weather satellite concept.

. . . Explorer VI, a combination meteorological and scientific satellite, was launched August 7, 1959. It was called the "Paddlewheel Satellite," because of its four paddle-shaped vanes, studded with solar cells to charge its batteries. The 142-pound sphere was equipped with a photocell to scan the Earth; it contained some 15 scientific experiments. Preliminary examination of data indicated that the Great Radiation Belt surrounding the Earth consists of many layers instead of the two bands discovered by the simpler instrumentation of earlier satellites and probes. An indistinct picture of the Earth's surface and cloud cover from a distance of 20,000 miles was transmitted by Explorer VI.

. . . Vanguard III, scientific satellite (last of the Vanguard series), was launched September 18. The 50-pound payload contained instruments to measure the Earth's magnetic field and X-ray emissions from the Sun.

. . . Explorer VII, a scientific Earth satellite to measure the Earth's radiation balance, was launched October 13, 1959. The 91.5-pound satellite, went into predicted orbit, all equipment working as planned. Experiments included: radiation balance; Lyman-Alpha X-ray; heavy primary cosmic ray; micrometeorite density; cosmic ray; exposed solar cell; temperature measurements.

. . . Pioneer I, first scientific space probe, was launched October 11, 1958. Although falling short of its lunar objective, the probe travelled about 70,700 miles before returning to the Earth. Pioneer I scored a number of firsts, including first determination of the radial extent of the Great Radiation Belt, first observation of the oscillations of the Earth's magnetic field and of the interplanetary magnetic field, and first measurements of the density of micrometeors in space.

. . . Pioneer III, scientific space probe, was launched December 6, 1958. This probe, also aimed at the Moon, failed in its primary objective but travelled 63,580 miles from Earth and discovered that the Great Radiation Belt was comprised of at least two bands.

. . . Pioneer IV, scientific space probe, was launched March 3, 1959, achieved an Earth-Moon trajectory. Passing within 37,000 miles of the Moon, the probe went into permanent orbit around the Sun. Pioneer IV, which was tracked to a distance of 407,000 miles, provided NASA scientists with an advanced tracking exercise and transmitted excellent radiation data.

Supporting unmanned and manned space missions of the future, the National Space Vehicle Program consists of a series of space-flight vehicles: Scout, Centaur, Saturn, and Nova. Each is capable of carrying a larger payload and of performing a more complex mission than its predecessors. The program was designed to get maximum capability with minimum development work. Each vehicle will be used in numerous tests to achieve high reliability, and will make use of previously flight-tested engines and vehicles.

The first of the series *Scout,* is a four-stage, solid-fuel booster that will cost $500,000—substantially less than other test vehicles of its size and capability. It will be 75 feet long, weigh 35,000 pounds, and have sufficient thrust to place a 150-pound payload in a 300-mile Earth orbit or fire a 100-pound instrument pack to an altitude of 5,000 miles. Because of its simplicity in handling, Scout can be launched from sites lacking expensive launching facilities. Contracts for all four stages of Scout have been let.

Centaur, to be available by 1962, will be capable of placing 8,400 pounds into a 300-mile orbit, and provide sufficient payload—730 pounds—to permit the installation of adequate controls for landing equipment on the surface of the Moon.

Saturn and *Nova* were in the development stage. The Saturn project, which has been the responsibility of the Development Operations Division of ABMA, was to be transferred to NASA, subject to the same provisions as the overall transfer. Saturn will consist of a cluster of eight Rocketdyne HI engines, each with a thrust of 150,000 pounds for a total of 1.2 million pounds thrust. It will have at least three stages. Nova will consist of six 1.5-million pound thrust Rocketdyne F1 engines for a total thrust of nine million pounds. Nova will have six stages, both vehicles will employ liquid oxygen and hydrocarbon as propellants.

A top priority project on the aeronautics side of NASA was the X-15, a rocket-powered experimental airplane designed to carry its pilot to an altitude of more than 100 miles at speeds approaching 4,500 miles per hour. The X-15, a joint Air Force-NASA-Navy project, is an interesting example of air-to-spacecraft evolution.

The rocket-plane, with North American Aviation's Scott Crossfield at the controls, completed its first captive flight on March 10, 1959, and its first glide flight on June 8. After attempts at power runs on December 4 and 11 were called off when fuel line troubles developed, the first successful powered flight was completed on September 17.

At 8:08 a.m. Pacific Daylight Time on that date, the X-15 was released from beneath the wing of its B-52 mother ship at an altitude of 37,600 feet. Powered by a pair of interim XLR-11 engines burning a water-alcohol compound and liquid oxygen, the X-15 climbed quickly to 52,100 feet, then began a powered descent in an S-shaped pattern. Nine minutes and 12 seconds later it touched down on the dry lake bed near its home base, the NASA Flight Research Center at Edwards Air Force Base, California.

Maximum speed attained during the flight was 1,395 miles per hour (Mach 2.1). Much higher performance was expected when the X-15's final engine, the XLR-99 is installed. A single XLR-99 is expected to develop about 50,000 pounds thrust—more than double the thrust of the two interim engines. The first XLR-99 engine, which burns a liquid-oxygen, liquid-ammonia propellant, was successfully ground tested at Edwards Air Force Base on September 1.

A few seconds after the X-15 was drop-launched by the B-52 at 9:39 a.m. on its November 5 power test, fuel in the tail section exploded. Pilot Crossfield, electing to stay with the X-15 rather than jettison, landed the rocket-plane safely six minutes later on an alternate dry lake landing strip. There was considerable damage to the fuselage.

Other tests were being planned at year's end. Following a carefully pre-arranged flight plan, the plane's performance will be gradually increased until it reaches maximum capability. Tracking and telemetry recording equipments were installed, under the supervision of NASA, along the X-15's 485-mile route from Wendover Air Force Base, Utah, to Edwards. The craft is heavily instrumented so that engineers and technicians on the ground can monitor the effects of high altitudes and speeds on the aircraft's structure and performance. Instrumentation also records the pilot's physiological reactions.

NASA research centers were hard at work on the entire spectrum of aircraft, from the "ground effect" system or airborne land vehicle that coasts on an air cushion just above the ground, to the rocket-boosted Dyna-Soar glider with which to explore the range between 4,000 miles per hour and satellite speeds of 18,000 miles per hour.

NASA scientists believe VTOL (Vertical Takeoff and Landing) and STOL (Short Takeoff and Landing) aircraft have a bright future because both have useful military and commercial applications.

The predecessor agency, NACA, started work on VTOL-STOL about 10 years ago, spurred on in equal measure by the success of the helicopter and by its limitations, plus the development of the turboprop engine. The helicopter is essentially a hovering machine which is relatively inefficient in forward flight. VTOL, on the other hand, is designed to be a conventional airplane with vertical takeoff and landing capability added.

VTOL-STOL airplanes tend to be as much as one-third heavier than the conventional transport and need twice the power. VTOL especially needs extra power because it lifts straight up by brute force, then shifts from hovering to cruising flight and back down again to hovering flight for a vertical landing.

NASA reached the conclusion that a combination VTOL-STOL is probably preferable to two separate types, because for practical operational use, both VTOL and STOL capability will be required.

NASA's research effort in this field was expanding. Two of NASA's biggest wind tunnels—at Ames and Langley Research Centers—were largely occupied with VTOL-STOL experiments. Research was leading toward eventual development of the propeller-driven VTOL transport, which looked promising for short-haul and airport-to-city commuting.

The "ground effect" concept is an offshoot of the aerial jeep, and has interesting possibilities within its limitations. A peripheral jet generates and contains pressure beneath the vehicle to provide it with support. It develops lift by a combination of pressure lift and jet thrust.

This vehicle appears to have some inherent advantages. However, it must glide along the Earth's contours or, as the Army puts it, "on the nap of the Earth," and is helpless in terrain creased by deep drop-offs or crevices.

NASA research was also in progress on supersonic transports and the supersonic B-70 chemical-fueled bomber, the "Valkyrie."

The Dyna-Soar—a hypersonic, rocket-boosted vehicle with swept-back delta wings capable of glide speeds in excess of 12,000 feet per second—is a joint NASA-Air Force undertaking. Preliminary studies began in 1956. The purpose of the glider, which will be manned, is to provide research information more advanced than that obtainable from the X-15 and to indicate whether such a vehicle has military possibilities.

Following in the NACA tradition, NASA's research centers were deeply involved in basic research in gas dynamics, combustion, higher impulse fuels, materials, and structures. Aeronautically oriented research will continue to be an important part of NASA's mission. As the thrust into space progresses, such research increases in importance. Space vehicles must fly into and out of the atmosphere. This, in some respects, is the most difficult part of the journey.

DIRECTORATE OF DEFENSE RESEARCH AND ENGINEERING

Early in the year, the Office of the Director of Defense Research and Engineering was established, and Dr. Herbert York was named head of that office. The new position replaced that of the Assistant Secretary of Defense (Research and Engineering), and the office was charged with the responsibility for supervising all research and engineering activities in the Department of Defense.

Specifically, Dr. York and his personnel were directed to advise and assist the Secretary of Defense in: scientific and technical matters; basic and applied research; research, development, test and evaluation of weapons, weapons systems and defense materiel; and design and engineering for suitability, producibility, reliability, maintainability, and materials conservation.

While the office did not have any projects of its own, it worked directly with all those that were especially critical, and was indirectly concerned with all of them.

With the great majority of defense research work being funded by the three services, a major part of the job of DDRE was to insure that nothing was overlooked and that the more important programs would receive the emphasis they deserved.

To aid him in this job, and to provide him with the specialized staffing he needed, the directorate relied on three organizations: the Advanced Research Projects Agency, the Weapons Systems Evaluation Group, and the Institute of Defense Analyses. Although none of these thr groups was directly under DDRE from an organizational standpoint, all of them performed tasks which were essential to the directorate's job.

The activities of ARPA are discussed below.

WSEG is a group that checks out the weapons systems, areas of work and planning of the Joint Chiefs of Staff and DDRE, to see how they will fit into the future. About two-thirds of the studies handled by WSEG are generated by the Joint Chiefs of Staff, with the remainder coming from DDRE, or in a few instances self-initiated within WSEG.

IDA is a group of scientists, under contract, who provide vital technical support for both ARPA and WSEG. IDA is a brain-trust for the Defense Department in about the same way that Rand Corporation is for the Air Force.

Ranking immediately after the service secretaries, Dr. York created six Operational Systems Offices, to be headed by Assistants to the Director. These covered the following areas: (1) Air Defense, (2) Tactical Weapons, (3) Strategic Weapons, (4) Communications, (5) Undersea Warfare, and (6) Special Projects.

ADVANCED RESEARCH PROJECTS AGENCY

In 1959, ARPA's responsibilities continued in three military research program areas: military space technology, ballistic missile defense, and solid propellant technology. In addition, a new program for materials research was assigned.

In the field of military space technology, projects costing $400 million were pursued during 1959. The approximate breakdown of these projects was as follows: Advanced surveillance and defense alarm systems, 45 percent; Flight development of critical space vehicle components, vehicle development and ground support, 35 percent; Military support missions (Communications and Navigation), 15 percent; Feasibility studies and exploratory research, 5 percent.

Within this overall breakdown, there were several space projects under advanced research status in ARPA throughout 1959. The Discoverer Project included over eight experimental launchings for advanced space vehicle research. The launchings provided information on attitude control, capsule ejection, recovery methods and techniques, ground communications, bio-medical experimentation, and satellite trajectory. The launch vehicle used in this series was a Thor booster with an Agena upper stage. The payload was a recoverable capsule.

Project Transit, based n the need for an all-weather navigational system, involves orbiting satellites equipped with radios to broadcast their positions. Moving receiving stations such as submarines and aircraft will use this satellite position information to locate their own positions to within 4/10ths of a mile. The first launching in this series did not result in an orbit as the third stage of the Thor-Able launch vehicle failed to ignite. Additional launchings are planned for 1960.

Notus, a project evolving from the need of the

Dr. Herbert York
Director of
Defense Research & Engineering

Brig. Gen. Austin Betts
Director
Advanced Research Projects Agency

services for an all-weather jam-proof, instantaneous communications system, neared flight test status. This communications satellite system was to investigate delayed repeater and instantaneous communications techniques. The system included polar orbiting satellites containing instantaneous repeaters for ground-to-air communications and equatorially-orbited 24 hour stationary satellites to provide broadband microwave or broadcast type communications for ground-to-ground transmissions.

A major ARPA effort during 1959, was devoted to the Saturn space vehicle. The vehicle will employ a cluster of eight engines and an array of modified Redstone and Jupiter tanks to provide 1,500,000 pounds of thrust. An ICBM type second stage and Centaur (high energy) third stage will complete the configuration of this space vehicle to launch 28,000 pound space stations into 300 mile orbits in the 1964-1965 time period.

The Space Surveillance System, providing a tracking and read-out capability against satellites, both radiating and silent, passing over the United States, was completed in 1959. Information, received from the detection "fence" network, is fed into a centrally-located data reduction facility, which transmits the reduced data to interested organizations.

In the field of Ballistic Missile Defense (Project Defender), more than 50 separate programs were undertaken to obtain the crucial information necessary for design of a system to meet the rising threat. The programs were designed to define the threat, to find improved methods for early warning, for identification and discrimination of the incoming warheads, and for destruction mechanisms and data processing.

A space project related to this effort is Midas, the short title for Missile Defense Alarm System. This system will employ satellites with infrared devices to detect infrared rays radiated by the flame of enemy launched ICBMs very early in their trajectories.

Fundamental advanced concepts of missile defense which will be technically, operationally, and economically feasible must be discovered. To this end, one phase in ARPA programming was the exploration of the 1980 time-period—a search for what may be needed, what will not work, and by the process of elimination, what will work.

Project Principia, of high importance to the Department of Defense, is the solid propellant research activity. Currently available solid propellants lack sufficient performance to permit optimum design of ballistic missiles, ballistic missile defense systems, and other guided missile and space vehicles. The basic objectives of the Principia program are: the discovery of new chemical formulas, development of practical methods of synthesis, and acquisition of the knowledge required to utilize the new materials in highly efficient solid propellants. The objective is to make available, for development applications, solid propellants having specific impulses at least 10 to 20 percent higher than propellants now in use.

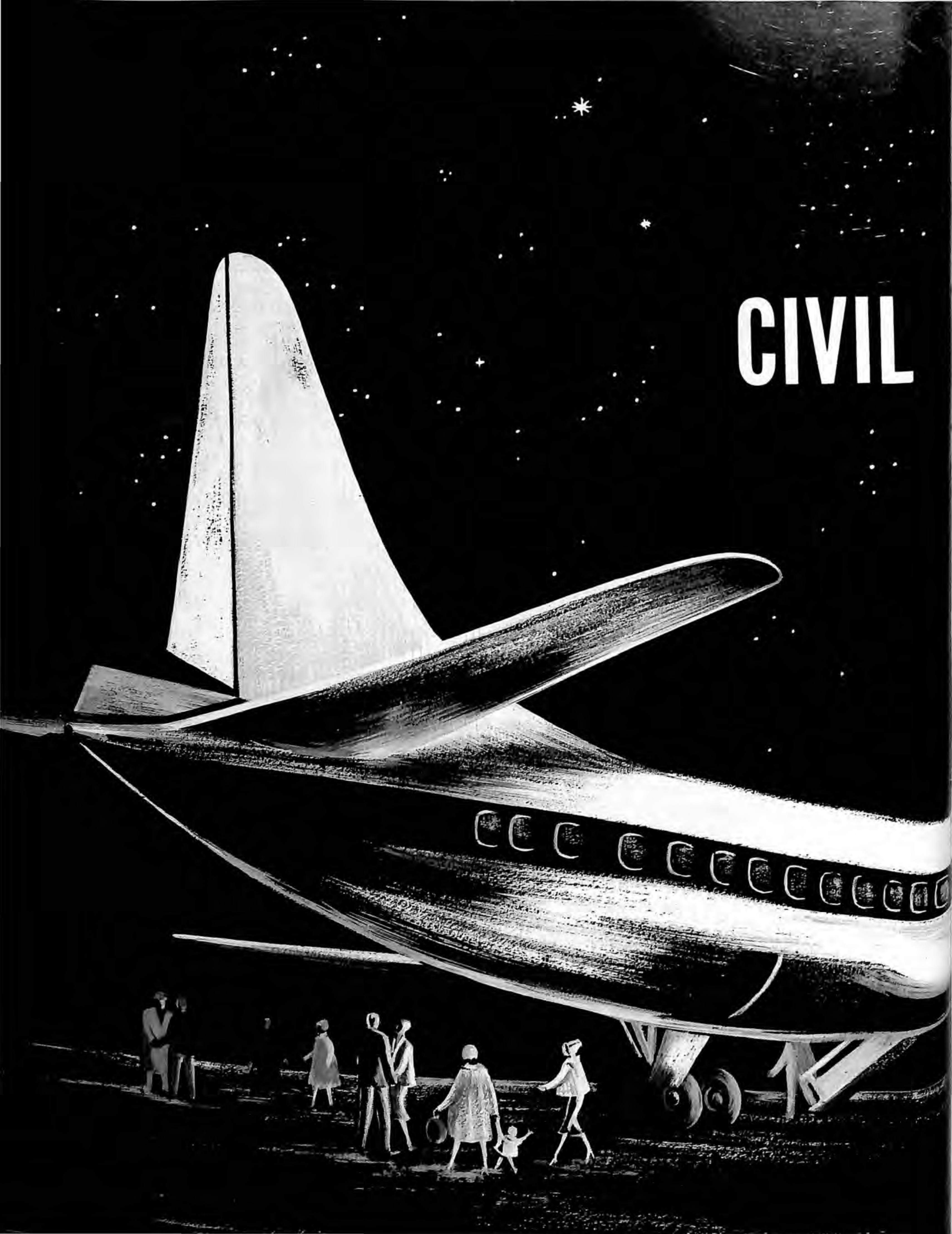
It was expected that, as a result of this research, solid propellants will be sufficiently energetic, as compared with those presently available, to allow substantial increases in warhead weight and range, or reduction in launch vehicle weight. An increase of 20 percent in specific impulse would almost double the warhead-carrying potential of future solid engine ICBMs. In 1959, funding in seven broad areas of solid propellant research and supporting projects totaled approximately $15 million.

The new field of ARPA responsibility, basic materials research, was Project Pontus, which includes fundamental theoretical and experimental work aimed at realizing a major improvement in structural and power conversion materials and in materials intended for very high temperature service.

The project, announced on June 18, 1959, was being conducted entirely in leading universities to take advantage of the highest level of scientific and technological know-how. It was expected that some $15 million would be obligated in this area during fiscal year 60. Most of these funds were to be used to establish interdisciplinary university laboratories.

In addition to these programs, exploratory research was conducted to advance knowledge in the fundamental areas of technology and science vital to military weapons programs. Feasibility studies investigated new concepts and novel weapons systems. Projects in these areas may not have clear military implications today, but applications will evolve as the studies progress.

CIVIL



AVIATION

THE AIRLINES

During 1959, the scheduled airlines continued to add turbine aircraft (turboprop and turbojet) to their fleets. Of the approximately 1,900 scheduled airline aircraft at the end of the year, about 300 were of the turbine variety. The airlines expected to take delivery of 190 additional turbine planes during 1960.

At mid-1959, the pure jets in service had carried more than one million passengers approximately two billion passenger miles without a passenger fatality. They completed almost 100 percent of the miles scheduled.

The airlines devoted more than a decade to planning for the advent of jet aircraft. One carrier reported that it had spent around $10 million in training flight and ground personnel for jet transport operations. Under such programs, problems are simulated that could not be attempted in actual flight.

Of the some 70 types of ground equipment needed to keep jet aircraft in flying condition, more than 50 were designed especially for jet service. These include ground power units, engine starters, airplane tow tractors, engine water purification and injection equipment, and sound suppressors for ground testing of engines. Improved baggage-handling techniques were introduced during 1959. Another important passenger-service item was the enclosed weatherproof corridor or "gangway", which permits passengers to pass between terminal and plane without setting foot on the ground.

The airlines ended the first seven months of 1959 with record revenues, traffic and service. However, they did not realize the same progress in earnings.

TABLE I—CONSOLIDATED AIRLINE INDUSTRY

(In thousands)

			First Six Months	
	1957	1958	1959	1958
Revenue Ton-Miles	4,032,265	4,074,720	2,215,619	2,007,493
Available Ton-Miles	7,122,017	7,265,772	3,915,429	3,600,342
Ton-Mile Load Factor (%)	56.62	56.08	56.58	55.75
Revenue Passenger-Miles	31,243,114	31,481,772	17,125,977	15,310,375
Available Seat-Miles	51,022,598	53,069,597	28,022,152	26,491,303
Passenger Load-Factor (%)	61.23	59.32	61.11	57.79
Operating Revenues	$2,114,889	$2,236,335	$1,234,989	$1,072,445
Operating Expenses	$2,050,557	$2,129,443	$1,177,835	$1,061,893

Sources: Quarterly Review Airline Traffic and Financial Data Air Transport Association of America (September, 1959).

While profit margins and rate of return were up, as compared with the same period in 1958, the return rate was still about three percent below the 10.6 percent average, annual rate recommended by Civil Aeronautics Board Examiner Ralph L. Wiser. It was approximately one percent less than the average industry return of 8.61 percent for the five-year period 1954-58.

Trunkline operating revenues for the period totaled $1,017,766,000 as compared to $870,614,000 for the similar seven months in 1958. Net income (before interest) was $53,900,000 in the 1959 period and $24,612,000 in 1958. Revenue passenger miles were 15.98 billion, compared to 14.30 billion for the first seven months of 1958. In terms of service, the airlines had available 25.86 billion seat miles, compared to 24.28 in the same 1958 period.

In October of 1959, six major scheduled airlines filed an amendment with the Civil Aeronautics Board extending the mutual aid agreement, into which they had entered a year earlier, for an additional year. The agreement provided for limited financial assistance to any party to the agreement shut down by a strike. The payments are based on the additional revenues received by the carriers still in operation. The purpose of the agreement was to minimize labor conflict in the air transport industry. For example, during 1958 there were 15 strikes against the airlines, ranging in duration from one-half to 108 days. Only one month of the year, August, was free from a strike, and even during that month the carriers were subject to strike threats. The unions involved were the Air Line Pilots Association, the International Association of Machinists, the Flight Engineers International Association, the Transport Workers Union, Air Line Stewards 'and Stewardesses Association, and the Brotherhood of Railway Clerks. The strikes forced cancellation or disruption of the travel plans of over 2,500,000 passengers, and cost the airlines involved an estimated $75 million in lost revenue.

The year 1959 saw increased cooperation between airline mail specialists and the Post Office Department. This closer working relationship was sparked by the Department's recognition of the mail transportation problem resulting from the rapidly changing pattern of the nation's transportation system. The Postmaster General pointed out that thousands of mail-carrying passenger trains had been discontinued and services to an equal number of communities completely eliminated. Thirty years ago about 10,000 trains were used for the movement of mail; in 1959, there were only 2,200. To help solve the resulting public-service problem, a new joint committee, composed of officials from the airlines and from the Post Office Department, was set up through the efforts of the Air Mail Committee of the Air Transport Association. It was explained that because of the airlines' greater capacity, coupled with the earnest desire of the CAB and the Post Office Department to expedite the mail, the users of the postal services sh 'd enjoy an improvement in the transportation of mail as significant as the change that saw the steam engine replace the pony express.

Considerable optimism was expressed by the airline industry during 1959 with regard to the long-anticipated "breakthrough" in air-freight operations. In 1954, the airlines collectively hauled 2¼ million air-freight shipments, for a gross of approximately $47½ million. Based on the first six months of 1959, it was estimated that at the year's end the carriers would have carried 4½ million shipments, for an increase of more than 100 percent. Dollarwise, this represented a gain to about $97 million.

Through the cooperation of the Air Transport Association and the National Motor Freight Traffic Association efforts were made to better freight services by establishing a uniformity that will make shipping easier and more efficient. This would include uniform rules tariff, a uniform bill of lading, and a uniform system for traffic handling between air and motor truck. The program foresaw a cutting of transit time for goods shipped via air and truck by as much as 24 hours. These joint efforts were described as a "concerted attempt to bring to the shipper the speed of air transport with the flexibility of intercity truck." Airlines serve about 600 cities in the United States; the motor carriers serve 30,000. The two industries were working on the assumption that it is clearly to the advantage of the shipper to take full benefit of the natural advantages of each mode of transport when using a combined service.

The airlines and the Railway Express Agency entered into an agreement representing a completely new approach to the management of air express service. The new partnership extended from a sharing of revenues to the day-to-day details of scheduling express shipments over the nation's airlines. For the first time, each of the two parties will have equal voice in the actual carrying out of the service. It was pointed out that total gross air express revenue forecast for the next five years runs to a quarter of a billion dollars. For the first seven months of 1959, shipments were up more than 16 percent and overall ton miles of express movements were up 21.4 percent—the highest level of activity in air-express history.

The problem of traffic control on the nation's airways got the recognition the airlines and other segments of the aviation industry had long sought when the Federal Aviation Agency (FAA) officially went to work on January 1, 1959. The new agency has unprecedented authority over all U. S. airspace. Its object is "to provide for the safe and efficient use of the airspace by both civil and military users and to provide for the regulation and promotion of civil aviation in such a manner as to best foster its development and safety." While much of the year was given over to setting up the mechanics of the organization, progress toward the stated objective was noteworthy. An unanticipated road-block was the cut-back in the budget requests for operations, maintenance and new facilities. This action compromised the FAA's ability to place into service all the facilities already contracted for or installed. However, authority was obtained in a subsequent appropriation bill to transfer $17 million from FAA's facilities fund to its operating expense fund to use in manning such facilities.

In the legislative field, the Federal excise tax on passengers was reduced from 10 percent to 5 percent, effective July 1, 1960. Congress increased from $80 million to $85 million the funds available to the Military Air Transport Services (MATS) for use in the procurement of commercial air transportation only. The airlines had supported efforts to have set aside a larger amount. In testimony before Congress, hope was expressed that they would be permitted to carry, at published rates and fares, much of the cargo now being hauled by MATS over airline routes. The carriers also called for more realistic practices by the Defense Department in procuring commercial airlift in order to permit the carriers to gain the financial strength required to purchase new and improved aircraft.

In the course of the year, the Senate Committee on Interstate and Foreign Commerce initiated a transportation policy study under the direction of General John P. Doyle (ret.). A council composed of representatives of the various forms of transportation, including the trunk, local service and supplemental carriers, was set up to advise on the study. It appeared likely that the study would continue throughout the year 1960.

Although no specific legislation was proposed, there was discussion regarding a program for guaranteed loans to carriers to purchase modernized cargo aircraft. There appeared to be a division of opinion in the industry as to the need for such legislation, some carriers being in favor, some finding no need for the legislation for themselves, and some opposed.

Allegheny inaugurates commuter flights.

ALLEGHENY AIRLINES

The year 1959 was perhaps the most significant in the 21 year history of Allegheny Airlines.

For Allegheny it was the year of evaluating and introducing turbine-powered equipment on its routes, pioneering revolutionary passenger-handling techniques, experimenting with fare concepts aimed at stimulating the low-cost travel market, developing new techniques of creative merchandising, and in general preparing for the substantial growth which the company expected in the coming 12-18 months.

On July 1 the airline inaugurated Atlantic Shore services with the Convair "540". Powered by two 3500 horsepower Napier "Eland" engines, this latest version of the world-famous Convair series proved to be both economical to operate and generally well-adapted to Allegheny's short-haul routes. Allegheny's decision to evaluate the "540" in scheduled service followed several years of intensive study of DC-3 replacement candidates.

Allegheny continued to augment its fleet of 40 passenger Martin Executives to keep pace with the spiraling demand for air service at the 29 airports it serves. A DC-3 retirement program was accelerated.

On October 4, Allegheny introduced the nation's first low-fare, no-reservation "commuter" service on jetprop nonstop flights on the 269 mile short-haul route between Philadelphia and Pittsburgh. For passengers willing to forego customary reservations and baggage handling services, a fare reduction of about 35 percent was made available.

Allegheny also begain selling books of ten tickets to high-frequency travelers between these two cities, passing on to customers as a 15 percent discount the estimated economies inherent in the single sale of ten tickets and the simplification of certain reservation procedures.

In permitting these reduced fares to become effective, the Civil Aeronautics Board said "these fares represent a worthwhile experiment in promotional fares and a lower cost type of service."

At the same time these low fares were put into effect, Allegheny launched a campaign to rid air travel of many of the irritating and time-consuming steps required for a passenger to board a flight. Ticketed passengers on the Pittsburgh-Philadelphia flights were permitted to by-pass congested ticket counter areas and go directly to the departure lounge where they are boarded as much as 25 minutes in advance of flight time. In addition to conveniencing passengers who may wish to board early, Allegheny's streamlined techniques permitted it to accommodate last-minute passengers without delaying the flight departure.

Passenger and cargo traffic topped all previous records on Allegheny during 1959 as all time daily and monthly marks were established. For the first year since beginning passenger service in 1949, Allegheny boarded over ½ million passengers. Cargo traffic continued the spurt which began as the 1957-58 recession eased off. During the first nine months of 1959, Allegheny's flights carried more cargo than during all of 1958.

Several Civil Aeronautics Board decisions during 1959 suggested the transition of Allegheny from a fledgling feederline to a major short-haul carrier. In a press release decision of May 19, Allegheny was extended into six populous cities in southern New England and linked its entire system with this area. The new cities at which service was expected to begin early in the spring of 1960 are Boston, Providence, New Haven, New London, Hartford/Springfield, and Bridgeport. The Board in certifying Allegheny for a major short-haul route between Boston and Washington, also added Reading, Pennsylvania and Islip, Long Island to the airline's system.

The Examiner in the Great Lakes Local Service Case recommended that Allegheny's Ohio Valley route be extended to Louisville, Kentucky.

Allegheny's unblemished safety record continued through 1959 as the carrier again qualified for the National Safety Council's "Award of Honor." Allegheny was one of four airlines to receive this top award in both 1957 and 1958.

Airport development continued at a fast pace on Allegheny's system as greatly expanded and modernized terminal buildings were dedicated at Wilkes-Barre/Scranton and Harrisburg, Pennsylvania. Several runway lengthening and tower construction projects were also completed during 1959.

ALOHA AIR LINES

Highlight of the year in Island aviation was Aloha Airlines' introduction of jetprop aircraft in inter-island service.

Following a series of Jet Age Days on Hawaii's major islands, Aloha placed the Rolls-Royce powered Fairchild F-27s in scheduled service June 15, 1959.

The new aircraft, air-co litioned on the ground as well as in the air with a high-wing configuration permitting unobstructed aerial viewing of Hawaii's scenic grandeur, proved an immediate success with both tourists and local residents.

Beginning with the June introduction, each succeeding month saw all previous passenger volume records in the airline's history.

The airline registered a 56.5 percent increase in passenger volume in June, 70.8 percent in July, 67.9 percent in August and 75.1 percent in September.

At year-end, Aloha operated a fleet of three Fairchild F-27s and seven Douglas DC-3s.

The airline had on order three additional jetprop F-27 aircraft for delivery in February, March and May 1960.

AMERICAN AIRLINES

Amerian Airlines in 1959 beame the first major trunkline to introduce jet service across the country.

Traveling time between the east and west coasts was cut 40 percent on January 25 when American inaugurated transcontinental jet service with daily flights in each direction between New York and Los Angeles.

During 1959 American extended its jet service to Washington, Baltimore, Chicago, Boston, Dallas and San Francisco. Also during the year American received authorization from the Civil Aeronautics Board to provide nonstop service between New York and San Francisco.

On January 23 American introduced its propjet Electra Flagships in flights between New York and Chicago. These new aircraft trimmed flying time between Chicago and New York to around two hours. American later during the year extended its Electra service to W ıshington, Boston, Dallas, Tulso, Buffalo, St. Louis and Detroit with plans for additional service as more airplanes were delivered.

American's introduction of its jet service between Los Angeles and New York with its Boeing 707 Flagships brought with it establishment of a new official transcontinental speed record between Los Angeles and New York of four hours and three minutes on the initial flight.

An American 707 Jet Flagship pioneered jet service across country.

American also set an official speed record for a Boeing 707 scheduled flight westbound from New York to Los Angeles of four hours and 47 minutes. In addition, one of American's 707 Flagships flew from Los Angeles to Friendship Airport in four hours to set another record.

During 1959, American announced a major engine modification for its fleet of 50 Boeing 707s from the conventional Pratt & Whitney turbojet power plants to newly developed and highly efficient turbofan engines.

The conversion program was scheduled to begin during 1960 and the Boeing 707s with the new improved power plants were to be placed in scheduled service in substantial numbers early in 1961.

The turbofan engine adds 4000 pounds of thrust to the basic JT3 (commercial designation of the J57), boosting total thrust to 17,000 pounds with the engine operating dry (without water on takeoff).

American also in the fall of 1959 announced the addition of a "Glove" which will fit on the leading edge of its swept wing jets.

The "Glove" will become an integral part of American's 707-023s, the smaller version of the 707 which are being delivered to American in 1960. The entire 707-123 fleet will be fitted with the "Glove" at the Boeing plant later as a retrofit. The "Glove" does two jobs: it contains new leading edge flaps to give the airplane better takeoff performance and lower stall speeds; and second, by thinning the leading edge of the basic wing the airplanes will be able to cruise at much higher speeds.

The program announced by American during 1959 as designed to provide "a second generation of jets" is intended to provide better performance, higher speeds and less noise. Shorter takeoffs and more efficient climbouts will spell less sound in the areas surrounding the airport runways.

During 1959, American opened the its jet age maintenance and engineering center at Tulsa, Oklahoma and early in November the first American Boeing 707 was placed in the shops for overhaul. American noted that this first 707, the Flagship New York, had flown various routes of American's system for approximately 2,100 of her allowable 2,400 hours. During that period she carried an estimated 42,000 jet passengers, or the equivalent of 100 passengers per five hour flight on 420 nonstop flights between New York and Los Angeles.

American during the first nine months of 1959 carried nearly six million passengers a total of more than four billion revenue passenger miles, which represented an increase of nine percent of the comparable period of 1958. During the first nine months airfreight ton miles had totaled nearly 74 million, up six percent over the same period in 1958.

American also predicted that its airfreight traffic for the full calendar year of 1959 would be in excess of 100 million ton miles.

In 1959 American began the conversion of 10 of its DC-7 passenger planes to DC-7F airfreighters. This provided American with a plane capable of lifting 33,500 pounds of cargo from coast-to-coast in about eight hours. First of the DC-7F airfreighters were placed in service between Newark, Detroit, Chicago and Dallas; and early in the fall the DC-7F service was extended to include New York, Los Angeles, San Francisco, St. Louis, Buffalo, Boston and Hartford.

Also in the fall of 1959, American carried its millionth passenger on its turbine-powered fleet.

At year's end American was operating 24 Boeing 707s and 24 Lockheed Electras. Still to be delivered were additional Boeing 707-023s and the remainder of its order of 35 Lockheed Electras. American also had on order 25 Convair 600 jet airplanes.

In the fall of 1959 American announced that it would introduce a new electronic reservations system. The system developed in conjunction with the International Business Machine is known as SABRE.

SABRE is a large electronic processing system, able to store more than 600,000,000 characters and to handle more than 7,500 complete airline reservations per hour.

American Airlines will begin installation of the SABRE system in late 1961 and most of the cities served by American will be linked to the computing center by the end of 1962. The computing center will be located in the New York metropolitan area and will be linked with other cities of the country by leased telephone lines.

The result of six years of research by IBM and American, SABRE makes possible vast improvements in reservations service to the airline's customers.

American, in 1959, also introduced the "aircheck" and commuter ticket systems to add to the convenience of its passengers in obtaining airline tickets.

BONANZA AIR LINES

In March of 1959, Bonanza Air Lines placed the Fairchild F-27A Silver Dart, with the larger RDA-7 engine, into scheduled operation. The Rolls-Royce jetprop powered Silver Dart has a 40-seat configuration, is completely air conditioned both on the ground and in the air, and is equipped with weather radar. Initial service was inaugurated between Reno, Las Vegas and Phoenix and between Salt Lake City and Phoenix with three of the propjets on hand. By the last quarter of 1959 Bonanza had six Silver Darts in operation.

In August, the company exercised its option with Fairchild to purchase four additional F-27s for delivery during the last half of 1960.

Along with its first year of providing jetprop service, Bonanza experienced the largest traffic year in its history with no significant change in its route pattern, schedule frequencies or plane-miles flown.

Preliminary estimates of 1959 traffic showed a total of 57,704,000 revenue passenger miles flown as compared to 41,944,000 flown in 1958—an increase of 37.6 percent. Originating passengers increased from 180,770 to 234,464 for an improvement of

Bonanza Silver Dart flies

29.7 percent. In nearly all cases, Silver Dart service replaced previous DC-3 schedules.

During the year, Bonanza added five points to its system. Four of these—Flagstaff, Grand Canyon and Page, Arizona and Kanab, Utah—were added to the Phoenix-Salt Lake City all-stop segment, and Oceanside, California was added to the segment between Phoenix and Los Angeles, via San Diego.

CANADIAN PACIFIC AIRLINES

A highlight of CPA's year was establishment of a new transcontinental service between Vancouver, Winnipeg, Toronto and Montreal on May 4, 1959. The service was limited to one flight per day by Government order.

Overseas, CPA continued to serve Tokyo and Hong Kong via the Aleutians, and Mexico, Peru, Argentina and Chile to the south. The airline's four country Latin American network extended from Mexico City to Toronto and Montreal in eastern Canada, and on across the Atlantic to Santa Maria, Lisbon and Madrid. CPA's South Pacific Service reached Honolulu, Fiji, Auckland and Sydney, and connected with the Polar Route to Amsterdam at Vancouver.

During the summer, CPA established a regular traffic stop on the Polar Route at Edmonton, Alberta.

In June, Britannia 314s were introduced on the Polar, North Pacific and cross-Canada services. CPA planned to put Britannias in service on the Toronto-Mexico City and Vancouver-Honolulu routes late in the year.

At year-end, CPA operated 10 DC-6Bs, five DC-3s, two C-46F freighters, five Convairs, eight Britannia

over Hoover Dam and Lake Mead.

314s, one Otter and one Canso. The line had 2,791 employees, including 235 pilots.

CAPITAL AIRLINES

Major developments at Capital Airlines during 1959 included an important new route award, the introduction of service at two new Florida cities, some impressive changes in customer service methods, and the announcement of plans for expansion of Capital's turbine-powered fleet.

A Civil Aeronautics Board decision on May 19 gave Capital authority to operate a new route between Chicago and Minneapolis/St. Paul. Capital's introduction of jetprop Viscounts on August 2 marked the first time turbine service was available to passengers between these important cities. The airline's schedule provided seven non-stop Viscounts in each direction.

Two Florida cities began receiving Capital service during the year. On January 15 the airline inaugurated service between Tampa and Pittsburgh, Buffalo and Miami. In October, Capital began offering flights between Jacksonville and Atlanta, Charleston, Pittsburgh and Buffalo to the north and Tampa to the south.

On August 2, Capital started offering air travelers the convenience of commuter tickets. These easy-to-use items, first introduced on Capital's Chicago-Twin Cities route, made it possible for the airline passenger to call and reserve his seat on a desired flight and then write his own ticket without making an inconvenient trip to an airline ticket office. The commuter tickets, which are delivered to air travel cardholders and commercial accounts in books of ten, proved overwhelmingly successful and by November 1, the ticket program was expanded to include Washington, Atlanta, Buffalo, Cleveland, Detroit, New York and Pittsburgh.

Reservations handling methods at Capital were highly streamlined in July when the airline began operating its UNIVAC Reservations System. Thirteen cities, which together generate more than 80 percent of Capital's four million passengers each year, were selected for the initial operation of the UNIVAC system. The cities were Washington, New York, Chicago, Detroit, Pittsburgh, Cleveland, Buffalo, Rochester, Norfolk, Milwaukee, Minneapolis/St. Paul, Philadelphia and Grand Rapids.

Developed jointly by Capital, Remington Rand and American Telephone and Telegraph Company, the system consists of 175 sending and receiving units (Agent Sets) which are connected by 1,900 miles of AT&T Teletype lines and associated equipment to Remington Rand's UNIVAC File Computer in the airline's Washington headquarters.

Through the use of the UNIVAC Agent Set, a Capital reservationist can answer questions on the availability of any Capital flights as far as six months in advance. In addition, the Agent Set enables reservations personnel to sell, cancel, check flight information or perform numerous other tasks with remarkable speed and accuracy.

Early in October, Capital President David H. Baker announced plans to expand the airline's turbine fleet through the purchase of five Lockheed Electras and seven Convair 880-M pure jet airliners. The 400 miles per hour, 70 passenger Electras were to be delivered to Capital in May, June and July, 1960. They are powered by General Motors Allison engines and will be used on Capital's medium haul routes beginning in June.

The seven Convair 880-M jets are custom designed especially for Capital. Designed to carry 97 passengers, the 880-Ms will be the world's fastest passenger jet with a cruising speed of 615 miles per hour. Equipped with wing leading edge slats and a large vertical fin and power boost rudder, the 880-M will have the short takeoff and landing characteristics of a turboprop with the speed and economy of a jet. Delivery of these transports was set for October, November and December, 1960, with first passenger flights scheduled for December.

Other noteworthy developments during the year were:

- The introduction of a new inflight magazine, VOYAGER, to replace the seat pocket flight kit.
- Formulation of an airline teletype agreement linking Capital's teletype system with those of United, American, Delta and Eastern.

CHICAGO HELICOPTER AIRWAYS

CHA experienced considerable growth during the year and broke all previous passenger lift records. The helicopter airline carried more than 200,000 passengers in 1959. Peak month was September, with 23,306.

Even before inauguration of jet service to Chicago, CHA's traffic was increasing steadily over the comparable months of the previous year, but when jet schedules into O'Hare International Airport were begun, growth rate increased considerably. From an estimated 2,000 passengers carried to and from the jets in April (first full month of jet service), the number increased to over 5,000 by August, and the total was expected to rise higher as more jet flights to the city are added.

CHA kept pace by adding more flights on its inter-airport and downtown routes. Schedules on the Gary and Winnetka suburban services were also stepped up and utilization of equipment was pushed to the utmost. A sixth Sikorsky S-58 12-passenger helicopter was added to the airline's fleet. CHA has expanded from 16 daily flights with 112 seats in November, 1956, to a 1959 year-end figure of 137 flights and 1,644 seats available.

CHA had on order three Sikorsky S-61s for delivery in 1961. The three-turbine S-61 has a 25-passenger capacity and a higher block speed than the S-58 (125 miles per hour versus 105).

The airline during the year pursued an aggressive promotional campaign covering a wide range of activities from newspaper and trade publication advertising to strategically located outdoor billboards. Included also was an effective interline program and special joint carrier advertising.

At Midway, phones direct to reservations were installed in prominent spots in the passenger concourses of American, Braniff/Capital, and United/Eastern. Information counters were set up in American Airlines' lobby at Midway and the main lobby of O'Hare.

Another major traffic builder is CHA's new Skytour promotion. The low flying helicopter offers an excellent, closeup view of the city, a view that is really unique. Unlike air sightseeing charter flights, or sightseeing buses for that matter, Skytours are good on any of the company's regular schedules so there is no delay until enough prospects are rounded up to make the trip profitable. To promote Skytours among other carriers, travel agents and the public, the company published a full color brochure in 1959. The folder is beamed at conventioners, vacationers and businessmen. It also pushes Skytours as a unique idea for sales awards and incentives of all kinds. A small ad in a Sunday paper brought in hundreds of requests for copies and information. Nine different "Magic Carpet" Skytours are described in the pamphlet. At least two major airlines already are planning to include a CHA Skytour in their package tour promotions. The Skytour program was expected to help swell the passenger total in 1960.

Chicago will purchase Sikorsky S-61s.

CONTINENTAL AIRLINES

Continental Airlines in 1959 boosted revenue passenger miles past the 700 million mark, more than a 60 percent increase from 1958.

Behind the rapid upsurge was introduction of Golden Jet Boeing 707s between Chicago, Denver, Kansas City and Los Angeles and a large expansion of turbine-powered Viscount II flights throughout Texas and New Mexico. By September, more than 80 percent of the airline's daily seat miles were being operated in pure jet or propjet powered equipment.

Introduction of pure jet service culminated a 51 million dollar expansion program. Approximately $27.8 million went for 15 Viscounts IIs, a 365-mile-per-hour, 52-passenger Vickers-built propjet with which Continental introduced the first turbine service west of the Mississippi in 1958. In early April, the last of the order was received and placed in service between Dallas-Ft. Worth and Albuquerque, El Paso, Lubbock, Amarillo and Midland-Odessa over new nonstop routes awarded by the Civil Aeronautics Board.

On June 8 the first of the company's four Golden Jet Boeing 707s went into nonstop service between Chicago and Los Angeles. On August 15, jet service was extended to Denver and Kansas City. On September 5, the last of six daily Golden Jet round trips between Los Angeles and Chicago was inaugurated.

The next day, Continental carried its 50,000th Golden Jet passenger. Before November 1, the airline had passed the 100,000 mark.

Introduction of Golden Jets cost Continental $23.5 million, including more than three quarters of one million dollars for the training of ground and flight crews and almost two million dollars for expansion of ground facilities, including a $630,000 addition to the company's Los Angeles maintenance base.

During the year, Continental entered the Trans-Pacific Route Case with an application to serve Hawaii nonstop from Chicago, Denver, Kansas City, Los Angeles and San Francisco. The company proposed using Boeing 707-124Bs, a forward fan conversion of its present aircraft. Each plane would hold 104 economy seats and 32 first class.

Continental also pursued its application to fly from Dallas, Ft. Worth, Houston, San Antonio, El Paso and Albuquerque into Los Angeles, San Diego, San Francisco, Las Vegas, Phoenix and Tucson and its application for turnaround service between Los Angeles and San Francisco.

Newest innovation to airline passenger handling was introduced by Continental with its Golden Jets. A director of passenger services was added to each plane as a fifth cabin crew member. Passengers no longer had to check in at airport ticket counters, except to leave their luggage. All ticketing functions were performed on board the aircraft by the director.

A management representative with a minimum of five years seniority, the director collected tickets, sold new ones, charged for excess baggage and even had a radio-telephone to call ahead for hotel, rent-a-car or continuing airline reservations.

Continental's 707 went into service.

DELTA AIR LINES

Delta Air Lines, which pioneered the trans-southern route in 1929, marked its 30th anniversary of passenger operations by being the first carrier to place the DC-8 jet transport in scheduled service.

Ranking sixth among domestic airlines, Delta inaugurated pure jet service between New York and Atlanta on September 18, 1959. By December 1 the Atlanta-headquartered company had a fleet of six Douglas DC-8s in operation.

Delta's Royal Jets fly non-stop between Chicago-Miami, Chicago-Atlanta, Atlanta-Miami, Dallas-Atlanta, Detroit-Miami, and Houston-New York, providing both deluxe first class and jet super-coach. The first of a fleet of ten Convair 880 jet-liners was scheduled for delivery in January, 1960 with first commercial operations planned for early spring.

Founded in 1925 as the world's first aerial crop dusting firm, at year-end Delta was serving 67 cities in 20 states, the District of Columbia, and six Caribbean countries. Besides DC-8s and Convair 880s, the company's 81-plane fleet included DC-7Bs, DC-6s, Convair 440s and C-46 all-cargo transports.

Delta scored marked gains in all categories of traffic for the 1959 fiscal year in which passenger revenues rose 17.26 percent, mail revenues 19.83 percent, and express 26.63 percent. Revenue ton miles increased 11.90 percent, while revenue passenger miles were up 10.35 percent to 1,554 million. A passenger load factor of 59.28 percent was achieved.

The company's operating revenues attained an all-time high of $103,805,000, up 17.73 percent over 1958. Net earnings after taxes of $4,062,000 equaled $3.62 per share, compared to $1,063,155 and 95 cents a share in the previous year.

During 1959 Delta registered impressive growth in aircoach operations which rose from 540,680,000 revenue passenger miles to 624,425,000. Aircoach services accounted for 41 percent of the total compared to only 38 percent in 1958 and 71 percent in 1955.

A multi-million dollar principal Jet Overhaul Base, centrally located at the Atlanta Airport, was scheduled for completion in the early spring of 1960, as was a similar but smaller facility at Miami International Airport.

Delta's payroll climbed past the $40 million mark in 1959 as employment topped 7,300.

Four cash dividends of 30 cents a share each were paid on March 2, June 1, September 1 and December 1 marking the 11th consecutive year of such payments.

Introduction by Delta of "Royal Service" flights with DC-7 equipment was one of the company's service highlights of the year. Additional patronage attracted by these flights made a significant contribution to revenues and earnings for the year.

EASTERN AIR LINES

Eastern Air Lines started turbine service on January 12 when it began operating its new Lockheed "Golden Falcon" Electras between New York and Miami. By year-end it had 40 of these aircraft in service over many major routes linking the principal northern cities of the United States with the resort areas of the South and Southwest, as well as with San Juan, Puerto Rico, and Montreal, Canada. During the first nine months of operation, over three quarters of a million passengers had been carried more than 600 million passenger miles aboard these aircraft.

Expected to join Eastern's fleet of 228 aircraft of all types in operation during the year were the first of its fleet of Douglas DC-8 pure jets which the company hoped to place in scheduled service early in the winter. Sixteen of these planes were on order. They will be equipped with the larger and more powerful J75 Pratt & Whitney turbine engines developing greater thrust than earlier types and equipped with improved sound suppressors.

Other types of aircraft in use by Eastern during the year included 29 DC-7B 68-passenger "Golden Falcons"; 19 DC-7B 90-passenger "Falcon" Super Coaches; 10 Super G Constellation 70-passenger "Golden Falcons"; 16 88-passenger Super C Constellations; 7 DC-6B 102-passenger aircoaches; 12 88-passenger Super Constellations; 18 60-passenger Constellations; 56 Martin 404 40-passenger "Silver Falcons"; 20 Convair 440 44-passenger "Silver Falcons"; and one Douglas C-54 Cargoliner.

The National Safety Council again awarded Eastern Air Lines its "Award of Honor" in 1959 for flying 552,496 aircraft hours during the previous year without a passenger fatality or major accident.

During the summer, Eastern moved its Miami passenger operations to the new central terminal at that city's International Airport, and in the fall occupied its new $20-million passenger terminal at the New York International Airport, Idlewild. These terminals, together with new and enlarged airport accommodations elsewhere on the system, gave Eastern the latest in passenger and baggage handling facilities and materially aided it in rendering better service to its customers.

During 1959 Eastern operated 18,731 unduplicated route miles linking 103 airports serving 126 cities.

New records for the volume of travel handled over the Eastern system were established during June and August, exceeding in both instances the largest previous volumes ever handled in a single month's time, including the normally heavy winter months of the two previous years.

During the year Eastern inaugurated flights into the Broward County International Airport, Fort Lauderdale, Florida, fro Newark New Jersey, resumed direct non-stop flights between New York and St. Louis; and, with the lifting of certain restrictions previously in effect, began operating direct daily flights between Chicago, Greensboro/High Point and Raleigh/Durham. Service to Malone, New York, was discontinued. With the introduction of the Electras and the upgrading of flights elsewhere as modern four-engine piston-powered equipment became available, there was considerable speeding up of service over many other important route segments. Following Civil Aeronautics Board authorization, Eastern was expecting at year-end to commence services between various major points on its system and Cincinnati, Milwaukee, and the twin cities of Minneapolis/St. Paul.

Occupying much attention during the year were the extensive hearings conducted by the CAB at Houston, Los Angeles, Miami and Washington, D.C., on the Southern Transcontinental Service Case. Eastern presented strong arguments supporting the need for such a route to serve the nation's most rapidly growing areas and emphasized its own qualifications to serve it, using new jet aircraft.

During the year Eastern linked its teletype lines to those of United, Southern and Capital Airlines, thus providing (with interconnections already previously effected with American, Delta and TWA) a private communications network for the exchange of reservations and other information amounting to 174,686 miles.

To bolster sales, Eastern introduced a variety of travel promotional ideas during the year, notably an expanded program of "Happy Holidays" low-cost package tours to Florida and other resort areas, including several effective during the winter months. Various experimental fares were established to encourage night-coach and family travel. A revived "Fly Now-Pay Later" plan was adopted in cooperation with the Beneficial Finance Co. Champagne service and additional stewardesses were placed aboard many first-class "Golden Falcon" flights, and complimentary meals were added to some deluxe day-coach services. An effort was made to develop more "Fly and Drive" business in cooperation with the auto rental agencies, and sales in-

Eastern's new passenger terminal was under construction at Idlewild.

centive vacation travel programs were worked out with a number of important manufacturing companies to develop increased charter and regular business which could be profitably handled. Most notable of these was the movement of some 3,000 dealers and distributors for the Gibson Refrigerator Co. from many cities in the United States to Puerto Rico during September.

An important change was made in Eastern Air Lines' management setup effective October 1, when Malcolm A. MacIntyre became President of the company, succeeding Captain Eddie Rickenbacker, Chairman of the Board, as chief executive officer. Thomas F. Armstrong took over the newly created post of Executive Vice President-Finance.

THE FLYING TIGER LINE

Two major developments marked the year of 1959 in The Flying Tiger Line, world's largest contract and airfreight carrier. The company completed the first profitable year of airfreight operations in its 15-year history and it placed an order for a fleet of 10 Canadair CL-44D-4 turboprop airfreighters, about the long-sought breakthrough of airfreight into the nation's major transportation markets.

In its June 30, 1959, annual report, the airline showed net income from operations of $2,806,389, highest in company history and more than double that of the preceding year.

This permitted the company to go ahead with the order for a turbine type airfreighter and it completed a deal with Canadair Ltd., Montreal subsidiary of the General Dynamics Corp., for $51-million worth of equipment, scheduled for 1961 delivery.

The new Canadair ships will embrace the much-discussed swing tail feature for greatly expedited aircraft loading and unloading, doing away with the conventional and awkward main side-door configuration. In the CL-44D-4, airfreight may be loaded straight-in or out.

By mid-1959, the company had established a fully-staffed research bureau which was putting together a new tariff, to be presented to the CAB early in 1960 and intended to create an entirely new tariff structure for airfreight. Under this tariff, the company estimated that by 1965 the airfreight industry would be producing between seven and 10 billion ton miles annually, against less than a billion in 1959. It said that it agreed with a study of the Stanford Research Institute that by 1975, airfreight would be flying 40 billion ton miles annually and producing revenues equal to that obtained in passenger transportation, or about $4 billion dollars annually.

FRONTIER AIRLINES

The year 1959 witnessed three major developments in the growth and operations of Frontier Airlines. It included a change in top management of the airline, a tremendous route mile growth in its operations and the addition of new flight equipment into its schedules.

In January 1959, Lewis B. Maytag, Jr., who had been Frontier's majority stockholder and chairman of the board, also assumed the duties of president of the airline. To assist Maytag in carrying out his plans for making Frontier Airlines a profitable operation, two new vice presidents were brought into the company. G. Ray Woody became Frontier's new executive vice president, while J. Dan Brock headed up the Traffic and Sales Department as its vice president.

During 1959, Frontier expanded very rapidly in the addition of new route miles, the number of cities served, and in the total of employees needed to carry on its expanding operation. As a result of the Seven States Area Case and the Montana Local Service Case, Frontier grow into a route system of 6,819 miles, serving 70 cities in 11 states of the Rocky Mountain west and mid west sections of the United States. A twin- engined fleet of 25 DC-3s and five Convair 340s was in operation. Approximately 1,200 employees staffed the functions necessary to operate the local service airline.

On July 1, 1959, Frontier began its Radar Convair service flying Convair 340s over the more heavily traveled routes of its system. The additional seating capacity of the aircraft, plus the added passenger comforts of pressurized cabins, attracted many additional passengers over the airline's high-altitude routes in the west. Two new features were added to the passenger services offered by Frontier on its Radar Convairs—snack food service, which featured trays of sandwiches, cheese wedges, fresh fruits and crackers, and the opportunity to purchase alcoholic beverages, which were sold for $1 apiece. The in-flight sale of miniature bottles of scotch, bourbon, martinis and manhattans were paying half the cost of the added food service. Both these services were innovations for a local service airline.

In November, 1959, Frontier Airlines broke ground for its new general office building, located near Stapleton Airfield in Denver.

LAKE CENTRAL AIRLINES

Lake Central's tenth year of operation brought many significant changes. Of primary importance was the termination of the Voting Trust Contract which placed ownership and responsibility of ownership in the hands of the stockholders in the airline. The stockholders' interests had been held by a voting trustee until the final litigation in the North Central-Lake Central Acquisition case. The Supreme Court's decision in June granted unqualified ownership of the airline to Lake Central stockholders, following nearly seven years of litigation with North Central Airlines.

During March, Lake Central announced the completion of the corporation's million dollar financial program. The two phase program included a $750,000 bank loan and the sale of a $300,000 issue of six percent convertible subordinated debentures.

Lake Central officials continued their evaluation of turboprop and VTOL equipment and stood ready financially to obtain the necessary aircraft to serve new routes awarded in the Great Lakes, Piedmont, or Cincinnati-Detroit cases which are before the Civil Aeronautics Board.

The CAB examiner in the Great Lakes Local Service Investigation case, Barron Fredricks, recommended that Lake Central be allowed to serve 16 cities through 13 additional air terminals in the states of Michigan, Indiana, Ohio, West Virginia, Maryland and the District of Columbia. This recommendation was made September 29 as a part of the initial decision of the examiner. The recommended routes total 1,727 new route miles and would increase Lake Central service to more than 49 cities in an eight-state area and the District of Columbia. Among the additional cities which the examiner recommended for Lake Central service are Washington, D. C.; Baltimore, Maryland; Charleston, Elkins, Clarksburg/Fairmont, Morgantown, Wheeling, Parkersburg/ (Marietta, Ohio), West Virginia; Akron/Canton, Findlay and Sandusky, Ohio; Columbus, Indiana; and Jackson, Michigan.

During the early part of the year, two additional DC-3s were added to the fleet, increasing the total to 12. With the larger fleet, Lake Central was able to increase its scheduled flights 15 percent, effective August 1. As many as four daily round trips were scheduled between various Lake Central cities.

Having closed 1958 with a net profit of $127,958, Lake Central continued to show financial improvement throughout 1959. New records were established in all major traffic categories. New monthly passenger boarding records and daily passenger boarding were announced throughout the year. The airline boarded its millionth passenger in November.

On June 2, Lake Central opened for service an expanded, up-to-the-minute communications network. The private line teletypewriter system interconnects 39 terminals and ticket offices. The new system adequately handles present requirements and can be engineered for future route extensions and passenger growth.

With the completion of the exterior design on Lake Central's fleet of DC-3, a committee was formed to study plans for re-decorating the interiors of the aircraft. The airline completely redecorated the interiors of two DC-3s, launching its decorating program which will extend into 1960 and the early part of 1961.

Two city ticket offices were opened during 1959. The first was opened in Indianapolis in the lobby of the Claypool Hotel, and the second CTO was located on Michigan Avenue in Chicago. Lake Central was the first local service carrier to open a CTO in Chicago.

MOHAWK AIRLINES

Mohawk's major innovation in 1959 was the introduction of four Convair 440 Golden Metropolitans, starting August 28th. The 440s serve New York City and the upstate cities of Syracuse, Utica, Binghamton, Rochester, and Buffalo. Purchased new from the Convair Division of General Dynamics in San Diego, they were priced at $700,000 each.

Public acceptance of the big black-gold-and-white Convairs was excellent. Gains as high as 103 passengers a week were reported on flights served by the 440s.

New Mohawk routes, to Cleveland from New York State points, and White Plains Providence-Boston, plus Poughkeepsie-Providence and Albany-Providence, were granted tentatively by the CAB. A route from Syracuse to Pittsburgh was being sought.

Mohawk's first year in its new three million dollar headquarters at Oneida County Airport, Utica, New York, was marked by few of the usual "getting settled" pains. While no direct estimate can be made, savings in time and money were realized by the centralization of Mohawk's administrative, maintenance, overhaul, and related activities.

Mohawk traffic boomed in 1959. An early estimate of 500,000 revenue passengers for the year will probably be exceeded. June was the largest month, with a total of 51,808 passengers. Mohawk, founded in 1945, took 11 years to carry its first million people, then 28 months to board the second million (August 1958), and the airline expected to reach three million by the middle of 1960.

Another 1959 highlight was the listing of Mohawk stock on the American Stock Exchange.

With an eye toward the future, Mohawk continued with a program of new equipment evaluation. Recent activities included simulated-scheduled flight of a Canadair-Convair 540, evaluation of the Allison turboprop Convair, inspection of the Fairey Rotodyne, and a study of the Fairchild F-27.

A unique Air Travel Account Program, effective April 1, 1959, speeded ticketing and accounting procedures. A book of 20 tickets, printed on standard IBM cards, was issued to the customer. These were signed and presented at the ticket counter marked with destination, flight and date by the agent, then forwarded to machine accounting, where the fare was computed from a master card, and the

Mohawk's 440 Golden Metropolitan.

passenger billed. The net result to the customer is faster service by eliminating the looking up of fares and filling out charge forms at the counter; faster and more accurate billing; and automatic ticket replenishment by use of a code punched on the sixteenth ticket in the book.

Mohawk at year-end served 34 major cities through 21 airports in Massachusetts, Michigan, New Hampshire, New Jersey, New York, and Pennsylvania. The airline owned four Convair 440s, nine Convair 240s, and seven Douglas DC-3s.

NATIONAL AIRLINES

National Airlines rounded out its first quarter century of air transportation service on October 15, 1959.

For the fiscal year ending June 30, 1959, National realized a net profit of $2,379,128 compared to a loss of $605,316 last year.

The increase in revenues was attributed in part to temporary suspension of operations by a competitor due to labor difficulties, although revenue increases over the previous year continued after the other airline resumed operations.

National had the distinction of being the first carrier to offer domestic jet service on December 10, 1958 and by May 15, 1959 had flown 65,000,000 revenue passenger miles with the Boeing 707. The aircraft, leased from Pan American, were returned for the summer. Jet service was resumed November 1, 1959 with four round trips daily bewteen New York and Miami.

On March 6, 1959, National's northbound flight No. 6 made a record flight of 109 minutes from Miami to New York, with an average ground speed of 660 miles per hour.

National started propjet Electra service on April 23, 1959 and provided coach as well as first class

National Airlines was scheduled to take delivery on Douglas DC-8s.

accommodations on the Electra between New York and Miami. National had 23 Lockheed Electras on order and by the end of the calendar year 1959 had 12 of its Electras in service over system routes.

National was scheduled to take delivery on its first Douglas DC-8 in December and service was scheduled for early 1960.

On September 2 the Greater Miami Aviation Association presented its 1959 Distinguished Service Award to National's president, G. T. (Ted) Baker, for "25 years of outstanding progress and development of airline service to Florida and the nation, and first to inaugurate jet service in the United States." On the same occasion he was also presented with aviation leadership awards from the cities of St. Petersburg, Jacksonville, Miami and the Metropolitan Dade County Commission.

National was a contender in the Southern Transcontinental Route case with its application to provide single carrier jet service across the southern tier of the United States between Florida and California.

NEW YORK AIRWAYS

Highlight of New York Airways' year occurred in May when president Robert L. Cummings, Jr., accepted the American Helicopter Society's Kossler Award from Don Berlin, President of Vertol Aircraft Corporation and Chairman of the Awards Committee, at the American Helicopter Society's 15th Annual Forum at Washington.

The award was for the "most outstanding practical application of the helicopter."

In May of 1959, in less than one full year of operation with its fleet of five Vertol 44s, New York Airways flew over 100,000 passengers in the 15-passenger Vertol helicopter.

It was announced in November that New York Airways and the Vertol Aircraft Corporation entered into an option agreement granting New York Airways the right to purchase the first five Vertol 107 multi-turbine powered helicopter airliners.

NORTH CENTRAL AIRLINES

Considerable growth marked 1959 for North Central Airlines as the "Route of the Northliners" expanded from 53 cities and 3,471 route miles to 68 cities and 5,228 miles.

The Seven States Area decision, handed down by the Civil Aeronautics Board in December, 1958, was responsible for this expansion, in which service was inaugurated to Appleton and Ashland, Wisconsin; Rockford, Illinois; Bismarck/Mandan, Devils Lake and Minot, North Dakota; Mankato and Worthington, Minnesota; and Aberdeen, Spearfish, Rapid City, Huron, Mitchell and Pierre, South Dakota.

Five 44-passenger, pressurized, radar-equipped Convair 340 Super Northliners were put into service April 26, joining North Central's 32 DC-3s.

Additional space in the Convairs sparked another "first" for the airline: meal service. Duluth-Chicago nonstop flights featured meals catered by former Waldorf-Astoria chef Hans Freischle of Duluth's Gourmet House. Menus rotated from prime ribs of beef with mushroom sauce to lobster-shrimp a la newberg to boneless breast of chicken with ham slice on toast. Continental breakfasts were served on some Convair trips while snack trays highlighted flights between South Dakota and Minnesota.

Festivities at Milwauk e's Mitchell field July 1 ushered in another North Central innovation—"Beer Flights"—when complimentary beer service was added to six Convair flights over Wisconsin.

Inaugurating air freight service on June 1, the company climbed to fifth place among the 13 local carriers in total air freight and air cargo volume. In 1958 it led the local airline industry in air mail, air express and passengers.

Shooting for a million passengers in 1959, North

Central smashed two of its own records for the local airline industry in the first eight months of the year when it carried 3,886 passengers on June 19 and 95,409 during August.

The airline's rapid growth created over 500 new jobs throughout the company's nine-state system during the first few months of 1959, bringing the number of employees up to 1800.

New aircraft, more employees and overall expansion caused a space shortage for the Twin Cities-based airline. This was alleviated in mid-year with the completion of a $375,000 line maintenance with overhaul hangar with office space at Wold-Chamberlain Field.

By mid-October the company had carried 4,035,000 passengers over 635 million revenue passenger miles since beginning scheduled operations in February, 1948, without ever having had a serious injury to passenger or crew.

NORTHEAST AIRLINES

The year 1959 became the first in the 26-year history of Northeast Airlines during which the Boston-based carrier boarded over a million passengers in a 12-month period. The one millionth passenger of the year was carried on a day in mid-October. As a result, the company expected to enplane more than 1,250,000 passengers by year's end. Best previous traffic record for a single year was the 1958 mark of 955,955 passengers.

Many of Northeast's new passengers were introduced to the company's service aboard its fleet of propjet Viscounts, which started to arrive during the second half of 1958 and were in full operation by February of 1959.

Penetration by the Viscounts of the company's high density markets along the east coast such as New York-Boston and New York-Washington helped to alleviate Northeast's traffic imbalance between Florida's peak winter season and New England's concentrated summer vacation period. The Viscounts, ten in all, were obtained through an equipment trust arrangement which provided payment over a seven-year period on reasonable interest terms.

The year saw Northwest bring more new faces into top management under the presidency of James W. Austin, who also took over the duties of general manager at the same time that David A. Stretch, President of Atlas Corporation, succeeded George E. Gardner as Chairman of the Board of Directors. Mr. Stretch was elected Chairman in February. Two months later, Thomas L. Grace, former President of Slick Airways, was elected Vice President of Operations, and Edmund O. Schroeder, one of the industry's top maintenance executives, was elected Vice President of Technical Services.

Major improvements were made during 1959 in Northeast's terminal facilities in such cities as Miami, Washington, New York, and Boston. Northeast became the first occupant in the new $16-million passenger terminal at Miami International Airport. When the new North Terminal at Washington's National Airport was opened, Northeast was among the first to be located in the new facility which features quicker and more convenient taxi and limousine service, better baggage handling, and quicker access to boarding planes. Northeast's ticket counters were completely refurnished at New York's LaGuardia Airport and Boston's Logan International Airport.

Ground was broken January 13, 1959, for the company's new $2.5-million hangar and office building at Logan Airport, Boston. This facility will be adjacent to the company's existing hangar, and when ready for occupancy, will enable Northeast to centralize many of its activities, particularly in the maintenance area. The new office building will house the company's general offices.

Northeast's continued growth in 1959 increased

New facilities for Northeast were being constructed at Logan Airport.

personnel to more than 2,400. The pilot list was up in the 300s and the stewardess list went up to 180.

After months of preparation, Northeast was ready to start its jet service between New York and Miami at the end of the year. Northeast's own crews were flying the Boeing Intercontinental 707 jets through a lease agreement with TWA, approved by the Civil Aeronautics Board.

OZARK AIR LINES

For Ozark Air Lines, 1959 was marked by its entry into the turbine aircraft field, the most extensive expansion in its history and an improvement in the airline's earning record.

Acceptance of its initial order of three Fairchild F-27 jetprops during the summer marked the airline's entrance into the jet age. The aircraft were placed in service later in the year. Delivery of the planes climaxed an intensive six months' training program, begun in March, for all of the airline's personnel.

In order to finance this jet program, Ozark raised approximately $2.7 million through a loan and the sale of 132,944 shares of stock. The loan was granted a federal guarantee by the Civil Aeronautics Board.

A rapid expansion program was accomplished by Ozark when the CAB awarded it additional 1,716 un-duplicated route miles in the Seven States Area case, bringing the airline's system to 5,273 route miles serving 54 cities in 10 states. Service over the new routes was inaugurated March 1 and expanded operations from 18,597 miles a day to 26,930 miles per day; a 45 percent increase.

New cities added to the system by this award were Madison, Wisconsin; Iowa City, Iowa; Omaha, Nebraska, and St. Joseph, Missouri. In addition to these four new cities, the award included additional or substantially changed service to 25 cities previously served by Ozark.

In 1959, Ozark flew over 7½ million air miles and well over one half million passengers.

Operations for the fiscal year resulted in a net profit of $87,958 as compared to a net loss of $128,706 for the previous year. Operating revenues were up 19 percent but operating expenses also rose 16 percent.

In October, Joseph H. Fitzgerald was elected president of Ozark. Floyd W. Jones was elected chairman of the board.

Also, as a mark of its corporate identity, Ozark adopted a stylization of the "three swallows in flight." In addition to being a distinctive modern insignia in itself, the emblem has further significance due to its association with the ancient symbol of safe travel and scheduled flights.

In September, Ozark completed its ninth year of operations with a record of 2,122,343 passengers flown, exceeding the two million mark in May, and a perfect record of safety.

During the year, Ozark maintained an average load factor of over 51 percent and recorded approximately a 30 percent increase in passengers flown. In September it established a new record for passengers boarded in one day with 2,191, upsetting the old record which had been recorded in May.

Expanding its facilities, Ozark leased a hangar and office space in Rockford, Illinois, and also entered into commitments involving terminal, hangar and fueling systems at O'Hare International Airport, Chicago, Illinois, which were scheduled to be completed in 1962.

At year-end, Ozark employed approximately 1075 persons, an increase in personnel of about 23 percent over the previous year.

PACIFIC AIR LINES

The year 1959 saw Pacific Air Lines enter the jet age, expand its service to major Pacific travel points and extend its nonstop operations.

Most important to Pacific Air Lines was the placing into service six F-27A propjet 44-passenger aircraft. The first three F-27As went into revenue service on April 26, 1959 and the second three, which were delivered in June, were placed in service on July 1. The company's fleet now consists of six F-27As, seven Martin 44-passenger aircraft and ten DC-3s.

Another major development was the extension of service to Portland, Oregon, now Pacific's northern terminal. This service was inaugurated on September 1, 1959 and provides Portland with nonstop F-27A service to Eureka-Arcata, one-stop service to the San Francisco-Oakland Bay Area and one plane service to San Jose, Monterey, Bakersfield and Las Vegas. A Martinliner provides service from Portland and Crescent City down the California coast to the Bay Area.

The year also saw Pacific inaugurate "Commutair" service between San Francisco, San Jose, Stockton and Sacramento and between Palmdale-Lancaster and Burbank-Los Angeles.

New nonstop service was instituted between Bakersfield and San Francisco; between Los Angeles and Monterey, and between San Jose and Los Angeles. Some schedules also provide nonstop service between Monterey and San Francisco. To meet the demand for connecting service with transcontinental airlines and additional business day commuter service Pacific also began nonstop flights daily between Santa Maria and Los Angeles International Airport.

The year 1959 also saw changes in the operating organization of Pacific Air Lines. C. A. Myhre, former president of Frontier Airlines, joined Pacific as vice president-finance.

In 1956 the University of Denver awarded Mr. Myhre the annual aviation award for outstanding achievement in aviation. He is a past president of the Denver University Alumni Associaton and was active in business and fraternal clubs in Colorado before moving to the San Francisco Bay Area. He also is a former director of the Air Transport Association and the Association of Local and Territorial Airlines.

R. E. Costello, formerly vice president in charge of traffic and sales, was named vice president of traffic to enable him to devote full time to the traffic demands. Max A. King, who joined Pacific as a vice president in 1953, was appointed vice president in charge of sales. Richard C. Withers, who joined Pacific in February, 1958, was named to the newly created post of passenger service manager under Mr. Costello.

The year also saw the introduction of a "jet-stop" political campaign when during the summer months, Governor Edmund G. "Pat" Brown of California, gave a mid-session report to the people in a three-day swing around the state in a chartered F-27A.

PAN AMERICAN WORLD AIRWAYS

By the end of 1959, little more than a year after Pan American World Airlines introduced Jet Clippers, the 575-miles-per-hour airlines were flying over most of the company's worldwide routes and had become the mainstay of the operation.

The inauguration of round-the-world jet service on October 10 climaxed a steadily increasing use of jet aircraft. Boeing 321 Intercontinentals operating out of both the east and west coasts of the United States cut the globe-girdling elapsed time to a little more than two days and reduced flying time to about 38 hours. The jet elapsed time was a full day less than piston-engine schedules.

At year's end Pan American jets also were serving many of the major European cities, flying a Polar route from the West Coast to Europe, and winging southward from New York to Buenos Aires. Jet Clippers also opened service to San Juan, Puerto Rico; Ciudad Trujillo, Dominican Republic; Nassau, Bahamas and Montego Bay, Jamaica, with flights from Miami, newest Pan American jet terminal, and New York.

The Jet Clippers' immediate public acceptance sent load factors to a consistent high level and gave promise of a record year in passenger traffic. By September, advance bookings on routes served by jets were up as much as 190 percent over a corresponding period of the previous year.

At the summer peak on the heavily traveled trans-Atlantic route, 50 Jet Clipper flights a week shuttled between New York and London or to Paris and Rome. That frequency was expected to be maintained through the rest of the year. All jet flights

Pan Am's 707s flew world-wide.

were in de luxe President Special or low-cost Economy configurations. First-class service was provided on the piston-engined Clippers.

During the record-breaking first week of July, when Pan American carried the greatest number of persons ever to fly the Atlantic in a single week, most of the 10,256 passengers flew in Jet Clippers.

In addition to London, Paris and Rome, jet service was extended in October to Frankfurt, Dusseldorf, Amsterdam, Brussels, Hamburg and Copenhagen.

Pan American also inaugurated American-flag jet service to South America. The first flight departed from New York on July 20 for Buenos Aires, via Asuncion, Paraguay. The service began as a once-weekly roundtrip and was later increased to two roundtrips. Jets cut the travel time between New York and Buenos Aires to 12 hours, half the time required for piston-engined planes.

Jet Clippers made their debut at terminals on the West Coast on August 26 when the first jet left on a Polar track to Europe.

Travel times were slashed almost in half by the inaugural flight, routed from San Francisco and Los Angeles to London. Flights operated on a twice weekly schedule, making the 5,525-mile trip in 11 hours, 20 minutes. On westbound flights the Jet Clipper's speed and the changes in time zones made it possible for a passenger to eat breakfast in London and be in San Francisco in time for a late lunch date.

A trans-Pacific service with Boeing 321 Intercontinental jets, which opened on September 5, offered flights from San Francisco or Los Angeles through Honolulu to Tokyo. By the following month the flight frequency was increased to four a week. Service between the West Coast and Honolulu was expanded to 16 roundtrips a week with Portland and Seattle being added as Jet Clipper terminals.

Pan American instituted its jet services with Boeing 707 aircraft, but began integrating long-range Boeing 321 Intercontinentals into the fleet in September. By the end of the year all of the airline's transatlantic jet service was with the Intercontinentals.

The Intercontinentals, with a range of 5,000 miles, fly nonstop across the Atlantic in both directions. They cut the New York to London flight to six hours, 30 minutes, and reduce the westbound crossing time to eight hours, 40 minutes.

Pan American dramatically introduced the Intercontinental as a press plane accompanying Vice President Richard Nixon to Russia. The Intercontinental sped from New York to Moscow nonstop in eight hours, 54 minutes.

Along with the upswing in passenger traffic, Pan American also noted increases in cargo which indicated a new high by the end of the year.

In preparation for an expanded cargo service, Pan American evaluated several types of all-cargo turbine-powered planes.

At the same time, the company took immediate steps to equip itself for a greater cargo lift by converting 10 DC-7C passenger planes to cargo aircraft.

The $2.8-million conversion contract, awarded to Lockheed Aircraft Service, contained an option for conversion of an additional 10 DC-7Cs. The first 10 planes were expected to be completed in early 1960.

Pan American planned for the converted DC-7C to carry 16 tons on a trans-Atlantic flight, or almost five tons more than a DC-6A, the cargo plane currently serving the route. The DC-7C will cruise at 300 miles an hour, 50 miles an hour faster than a DC-6A.

The airline instituted an all-cargo service across the Pacific with DC-4s on April 1 on a once weekly basis. Flights leave San Francisco and are routed via Honolulu and Guam to Manila. The DC-4 Cargo Clipper has a capacity load of 15,000 pounds.

PANAGRA

To meet the demand for tourist and first class service to South America prior to introducing jet service on that continent early next year, Panagra (Pan American-Grace Airways) in 1959 converted its DC-6B and DC-7 fleets to dual configuration.

In so doing, the airline extended its first class service to Cali, Quito and La Paz, increased this service to Guayaquil, Talara, Lima, Antofagasta, Santiago and Buenos Aires, and for the first time provided daily tourist service to these last two named South American capitals.

The airline also continued its excursion fares, which it had introduced in 1956, to encourage and stimulate group and individual travel to South America and extended their time limit from 30 to 45 days to permit longer trips. These excursion fares, which reduce by as much as $200 the price of a trip around South America, have made it possible for travel agents in this country to offer more escorted and independent all-inclusive tours of South America.

In prepartion for the start of its DC-8 jet service to South America early in 1960, Panagra began an extensive training program for flight crews and operations personnel. Special training courses for pilots, mechanics and ground personnel were conducted in the United States and South America. Sales and traffic personnel also were readied for the jet with additional instruction to cope with some of the new problems which might arise in handling increased loads of 100 or more passengers and tons of baggage and cargo.

The year also saw a 15 percent rise in Panagra's cargo during the first half of 1959 as a result of continued expansion of industry and exploration of oil and mineral deposits in South America.

To expedite these shipments between the U.S. and South America, the airline eliminated the overnight stop on its DC-4 all-cargo service between the Unted States and Bolivia. It also transported the household effects of the 500th family to be moved by the airline's "CASAPAK," an air-van type of plywood container designed exclusively for Panagra to eliminate packing and crating and protect shipments of home furnishings.

In the way of passenger service, the airline added a champagne supper on its "El Inter Americano" flights to South America. The late supper snack, offered immediately after take-off from Miami, consists of Peruvian jumbo shrimp, finger sandwiches of ham, chicken, turkey, imported cheese and tasty spreads and assorted cakes served with French champagne or Chilean wines and other liquors and non-alcoholic beverages.

In 1959, the airline continued its travel fellowships program designed to foster closer relations and create better understanding between the Americas, by providing 18 fellowships for South American students to travel to the United States to study. These brought to 326 the number of travel fellowships awarded to South American students by Panagra since the program was started in 1937.

A special aviation award was presented to Panagra by the Inter American Safety Council for its perfect safety record during the past 15-years of scheduled operation to seven South American countries. The airlines also received the National Safety Award of Honor for 1958.

During the 15 years covered by the awards, Panagra flew a total of 1,991,495,000 passenger miles without an accident or fatality in passenger service over its routes in Panama, Colombia, Ecuador, Peru, Bolivia, Chile and Argentina.

SEABOARD AND WESTERN AIRLINES

In 1959, Seaboard & Western Airlines advanced in all phases of its operations across the North Atlantic.

By the end of the year, Seaboard & Western was providing unprecedented all-cargo flight frequencies between the United States and Europe and the greatest all-cargo capacity on the North Atlantic route, serving more European destinations with all-cargo service than any other trans-Atlantic carrier.

Major events crowded the Seaboard & Western calendar during the year, highlighted by its order for five (and an option for five additional) jetprop CL-44 air freighters from Canadair, Ltd. The radical swingtail CL-44 was expected to reduce direct operating costs of trans-Atlantic cargo service up to 50 percent, while carrying twice the load of the company's Super Constellations. Seaboard &

Seaboard & Western Super Constellation is loaded for departure to Europe.

Western was scheduled to take delivery of its first CL-44 early in 1961.

On the basis of the operating characteristics of the CL-44, Seaboard & Western was also able to forecast a 69 percent reduction in trans-Pacific cargo rates in its September application to the Civil Aeronautics Board for these routes between the United States and points in the Far East and the South Pacific.

During the year, Seaboard & Western marked another milestone in its development as a scheduled all-cargo carrier. This was the carrier's full certification in April to carry U. S. mail.

Cargo traffic itself reached all-time highs. In the second quarter of 1959, Seaboard & Western for the first time in its 13 year history lead all scheduled North Atlantic carriers in cargo tonnage.

The stepped up pace of Seaboard & Western's operation was reflected on the ground as well as in the air. In August, the company's executive and administrative headquarters was moved from Manhattan to a new three-story building at New York International Airport.

By the year's end, Seaboard & Western had also occupied two major aircraft maintenance facilities, one at the company's home base, New York International Airport, and the second at Shannon Free Airport, Ireland.

On the commercial side of Seaboard & Western's activities the company's sales office network was expanded greatly on both sides of the Atlantic. In the United States, 1959 saw the establishment of new sales offices in San Francisco, Los Angeles, Atlanta, Dallas, San Antonio and Washington, D. C. In Europe new sales offices were opened in Berlin and Hannover, Germany, and in Birmingham, England.

In 1959, Seaboard & Western Airlines was authorized to serve Dover and McGuire Air Force Bases in the United States and the Air Force installation at Mildenhall, England, for military cargo traffic. Authorization was also received for commercial service to Hannover, Germany.

SOUTHERN AIRWAYS

In 1959, Southern Airways observed its tenth anniversary year of providing local airline service to the South. On June 10, 1949, Southern could count on only 36 employees to cluster around the company's one airplane as it departed from Atlanta's Municipal Airport bound for Memphis with stops at Gadsden, Birmingham and Tuscaloosa, Alabama, and Columbus, Mississippi. At year-end, as the airline celebrates "Going Places With the South for 10 Great Years," more than 700 employees and a fleet of 19 DC-3s linked 37 cities in eight southeastern states.

In its ten years of operation, Southern Airways operated without passenger injury and carried 1,436,437 passengers a total of 250,463,002 passenger miles. With the inauguration two years ago of regularly scheduled air freight service between certain terminals on its system, Southern experienced an upswing in this revenue category as well as in air express, air mail and air parcel post.

Through June 30, 1959, Southern Airways passenger planes had carried 9,592,000 pounds of air mail. This figure represents approximately 287,-769,000 letters or 72 letters for every man, woman and child in the 37 southeastern cities Southern serves.

A review of the year's activities reveals the following significant events:

On January fifth additional round trips were added between Huntsville, Alabama and Atlanta and between Eglin Air Force Base, Florida and New Orleans. When Huntsville and its Redstone Arsenal were added to Southern's system in December, 1958, the event gave Southern the distinction of serving more military installations than any other airline in the world.

Southern Airways inaugurated the first arline service into University/Oxford, Mississippi and Bogalusa, Louisiana on July 1, adding these two cities to the list of 15 which are served exclusively by Southern.

July 21 was probably the most memorable day of the year for Southern. It was on that day that the Civil Aeronautics Board released its tentative decision in the Southeastern Area Local Service Case which would authorize the airline to begin service to ten Tennessee cities and seven other cities in the South. This award would bring to 54 the total number of cities served and would be the largest annexation of service awards to Southern in its ten-year history.

TRANS-CANADA AIR LINES

During the last week of 1959 Trans-Canada Air Lines expected to take delivery of the first of six ordered Douglas DC-8 jetliners, highlighting another year of airline development and expansion.

The 127-passenger, 550-mile-an-hour DC-8s will go into trans-continental service between Vancouver, Winnipeg, Toronto and Montreal on April 1, 1960, and between Canada and the United Kingdom on June 1.

In 1959, TCA inaugurated weekly return service between Canada and Vienna, Austria, with Super Constellation aircraft; began weekly direct return service between Toronto and Tampa, Florida, with 44-passenger Viscount turboprop aircraft and started a new daily trans-continental Eastern and Western Mercury service between Montreal, Toronto, Winnipeg and Vancouver. In addition, flight frequencies were increased on many of the airline's already existing domestic, trans-border and overseas routes.

Also in 1959, the airline began construction on a $20-million overhaul and maintenance base at Montreal, the world's first designed exclusively for turbine aircraft. Construction began in 1959 on a $5-million overhaul and maintenance base for turbine aircraft at Vancouver. Both were to be completed in 1960.

During the year, TCA placed a $3.5-million order for an electronic reservations system, to be in operation by 1961 when the airline expects to be operating an all-turbine intercontinental air fleet, flying DC-8s, Vickers Vanguards and Viscounts.

At the year's end, TCA was flying over 32,000 miles of air routes, serving 40 communities in Canada, seven in the United States, eight in Europe, five in the Caribbean and Bermuda.

Its aircraft fleet consisted of 49 Vickers Viscounts, 14 Super Constellations, 21 Canadair North Stars and nine DC-3s, with six DC-8s and 20 Vanguards on order.

TRANS WORLD AIRLINES

For Trans World Airlines, 1959 was the "year of realization." During the year the realization of three major and significant objectives solidified TWA's position still further as a major world airline.

These included integration of Boeing 707 jetliner schedules on United States and International routes; a new form of company organization; and record traffic and revenues in the second and third quarters, which, combined with firm cost controls, indicated the year would end with a healthier financial picture than 1958.

TWA became a leader in the ranks of airline jet operators with the inauguration on March 20, 1959, of the first nonstop jet service between New York and San Francisco. TWA has steadily increased its daily jet schedules and at year-end was serving 11 U. S. cities.

This high jet milage contributed to TWA's system total for all equipment during the first nine months of 1959 of 4,393,000,000 revenue passenger miles.

On November 23, TWA extended its jet service nonstop across the Atlantic to Europe, with the larger, longer-range Intercontinental version of the Boeing 707. Initial schedules were from New York to London and Frankfurt. On December 3 jet flights between New York and Paris and Rome were inaugurated. As the only U. S. airline flying both U. S. and trans-Atlantic routes, TWA provided the only single-carrier jet service linking U. S. cities and European centers.

Two of TWA's Boeing 707 jetliners.

In preparation for the addition of the Convair 880 to TWA's jet fleet early in 1960, TWA training instructors began indoctrination courses during the second half of 1959 in the operation of the 880.

During the year succeeding phases of TWA's new organization structure were announced by President Charles S. Thomas. This marked the first major change in the company's form of organization in 12 years. The plan effected a separation of line and staff functions and responsibilities. Corporate planning and policy making was put on an organized staff basis and separated from the day-to-day line operations. Senior vice president E. O. Cocke, 30 year veteran of TWA and former sales vice president, was named system general manager to direct the day-to-day line operation.

By the end of the second quarter of 1959, TWA was able to announce a profit for the period after a loss for the year 1958 and traditional first quarter 1959 losses. By the end of September, the company reported all-time records for revenue and traffic for the month and for the first nine months of the year. Earnings before taxes for the nine month period were $18,353,000, resulting in a net profit after taxes of $9,068,000 or $1.36 a share, both all-time highs.

Other major programs and events highlighted TWA's progress during the year.

Beginning October 1, TWA greatly expanded its cargo capacity by putting into service a modern fleet of 1049H Constellations, on both U. S. and international routes. Four weekly round-trip international all-cargo flights and three daily domestic trips were scheduled, offering a combined domestic and international all-cargo airlift potential of 6,157,000 available ton miles a month.

In June, ground was broken for the construction of TWA's new $12-million passenger terminal at New York International Airport. The building was designed by Eero Saarinen. A scale model of the dramatic structure was on exhibit at the New York Museum of Modern Art earlier in the year.

TWA President Thomas received two public service honors. In January he received the Navy's Distinguished Public Service Award and in May Secretary of the Air Force James H. Douglas presented him with the Exceptional Civilian Service award for his substantial contributions to national defense and his active role in strengthening the civil reserve air fleet program.

Apart from scheduled operations, TWA made news in far places during the year as a result of a special Boeing 707 jet flight to bring back U. S. newsmen covering Vice President Nixon's trip to Russia and Poland.

TWA was the first U. S. flag commercial airline to fly into Poland. At Moscow some 5,000 Russians, including Soviet Premier Khrushchev, walked through the TWA Boeing during the two days it was on public display there. Mr. Nixon flew on the TWA special flight on the segment between Warsaw and Iceland and held a press conference in flight.

UNITED AIR LINES

Introduction of the DC-8 Jet Mainliner, climaxing more than a decade of company research and planning for turbine-powered flight, over-shadowed all other events in the 1959 operations of United Air Lines.

The first of 40 DC-8s which United had ordered at an over-all cost of $225 million was delivered in June at Long Beach, California. The aircraft embodied great technological advances, in addition to many innovations in passenger comfort. Cabins and compartments, designed by Raymond Loewy Associates, accommodated 52 first-class and 53 coach passengers.

United inaugurated DC-8 Jet Mainliner flights on U. S. Route No. 1, New York-San Francisco, on September 18. The new jetliner subsequently was placed in service between New York-Los Angeles, Chicago-San Francisco, Chicago-Los Angeles, San Francisco-Los Angeles and Chicago-Washington/Baltimore.

For most of the year, however, the company operated an all-piston engine fleet against increasing jet competition. Despite jet competition in the months before the DC-8 was introduced, the company's traffic continued to expand. By midyear, for example, United had carried 3,689,000 passengers as compared with 3,441,000 in the first six months of 1958. Revenue passenger miles totaled 2,573,000,000, an increase of ten percent over the previous year. Freight ton miles amounted to 38,097,000, up 33 percent; mail ton miles, 17,497,000, up 13 percent and express ton miles, 5,958,000, up 28 percent.

On June 11 a new company record was set in single day passenger volume—26,139 as against the previous high of 25,602 flown on August 29, 1958. Similarly, June proved the busiest month in company history. Revenue passenger miles totaled 534,664,000, an increase of four percent over June of 1958.

Piston-engine aircraft were all-important in daily operations but jet planes were dominant in company research and planning. In June United contracted for seven more Boeing 720s, increasing its total order for this type of intermediate jet to 18. The first of the 18 came off the Boeing assembly line in the fall. The 615 mile per hour aircraft is designed to fly in and out of any airport that can accommodate DC-7s.

A $10-million DC-8 Jet Mainliner training program, involving 12,000 of United's 21,000 employees, was fully underway by early summer. Training of jet flight crews had begun in September, 1958, by means of the first DC-8 electronic flight simulator to be acquired by an airline. An electronic DC-8 systems and crew trainer also was placed in use, along with a simulator which duplicated the performance of the J57 and J75 jet engines.

Delivery of the DC-8 Jet Mainliners was accomplished by the introduction of specialized ground equipment, designed for utmost speed and efficiency in servicing the new planes. Approximately 70 types of machines and vehicles had been developed by United in preparation for jet operations.

Among the new items were motorized passenger loading stands which moved to and from the jetliner under their own power, operated by passenger agents. This eliminated the customary tugging and pushing. On-and-off loading of baggage and cargo was greatly accelerated by the use of tub-like containers, automatically lifted in and out of the plane. Removal of DC-8 baggage for 105 passengers could be accomplished in less than three minutes.

United also introduced passenger handling procedures greatly improved over former methods. The high speed check-in system, for example, speeded the flow of jet passengers through the terminal and into "holding rooms" at the gate of outbound flights. The new system was patterned after the arrangement of a super market, with passengers checking in at "islands" rather than at counters which bar the direct onward movement of traffic.

Flight planning by electronic computer was another significant innovation which United instituted with DC-8 service. In contrast with manual calculations, which require at least an hour, the computer analyzes hundreds of variables in the wind, temperature and weather conditions at different altitudes. A highly accurate flight plan is produced in less than three minutes.

United's passenger terminal at New York's Idlewild terminal was completed in late fall. Designed to accommodate 2,000 travelers daily, it is equipped with the high speed check-in system, automatic baggage counter facilities, and other advances. Passengers board and deplane by means of enclosed "Jetways," which extend from the scond floor of the terminal to the door of the aircraft.

Jet engine test cells were built at United's maintenance base in San Francisco and the company also completed a turbine engine overhaul plant. The latter was named the William P. Hoare Turbine Building, honoring United's vice president-base maintenance, upon his retirement in October after 32 years of company service.

A new flight kitchen which United opened at San Francisco attracted wide attention because of its closed-circuit television system. The kitchen, covering 25,000 square feet, was designed to produce up to 6,000 meals daily. Closed-circuit television was installed so that information on meal orders can be flashed simultaneously to various work locations.

To spotlight the DC-8 Jet Mainliner at major cities, United staged Jetarama, the largest exhibit ever developed by an airline. Housed in three circus tents, Jeterama visited San Francisco, Los Angeles, Chicago, New York and Baltimore. Approximately 500,000 attended the unique jet show, which will tour other cities on United's system in 1960.

WESTERN AIR LINES

The year 1959 proved for Western Air Lines a period of unparalleled progress, highlighted by the addition of the airline's first turbine-powered aircraft, introduction of a comprehensive electronic reservations system and important alterations of the WAL route system.

Western became the first airline in the West to introduce Lockheed Electra propjets when, on August 1, the 410-mile per hour planes were placed in service between Los Angeles, San Francisco, Portland and Seattle. Additional flights were inaugurated on October 10, providing flight time savings of more than one-third between Los Angeles and Phoenix, Salt Lake City and Minneapolis-St. Paul.

First Electra jet in the WAL fleet was delivered on May 28 and the airline received four others during the year. Four more were to be delivered in 1960, completing Western's original order for the Lockheed transports.

Earlier in the year, Western placed into operation the most advanced reservations system in existence, the Resetron, which linked 96 locations in 13 western states, Canada and Mexico for instantaneous replies to requests for reservations information.

Built by the Teleregister Corp. of Stamford, Connecticut, the Resetron proved highly effective in storing information on as many as 60,000 flight segments up to six months in advance.

Important addition to the WAL route system was Calgary, key city of the province of Alberta, Canada. Establishment of the first U. S. airline service to the Canadian city on June 1 was made possible by joint Canadian-U. S. approval, in March.

Bringing Western's route-modernization program nearer final completion was a Civil Aeronautics Board action transferring to local service carriers 13 cities on the WAL system. Included in the group were Rochester and Mankato, Minnesota; Spearfish, Brookings, Hot Springs, South Dakota; Chadron, Alliance and Scottsbluff, Nebraska; Lewiston and Cut Bank, Montana; Logan and Ogden, Utah; and Jackson, Wyoming.

At year's end, Western officials were seeking CAB authority to extend the airline's route system to Hawaii, in the Trans-Pacific Service Case; Dallas, Fort Worth, San Antonio and Houston in the Southern Transcontinental Service Case; between Denver and key cities in Texas and to other points in the west.

All previous traffic records for WAL were wiped out during August when the airline's total operating revenues reached $6,499,000 and net earnings reached $769,000, highest one-month totals in the airline's 33-year history.

Western broke the credit barrier on air travel in September when it became the first airline to honor Diners' Club and Hilton Carte Blanche credit cards in payment for flights throughout the WAL system.

HELICOPTERS

In 1959 the arrival of commercial jet transportation focused the attention of the traveling public and city planners on the lack of adequate airport to city-center transportation. Airline reservation systems and baggage handling procedures were being streamlined to fit the jet age, yet the trip to and from the airport continued to be tedious and time-consuming—notably so—after a five hour and 25 minute transcontinental flight.

In recognition of this lack, a major activity of the industry's Helicopter Council during the year was providing assistance to Federal, state and local governments in planning for heliports. Toward this achievement, Council staff and representatives recommended the National Institute of Municipal Law Officers adopt and distribute to its members a model heliport ordinance.

The Council also provided assistance to municipal officials where plans for heliports or revision in heliport regulations were being considered; for example: the cities of Philadelphia, Detroit, St. Louis, Columbus, New Orleans and Trenton, New Jersey were conducting heliport site surveys. Paterson, New Jersey, was constructing a municipal heliport under the Federal Airport Act financing plan.

Two important heliport planning conferences were held during the year.

In May, the Chicago Association of Commerce and Industry sponsored a Helicopter Conference attended by more than 300 industrial leaders. In September, the Los Angeles Chamber of Commerce sponsored a two-day symposium on "Planning, Designing Urban Helicopter Facilities. Architects, structural engineers, insurance executives, city planners, manufacturers and Government representatives attended this the first such meeting ever held.

A feature of the Los Angeles symposium was a demonstration of flight characteristics and varied uses of the helicopter. Th Los Angeles Police and Fire Department, the County Sheriff's office, and Council member company helicopters demonstrated search and rescue procedures, fire-fighting, traffic control, autorotations and simulated rooftop landings.

A preliminary survey of heliports and helistops in the United States prepared by the Helicopter Council revealed 21 states and the District of Columbia have 264 heliports/helistops (these do not include airport areas reserved for helicopter landings) and 22 proposed facilities. Of the 264 established heliports, 237 are ground level and 27 are rooftop. In addition, there are approximately 100 helicopter platforms on moveable and stationary oil rigs in the Gulf of Mexico where the helicopter is an accepted "tool" of that industry.

This survey showed an interesting trend—the increase in the number of hospitals, motels and industrial plants that have helicopter landing facilities.

The year 1959 marked a continued growth in the number of commercial helicopter operators. More than 35 new services were organized during the year. Based on the annual Helicopter Council survey, at year-end there were 156 operators in the United States and Canada. These companies, using more than 630 three-to-15 place helicopters provide aerial taxi service in their communities and routine and unusual transportation for the oil, construction,

Premier Khrushchev sits in Sikorsky S-58 prior to sightseeing trip over Washington.

agriculture, mining, ranching and electrical power industries.

The Helicopter Council survey also reported that more than 100 companies and corporations operate helicopters to transport top officials and high priority materials from plant-to-plant, plant-to-down town and plant-to-airport. Considerable expansion of this executive transportation market was anticipated by the industry.

Government agencies in the United States and Canada continued to use the helicopter for traffic surveys, forest-fire patrol, rescue and as stand-bys in the event of local disasters. At year-end there were 27 governmental agencies in the United States and Canada operating more than 65 helicopters.

American-built helicopters were being operated all over the world. In South America alone, more than two hundred helicopters were in service.

The President during 1959 made greater use of his "Chopper" for official trips from the White House Lawn to Camp David, the airport and other nearby points. A highlight of U.S.S.R. Premier Khrushchev's visit in September was the unscheduled 40-minute helicopter sightseeing flight over Washington with the President.

An official spokesman for the Helicopter Council served during 1959 on the Federal Aviation Agency-Industry Heliport Working Group in preparing the official FAA Heliport Design Guide. The completed Guide was scheduled for publication late in the year.

The three scheduled helicopter airlines—Los Angeles Airways, Inc., Chicago Helicopter Airways, Inc. and New York Airways, Inc.—set new records in the numbers of passengers carried. During the first six months of 1959 they carried a combined total of 297,000 passengers. In October alone, Chicago Helicopter Airways carried 22,265 passengers, a 91.9 percent increase over October, 1958.

The first issue of the official magazine of the helicopter operators was published in July. Another noteworthy journalistic trend during 1959 was the use by many non-aviation publications of a large number of helicopter feature articles.

The role of the helicopter as a rescue vehicle has long been recognized. This year that role was given added recognition during the annual convention of the American Medical Association at Atlantic City New Jersey. "Project Medi-Copter," commercially sponsored, provided approximately 3,500 physicians with helicopter flights "designed to familiarize them with the advances now being made in medical transportation."

The Army Medical Service marked its 184th anniversary on July 27, 1959. At year-end, the Service was operating 12 helicopter units, four in this country, five in Europe and three in Korea. The helicopters, known as the "Flying St. Bernards" have proved so successful in the work of rescue and aid that the Army is now considering a major expansion of their use.

Another Army anniversary during 1959 was the successful completion of 200,000 fatality-free helicopter flight training hours at the Army Helicopter School at Camp Wolters, Texas. Approximately 100 helicopter pilots were graduated from this School each month.

The Military Services—Army, Navy, Air Force, Marine Corps and Coast Guard—continued as the major users of helicopters for aerial reconnaissance, fire-fighting in crash-rescue, anti-submarine warfare and to transport ammunition, supplies and troops.

The deep interest of the military in helicopter progress was demonstrated by the announcement of Army and Marine Corps participation in the world's first helicopter all weather air traffic operational test to be established late in the year. The two services, with Helicopter Council members, joined with the Federal Aviation Agency in this project. Daily flights were made, regardless of weather conditions, between Philadelphia and New York and between Bridgeport, Connecticut and the FAA National Aviation Facilities Experimental Center, Atlantic City, New Jersey.

The American Legion, at its 1959 National Convention, resolved to "reaffirm the principles and objectives" adopted at their 1958 Convention to "promote and encourage the development and use of helicopters and the passage of necessary ordinances and regulations as will permit their efficient operation."

During 1959, turbine-powered helicopters were in production for the military and commercial use. Turbine power not only afforded reduced vibration and noise, but also provided simplified maintenance and better performance and reliability.

In the words of the Helicopter Council Chairman, "American cities today are afflicted with a problem known as suburbia—with the result, our nation is headed for the most gigantic traffic jam in history." Helicopters have proved their ability to over-come the age old barrier of terrain, opening up inaccessible areas. With the improved performance and increased payloads of the helicopter, given an adequate system of city-center and suburban heliports, the helicopter promised to greatly aid in providing transportation above the everyday traffic of metropolitan centers.

GENERAL AVIATION

General aviation, which is all civil flying except the airlines, particularly the business use of private aircraft, continued its rapid growth during 1959.

At year-end, the active general aviation fleet numbered about 70,000 units as compared to about 1,900 airliners; and general aviation flying exceeded 12 million hours a year, compared to about 3.6 million airline hours.

General aircraft production figures were also evidence of the steady growth trend. Unofficial figures for October indicated that the ten-month total would be approximately 6,300 aircraft for a retail value of about $145 million. This compared with a year-total of 6,414 units in 1958, having an estimated $135-million retail value. It was evident from these comparisons that the total 1959 figures would be substantially in excess of 1958, and that a record in unit and dollar volume would be established.

During the year, thousands of businessmen found the small airplane to be an almost indispensable part of their business activity, and a great majority of the nation's largest corporations operated fleets of small planes.

The largest segment of general aviation flying was for business purposes, which had more than doubled in the past decade, and at year-end stood at an annual rate of about six million hours.

The National Business Aircraft Association reported that over the past five years, the rate of annual increase in business flying had been 13 percent. This represented an annual rate of growth greater than that experienced by all other general aviation flying combined.

Business aircraft accounted for 28,000 of the more than 70,000 total active civil aircraft registered with the Federal Aviation Agency. NBAA estimated the following breakdown of aircraft by class: (1) Multi-engine (9-place and over), 750; (2) Multi-engine (under 9-place), 5,040; (3) Single Engine (3-place and over), 18,500; (4) Single Engine (1-place and 2-place), 3,950; (5) Helicopters, 78.

Over 1,000 of the business aircraft delivered during the year were multi-engine. Corporation owner-

THE CHANGING COMPOSITION OF CIVIL AIRCRAFT MOVEMENTS REPORTED BY F.A.A.—OPERATED CONTROL TOWERS

Civil Aircraft Movements

	Local		Itinerant		Air Carrier		
Year (1)	Number (2)	Percent (3)	Number (4)	Percent (5)	Number (6)	Percent (7)	Total (8)
1946	7,076,385	67.0	1,121,811	10.7	2,357,826	22.3	10,556,022
1947	11,289,119	70.2	1,931,497	12.0	2,854,481	17.8	16,075,097
1948	10,376,900	64.4	2,499,919	15.5	3,241,941	20.1	16,118,760
1949	7,724,373	54.6	2,721,925	19.2	3,713,257	26.2	14,159,555
1950	6,536,042	48.1	3,048,838	22.4	4,001,947	29.5	13,586,827
1951	6,178,704	43.6	3,442,225	24.3	4,555,509	32.1	14,176,438
1952	4,565,689	35.6	3,398,600	26.5	4,866,358	37.9	12,830,647
1953	4,013,814	30.6	3,704,780	28.3	5,384,416	41.1	13,103,010
1954	3,946,162	29.1	4,068,638	30.1	5,520,599	40.8	13,535,399
1955	4,008,188	27.6	4,533,275	31.2	5,985,916	41.2	14,527,379
1956	4,654,656	28.1	5,366,175	32.4	6,553,366	39.5	16,574,197
1957	5,512,261	28.6	6,616,364	34.4	7,112,208	37.0	19,240,833
1958	6,099,391	29.0	7,937,747	37.7	6,977,671	33.3	21,034,809

Source: Federal Aviation Agency

This Lockheed JetStar was on display at the NBAA convention in October.

ship increased significantly with over one-half of the manufacturers' dollar volume gained from the sale of new aircraft to corporate purchasers.

The year 1959 saw the first deliveries of new turboprop transports for business executives use. Fairchild delivered fifteen F-27s to corporate users. Grumman delivered five Gulfstreams to corporate users, and planned to deliver 30 more within the next year.

Both the Lockheed JetStar and the North American Sabreliner were being offered to executive users with first deliveries of the JetStar to be made during 1960. Over 100 of these aircraft were on order by corporate users.

Safety was the prime consideration in business aircraft operations. During 1959, NBAA awarded Safety Award Certificates to 51 companies and 165 business pilots who had flown a total distance of 165,620,468 miles without damage to aircraft, or injury to passenger or pilot.

Most active small aircraft had at least two-way radio, and over 30,000 had omni equipment so they could operate with complete safety under VFR (Visual Flight Rule) conditions. The multi-engined fleet was well equipped for all-weather flying under FAA Instrument Flight Rules (IFR). More than half of the active single-engined fleet were also so equipped. The availability of communication and navigation equipment of a satisfactory size and weight, which were accurate, dependable, simple and easy to operate, and economically priced, contributed greatly to the utility of small business and private aircraft.

Shown in this section is a table entitled "The Changing Composition of Civil Aircraft Movements Reported by FAA Operated Control Towers."

In the table, movements are broken down into three categories: local; itinerant; and air carrier. Local movements included pleasure and sport flying around an airport, and instruction flying which involved take-offs and landings from the same airport, touch and go landings, and so forth. Air carrier movements were the movements of scheduled airlines. Itinerant movements were those to and from an airport such as those that would result from cross-country flying. In this category goes the great bulk of business flying activity.

It is apparent from the chart that the most dramatic increase occurred in itinerant movements.

In 1959, the Federal Aviation Agency predicted that the general aircraft fleet would grow to about 105,000 units by 1975, and a general aircraft industry-sponsored survey estimated the general aircraft fleet would generate at least 20 million flying hours in 1975.

Industry experts did not anticipate any revolutionary changes in general aircraft configuration or characteristics as compared with the current models. Rather, they felt that the revolution had already taken place in the form of transportation benefits experienced by users.

Industry expected that beginning within the next five years there would be a continuous growth in the number of turbine-powered aircraft. Of these, turboprops would outnumber the pure jets. But the percentage of these turbine-powered craft to the total fleet would be modest. Expert viewpoints were that piston-powered aircraft, though much improved over those of today, would continue to make up the bulk of general aviation's fleet for many years to come.

Federal aviation planners predicted that the IFR capability of the general aircraft fleet, and the pilots who fly these aircraft, which is already proportionately large, would continue to increase. Operational surveys made under the jurisdiction of the Curtis Report studies predicted a five to eight time increase in general aircraft IFR operations over present IFR peak loads would be generated by the general aircraft fleet by 1975.

GOVERNMENT

AND AVIATION

The first session of the 86th Congress was relatively unproductive as far as aviation was concerned. Although industry was subjected to a series of investigations involving alleged waste, duplication and influence peddling, no new laws resulted and few changes were recommended by year-end.

Despite a determined effort by industry to soften the Renegotiation Act, a flat three-year extension, to June 30, 1962, was granted with a promise that a thorough review of the law would be made. Approved separately was a bill to enable contractors who were forced to return excess profits, to file for refunds or credit for income taxes paid on these funds. Legislation would extend the filing period a year after final renegotiation order was final.

An amendment was added to the $1.2-billion construction authorization bill compelling Pentagon arm planners to justify all operational arms through both Armed Services units.

The existing corporate tax of 52 percent was extended for one year to June 30, 1960.

At the request of the Navy, lawmakers established a Bureau of Naval Weapons to place the Navy arms system under the direct control of a single executive. This replaced the Bureau of Aeronautics and Bureau of Ordnance.

The prior year's concern over funding of the nation's military weapon and civilian space programs lessened considerably during the year, and although a large ($39.2 billion) defense appropriations bill was finally approved, it was $20 million short of the President's request. Congress also voted $1.3 billion for military construction for the three services, and a compromise $500 million for operation of the National Aeronautics and Space Administration (about $30 million short of that agency's request).

Still pending at year-end were controversial bills involving procurement (to put competitive negotiation on a par with advertised bidding and to encourage wider use of the weapon system), risk insurance for defense contractors, incentive awards to spur research, Pentagon reorganization, and a new recommendation for a merger of the Army and Air Force.

Another element of the industry, air transport, also suffered from legislative inactivity.

Hopes for a $575-million four-year airport aid program were crushed early by White House opposition, and all that resulted from the ensuing squabble was a stop-gap bill to extend aid for two years at the present $63-million level.

Legislation to facilitate loans for turboprop and jet aircraft won approval in a form that would lift liability from firms leasing out engines and propellers and extend it to the carrier using the equipment.

A compromise provision, allowing half of the 10 percent passenger tax to expire June 30th, 1960 was approved; but by that date, the House Ways and Means Committee, aiming to broaden the tax base and kill many special exemptions, planned an extensive review of the tax picture.

Final figures on appropriations granted were: *Civil Aeronautics Board*, salaries and expenses, $6,-925,000, only $575,000 less than requested; subsidy payment cash—$58.5 million. *Federal Aviation Agency*, operations, $301,700,000, about $26 million less than requested; establishment of air navigation facilities, $135,200,000; and research and development, $48,725,000.

Postponed until the second session were the following: a proposal to set up a government-guaranteed loan system for development of an all-cargo aircraft, a proposed bill to give the postmaster limited power to contract for transport of mail with airlines; a proposal to raise the aviation gas tax; legislation to compel arbitration in airline strikes; a bill to regulate agency controls, and legislation involving free and reduced-rate transportation.

Approved during the first session was nomination of Elwood R. Quesada as FAA Administrator; postponed was nomination of CAB Chairman James Durfee to the U. S. Court of Claims.

FEDERAL AVIATION AGENCY

The Federal Aviation Agency completed its first year of existence as an independent organization on December 31, 1959, and for the first time in its history, civil aviation had a focal point, not only for the development of major policies, but the long-range plans to implement those policies, and the preparation and presentation of the budget requests to support them. Also for the first time in history, the essential management functions necessary to support the common needs of civil and military aviation were centered in a single authority.

Under the law (Federal Aviation Act, August 23, 1958) the FAA was assigned an extraordinarily complex mission which included such functions as the following: the establishment of a common system for the control of air traffic; the development and fostering of civil aeronautics and air commerce in the United States and abroad; the development, testing, and evaluation of air navigation systems, procedures, and facilities; the acquisition, establishment, improvement, and operation of air navigation facilities; the formulation of airspace policy and the assignment of airspace by rule, regulation, or order; the establishment of rules and regulations governing air traffic and the flight of aircraft; the review of proposed locations or modifications of airports, landing areas, and missile and rocket sites to assure conformity to airspace policies, the public interest, and the needs of national defense; arranging for the publication of aeronautical charts and maps; the collection and dissemination of information relative to civil aeronautics; the undertaking or supervision of developmental work tending to the creation of improved aircraft, aircraft engines, propellers and appliances; the administration of a national program of financial and technical assistance to State and local public airport authorities; the promotion of safety in flight by prescribing rules and regulations governing flight procedures and operations; the certification of airmen, flying and maintenance schools, and repair stations; and the determination of the airworthiness of aircraft and aircraft components; the operation of Washington National Airport and the construction and operation of Dulles International Airport.

Many of these functions were not new and were provided for in whole or in part by other legislation. The principal significance of the Federal Aviation Act was the consolidation and reemphasis of authority which it provides, and the fact that it established an independent aviation agency reporting directly to the President.

Programs of the Agency were administered by five line Bureaus:

The Bureau of Research and Development. Successor to the Airways Modernization Board, the Bureau's principal responsibilities are the development and testing of new air navigation aids, air traffic management systems, and major improvements in existing services.

Elwood R. Quesada
FAA Administrator

The Bureau of Flight Standards, which develops and enforces the rules and regulations required to promote safety in flight; issues pilot and aircraft certificates, maintains surveillance over all civil air operations, certifies aviation schools and repair facilities, participates in investigations, and checks the accuracy of air navigation aids.

The Bureau of Facilities and Materiel, which acquires, establishes, installs, and maintains the air navigation aids operated by the FAA; administers airport construction grants under the Federal Aid Airport Program; and is responsible for the construction of the Dulles International Airport. It is responsible for procurement of materiel for the Agency, and administers the Facilities and Materiel Depot at the FAA's Aeronautical Center in Oklahoma City.

The Bureau of Air Traffic Management. Largest of the FAA Bureaus from the standpoint of total employees, (nearly 15,000) it administers airspace allocations, operated airport traffic control towers, air traffic communications stations and air route traffic control centers.

The Bureau of National Capital Airports. This is a transitional office to provide for integrated operation of the Washington National and Dulles International Airports. On August 17, 1959, the Administrator transmitted to the Congress legislation to create a National Capital Airports Corporation, which would replace the Bureau.

In the over-all direction and control of the Agency, the Administrator was assisted by a Deputy Administrator and three Assistant Administrators.

The Deputy was appointed by the President and confirmed by the Senate, and delegated the authority to act on behalf of the Administrator on all aspects of the Agency's operations.

The Assistant Administrator for Management Services is responsible for budgeting, accounting, management analysis, program evaluation, and procurement and supply policies.

The Assistant Administrator for Personnel and Training heads the Agency's personnel program, directs its training functions, and is responsible for security matters.

The Assistant Administrator for Plans and Requirements assists the Administrator in the development of Agency policies, goals and requirements, and conducts economic and other analytical studies in connection with long-range planning.

As in the case in all large independent agencies, the Administrator is also assisted by a number of important staff offices tailored to the Agency's specific needs. They are:

The Office of the General Counsel, which provides legal counsel and advice to the Administrator and directs and supervises the ramified legal work of the Agency.

The Office of the Civil Air Surgeon, established by the Administrator to give emphasis to civil aviation medicine and aero-medical research. This office recommends standards for mental and physical fitness of airmen and air traffic controllers, oversees the medical examination of airmen and others whose health could affect safety in flight, and directs research in aviation medicine.

During the year a contract was negotiated with the Eye Research Foundation, Bethesda, Maryland, for a study of the visual sensitivity of pilots to assist in evaluating runway lighting systems. The project will be carried out at the FAA's National Aviation Facilities Evaluation Center and will cover the activity of 36 pilots in as many as 1,500 separate landings, using various types of runway lights under various weather conditions.

A research contract was also awarded to the Johns Hopkins Hospital, Baltimore, Maryland, to undertake studies which would lead to development of an improved system for recording pathological heart conditions. This would make possible establishment of more discriminating medical standards for airmen applying for their medical certificates and eliminate blanket restrictions now required where insufficient definitive medical data now exists.

Plans for establishment of a Civil Aeromedical Research Center, under the direction of the Civil Air Surgeon, were announced. The research will stress the development of the advance medical data necessary to meet anticipated operational problems as civil air operations move into higher altitudes and greater speeds.

The Office of Congressional Liaison, a small unit concerned chiefly with facilitating communication with Members of Congress and their staffs on the many matters in which Agency activities are of a direct interest to the Congress.

The Office of Public Affairs, charged with keeping the public and the news media informed of the Agency's activities.

The Office of International Coordination. This office handles the FAA's technical assistance to foreign countries—28 Technical Assistance Groups were operating at year-end. Approximately $6 million was made available for this purpose by the International Cooperation Administration in the fiscal year ending June 30, 1959. The funds were used for such projects as airport construction and establishment of radio aids overseas, and for training of foreign nations in the United States. The OIC also serves as a clearing house for dealings on technical matters with ICAO and other international bodies, and administers the exchange-of-information program with foreign governments.

The Aeronautical Center at Oklahoma City, Oklahoma. Headquarters for the extensive training programs conducted by the FAA. These programs include basic, advanced, and refresher courses for FAA personnel, and for such foreign nationals as are assigned to the Center under the International Cooperation Administration's Technical Assistance Program.

The Center is the location of the Facilities and

Control Room, San Antonio Air Route Traffic Control Center

Materiel Depot which is responsible for aircraft and avionics standardization, the overhaul and heavy maintenance of FAA aircraft; first echelon maintenance of FAA aircraft based at Oklahoma City, central warehousing and materiel distribution for the Agency, and the operation of shops for the repair and fabrication of navigation and air traffic control equipment.

The Civil Aeromedical Center will be constructed here. Plans call for completion of the new facilities by June 30, 1961.

At Atlantic City, New Jersey, the FAA established the *National Aviation Facilities Experimental Center* (NAFEC) to develop, modify, test and evaluate systems, procedures, facilities and devices to meet the needs for safe and efficient air traffic control of civil and military aviation.

Dulles International Airport. Clearing of the 9,600 acre site at Chantilly, Virginia, was begun on September 3, 1958 and heavy grading operations on October 27, 1958. In October 1959, one of the 11,500 foot runways was ready for use and the second close to being finished. Scheduled for completion early in 1961, the FAA expected to be handling 4-million passengers a year at Dulles by 1965, 6 to 7 million by 1970, and 8 to 10 million by 1976.

Since the passage of the Federal Aviation Act, the Agency assumed and performed most of the functions entrusted to it. Employees totaled approximately 34,000 at year-end, 3,000 of whom were assigned to the field organization comprising nearly 1,500 offices and facilities throughout the 50 states and a number of overseas locations.

Under the direction of the Administrator an unprecedented degree of civil and military cooperation was attained. No time was lost in trying to find an amicable solution to the touchy problem of airspace allocation. One of the Agency's earliest announcement was to the effect that everyone's claim to the airspace—the airlines, the military services, and general aviation—was legitimate and would be fairly met to the maximum extent possible.

An immediate study of the airspace blocked off for strictly military purposes resulted in the elimination of the Western, Eastern, and Presque Isle air defense identification zones, and a relaxation of restrictions in the remainder. Climb corridors for jet fighters were revised, permitting civil aircraft to fly in airspace either above or below them, or when they are not in actual use, through them, and similar arrangements made with respect to other restricted places.

A further, and detailed survey was being made of the more than 500 restricted areas still remaining to determine how, and how often, they are used. The study was to cover the twelve month period between July 1, 1958 and June 30, 1959. From the data compiled during this time, the FAA will develop its long-range plans and policies with regard to airspace utilization.

An agreement was made with the Department of Defense under which aircraft—high performance jets and other types—would be made available to the FAA through loan or transfer from the military services. As a result of the negotiations, the FAA will be able to secure aircraft needed for test and research without the considerable expense that would be incurred by purchase.

FAA flight operations inspectors were graduating in increasing numbers from the USAF Strategic Air Command's KC-135 jet training course at Castle Air Force Base, California. These inspectors have the responsibility for testing and certifying the proficiency of airline pilots. The course covered six weeks of ground school and five weeks of flying instruction and provided invaluable training in the over-all operational problems associated with jet aviation.

A second training program was initiated under which FAA test pilots would get the benefit of new and additional training in Air Force and Navy test pilot schools.

FAA's plan for utilization of the airways in the event of war or mobilization called for the integration of the air traffic control system with the air defense system; continuous operation of the Federal Airways, and the retention on duty of civilian air traffic controllers in a special status.

In this connection, nine FAA centers for high altitude air traffic control will be established at Air Force SAGE (semi-automatic ground environment) super combat centers. This action will result in increased safety for high altitude civil and military jets and will substantially reduce the traffic burden on the existing 30 FAA Air Route Traffic Control Centers charged with handling en route traffic at all altitudes. After the combined centers are operating, the existing FAA Air Route Traffic Control Centers will become Terminal Transitional Centers and assigned the control of traffic below 24,000 feet in heavy traffic areas.

A further joint-use of facilities program was worked out with the Air Defense Command. Because the FAA's long-range radar could not give adequate high altitude coverage to the commercial jets, the ADC made its facilities available for that purpose. During the year, at 28 military sites throughout the country, civilian controllers of the FAA gave radar advisory service to scheduled airliners crossing the continent above 24,000 feet. At other locations the military was served by FAA radar.

The billion dollar airways modernization program, begun in 1957, was well under way at year-end. By the end of the year, Federal Airways stood at 165,000 miles of VOR airways, and 55,000 miles of low frequency airways, providing all who use them with a widespread system of visual and electronic aids to navigation and landing. Traffic control was exercised from 300 terminal control towers; 345 air traffic communications stations, 35 air route traffic control centers, and 54 military facilities.

In addition to acquiring the newest and finest radar and other electronic equipment that science and engineering could produce, larger numbers of air traffic controllers were being trained; the aeronautical weather services were being improved, and new control procedures were being developed.

One of the most difficult problems in the internal functioning of air traffic control facilities, particularly en route traffic control centers, involved the processing of data for presentation on air traffic displays for analysis by the controller. To enable the controller to devote his full attention and skill to the separation and expediting of traffic, electronic computers which relieve him of such secondary duties as verbally relaying information, coordinating with other controllers, and the manual preparation and posting of data, were being installed. Computers were in use at New York, Washington, and Indianapolis by year-end and were scheduled for Pittsburgh, Cleveland, and Boston. By 1963 it was expected to have the entire air traffic control system on a semi-automatic basis, with control being exercised through such devices as three dimensional radar and pushbutton air-to-ground communications.

Air traffic control was not exercised in all of the airspace, but confined to the 10-mile wide airways and areas of high density traffic around air terminals where a multiplicity of proximate and intersecting routes create a problem. Control was also exercised in the space at and above 24,000 feet. This is known as the Continental Control Area and is the realm of the high altitude jet routes. A jet route is a direct course between navigational aids for the navigation of turbo-jet aircraft. They have no specified widths and do not conform to the airways structure which exist below 24,000 feet.

The problem of air traffic control was complicated by the phenomenal increases in all categories of flying and the ever-increasing divergence of aircraft performance characteristics.

During 1959, radar advisory service which provides the pilot with air traffic information on other aircraft in his vicinity, and when necessary gives him vectoring service, was extended to 16 high density routes. As the radar network grows, the FAA plans to make a complete change over to radar displays and control procedures, doing away completely with the existing flight progress boards and non-radar panoramic displays.

Additional VOR and VORTAC facilities were put into operation in 1959. As of December 13, 1958, 17 VORTACS were in commission; 38 were added during the first nine months of 1959, bringing the total to 55. The 576 VORs in operation at the end of 1958 were increased by 31, making a total of 607 on September 30. Eventually the FAA planned to bring the total VORTACs to 1,200.

Among projects being developed under a research and development contract was a radar system that will provide traffic controllers with the altitude of an aircraft in addition to the direction and distance from station.

Another experimental device being tested was the REGAL (Range and Evaluation Guidance for Landing). It is designed to give the pilot information on distance to touchdown and elevation above the ground to guide him on proper glide path slope.

Approach and runway lights of the "flush" type, imbedded in the pavement, sturdy enough to withstand the impact of the heaviest planes were developed and under experimentation.

A nationwide study of air traffic, covering the entire field of flight, air carrier, military and general aviation, was conducted in 1959.

Phase One was made in January to coincide with the lowest level of air activity. Phase Two covered the annual peak of activity during July and August. The composite picture obtained presented the facts on 52 percent of general aviation flying, and 100 percent of military and airline operations taking place during the specified time periods. The data, when consolidated, will provide a total of approximately 200,000 flight segments (a single flight landing at two cities makes up two segments) and from this sampling, using methods perfected by the Bureau of the Census, the air traffic patterns for the entire country may be scientifically predicted.

One of the largest high-speed electronic computers yet built was used to digest and analyze the great mass of data gathered for the study, processing the maze of statistics into a set of 150 equations from which valid traffic forecasts up to 1980 can be made. This computer can recreate a cross-country flight in all its essential details in less than one-tenth of a second. It can also, using the equations, develop an accurate estimate of situations likely to occur at any place, at any time, in the next 20 years, such as: the peak number of landings and take-offs by light twin aircraft at a given airport during a certain activity during a certain activity period in 1964, 1969, or 1980; the peak number of single-engine Air Force jets that might be expected in the airspace over any one or all of the 920 blocks of airspace covered by the study, during any specified period; the peak number of large multiengine aircraft flowing between Washington and New York—in pertinent detail—now and in 1980; The expected activity at Idlewild airport between 5:00 and 6:00 p.m. on a Sunday in July of 1964 in perfect weather and under conditions of restricted visibility.

To further the interests of general aviation, there was established within the Bureau of Flight Standards, two new branches, the General Operations Branch and the Business Operations Branch, to work exclusively in these areas. Twelve General Safety Inspectors, all business flying specialists, were assigned to key district offices around the country for the convenience of general aviation aircraft owners and the FAA plans to increase this number as time goes on.

Recognizing the need for greater knowledge of how rotary winged aircraft perform under instrument conditions and when operating in high density traffic areas, the world's first air traffic control service for helicopters was established by the FAA at New York City. Daily flights, regardless of weather conditions, were scheduled from Philadelphia to New York, and from Bridgeport, Connecticut to the FAA National Aviation Facilities Experimental Center at Atlantic City, New Jersey.

An extension of the Airport Aid Bill was signed into law by President Eisenhower on June 30, 1958. The bill extended for two years the program of Federal grants to the States for airport construction, providing $126 million for the two year period. FAA programs for these two ye: will stress projects required for increased safety, although the bill gave the Administrator broad discretionary authority to use Federal money for other essential construction.

A joint weather research program was organized with the Department of Defense and the United States Weather Bureau. FAA's contribution was to be a two-year study and analysis of the type and amount of weather information needed to cope with the increasing volume of air traffic anticipated in the next 15 years. The long range research will be the most comprehensive investigation of aviation weather needs yet undertaken. First take will be to collect weather data used in the air traffic control system, the air navigation system, and by the users of the nation's airspace. Data collected will include weather information relating to advance flight planning, preflight planning, ground operations, takeoff, en route flight, approach, landing, and flight safety.

In this connection, a contract was awarded by the Department of Defense to United Aircraft Corporation for the development of a new high speed automatic aviation weather system for the joint use of military and civil aviation. If successful the prototype system may form the basis of a revised national and even global weather reporting system.

A special feature of the FAA's organization was the joint civil-military character of its staffing. Although most of the employees are civilian, there are 132 officers of the Army, Navy, and Air Force serving in the Agency. Among the key positions held by military personnel are those of Assistant Administrator for Plans and Requirements, Deputy Chief of the Office of International Coordination, Deputy Director of the Bureau of Air Traffic Management, and Deputy Directo of the Bureau of Research and Development.

CIVIL AERONAUTICS BOARD

Major alterations in the domestic trunkline route systems were made during 1959 as a result of formal decisions of the Civil Aeronautics Board. In the Great Lakes Southeast Service case and the St. Louis-Southeast Service case, Northwest Airlines was extended to Miami from Chicago; Capital Airlines was put into the Buffalo-Miami market; Delta

Air Lines was extended from Cincinnati to Detroit; and Trans World Airlines was awarded a St. Louis-Miami route. Numerous other modifications were made in the certificates of Delta, Eastern Air Lines and United Air Lines to improve service to the southeast.

In the Chicago-Milwaukee-Twin Cities case, Capital was extended from Chicago to Minneapolis/St. Paul, primarily to improve service between Chicago and Twin Cities, but also to add new through services to these cities from other points in the east; Northwest was granted nonstop authority from the Twin Cities and Milwaukee to Atlanta and Florida points; and Eastern was extended to the Twin Cities as a second carrier for services to the southeast.

Hearings in the Southern Transcontinental Service case were completed by the end of 1959.

The Board approved American Airlines application for nonstop jet service in the San Francisco-New York Nonstop case, thus providing the third such service in this market.

The Board gave increasing attention to local service improvement, continuing its program of broad-scale area proceedings instituted to achieve a comprehensive review of local air service needs throughout the country. The needs for expanded local air transportation between smaller communities and important metropolitan cities increased as the trunkline carriers acquired new and faster aircraft in expanded long-haul services. The local carriers were also supplementing their DC-3 fleets with larger and improved two-engine aircraft, including the Fairchild F-27, the new American-built short-haul turboprop aircraft and the turbine-powered Convair 540. By the end of July eight of the local carriers were operating these mixed fleets.

In the eleven area proceedings, covering the entire United States, the broad objective was to determine the overall needs for local air transportation and the extent to which the local air carriers can fulfill these needs. This survey involved in some cases suspension or deletion of trunkline authority at certain cities or segments where local service lines might provide equal, additional, or improved services, and liberalization of operating authority for local air carriers on their expanded routes to offer services designed to meet the changing needs of the traveling public in the most economical manner possible. Four cases were completed with final opinions issued, and in two cases the Board announced its tentative vote, with the final opinions still pending. The remaining five cases were in various procedural stages.

As the result of an agreement between United States and Canada providing for additional trans-border air services, several cases involving trunk and local service airlines were instituted and progressing to an early conclusion. They involved service on routes between Spokane-Calgary; Buffalo-Toronto; Hancock/Houghton, Michigan, Duluth/Superior and Port Arthur/Fort William, Canada; and between Williston or Minot, North Dakota, and Regina, Canada.

Traffic generated in the scheduled services of the three rotary-wing air carriers, in Los Angeles, Chicago, and New York, continued to expand rapidly. New York Airways reequipped and is operating larger, faster rotary-wing aircraft, while the other carriers plan to reequip with the new turbine-powered helicopters.

Approximately 80 applications for authority to provide similar service by rotary-wing aircraft in other metropolitan areas were pending. Action on these applications was not scheduled by the Board, however, because of the substantial federal subsidies required for this type of operations.

The financial difficulties encountered by all-cargo carriers provided the basis for an expedited but comprehensive investigation instituted by the Board. The Board denied exemption requests of all-cargo carriers for subsidy eligibility, but ordered a thorough review of the entire domestic all-cargo picture, including the question of whether this carrier group should be eligible for subsidy and whether present all-cargo routes should be renewed, and if renewed, whether they should be modified. Hearings began in 1959.

In the General Passenger Fare investigation, initiated by the Board to develop appropriate and well-defined standards as to the earnings which are required by the domestic trunkline carriers for proper development consistent with the public interest, all procedural steps were completed, and the case was awaiting final Board decision.

Seven loans to airlines for the purchase of equipment were authorized under the authority given the Board in Public Law 85-307 to guarantee loans for aircraft purchases. Thirty carriers were eligible for this assistance, including the mainland local service airlines, and airlines providing local services in Alaska and Hawaii and to the Bahamas, and the three helicopter services. The law authorized the Board to guarantee loans up to $5 million per airline; the guaranty may not exceed 90 percent of the loan. Guaranties may be made only if the Board finds that the air carrier would not otherwise be able to obtain funds for the purchase of aircraft upon reasonable terms, and only if the aircraft purchased will improve service and efficiency. This Board authority will expire in 1962. Equipment purchased under guaranteed loans included five Vertol helicopters, 25 Fairchild F-27s and five Convairs.

An important aspect of the Board's work was the decision in the Six Carrier Mutual Aid Pact case, where the Board approved, with certain conditions, a six-carrier agreement providing that, under specified circumstances, the signatory airlines will come to the financial assistance of a signatory carrier which is being struck.

The Board, in the Large Irregular Air Carrier Investigation, issued its opinion providing for certificates of public convenience and necessity to 23 supplemental air carriers for domestic service. Twelve certificates were for five years and eleven for two years. The services authorized are substantially the same as those previously permitted under exemption—unlimited domestic charter service, and up to ten round trips per month between any pair of U. S. points in individually-ticketed passenger and/or individually/waybilled cargo service. Two additional carriers were subsequently given temporary certificates, after further consideration. Certain other carriers were found not qualified for certificates. The supplemental class is left open for limited entry pending a general re-examination of the need for and scope of supplemental service when the five-year certificates come up for renewal. Foreign and overseas supplemental air service will be the subject of a future decision.

During the year the Board converted its Transatlantic Charter Policy into an economic regulation. The regulation carries out the main lines of the earlier policy, but in a more permanent form and with further clarification and improvement of details and language. The number of trans-Atlantic charter flights of the type where cost is prorated among the passengers continued to increase. These flights gave bona fide groups an opportunity to secure trans-Atlantic transportation at a cost well below individually-ticketed air service.

In the field of aviation safety, under the Civil Aeronautics Act of 1938, the Board was responsible for the investigation of civil aircraft accidents, for the adjudication of enforcement proceedings involving air safety certificates, and for the development and promulgation of Civil Air Regulations, the safety code. However, with the enactment of the Federal Aviation Act of 1958, Congress created the independent Federal Aviation Agency, and on January 1, 1959, the effective date of the new legislation, the Board transferred its rule-making functions to the FAA to form a nucleus for that agency's safety regulation operations.

AGRICULTURAL RESEARCH SERVICE

DEPARTMENT OF AGRIC .TURE

The Department of Agriculture continued to make extensive use of commercially-owned aircraft for insect control purposes throughout many areas of the U. S. in 1959. From January until late summer, supervisory pilots of USDA's Agricultural Research Service flew 220,000 miles or a total of nearly 1,470 air-hours in 26 States while assisting with the direction of insect control or eradication programs, making experimental applications of insecticides, and conducting aerial surveys.

More than 70 aircraft were used in pink bollworm eradication work in Arizona where eight applications of insecticide were made at six-day intervals during the growing season on approximately 75,000 acres. All the acreage was treated with DDT insecticide formulations in both dust and spray form.

In cooperative ARS-State-rancher grasshopper-control programs, approximately 765,000 acres were treated by commercial aircraft in seven States. Two-thirds of the total was in New Mexico and Wyoming. Several thousand acres treated for grasshopper control in Idaho also included an infestation of Mormon crickets.

Contracted aircraft applied insecticide to approximately 75,000 acres of woodland in New York as part of the long range ARS effort to eradicate the gypsy moth, serious pest of trees. A similar program covering some 20,000 acres was also carried on in Michigan. Experimental aerial applications of about 50 promising chemicals and microbial insecticides potentially useful as a substitute for DDT against the gypsy moth in sensitive areas such as dairy pastures, were conducted by ARS pilots on 37 test plots comprising 3,000 acres.

Commercial aircraft, contracted by ARS and the states, applied granulated insecticide on approximately 500,000 acres during the year in Alabama, Arkansas, Florida, Georgia, Louisiana and Texas in the cooperative Federal-State imported fire ant eradication program begun in 1957. Part of the acreage treated also included areas infested by the white-fringed beetle.

In a cooperative USDA-State program to eradicate isolated Japanese beetle infestations in Illinois and Michigan, contracted aircraft applied more than 460,000 pounds of granulated insecticides to prevent the spread of the beetle. The total area treated was approximately 23,000 acres.

Cessna aircraft is loaded with boxes of screwworm flies.

About 20 privately-owned Cessna 172s were modified for use in the cooperative ARS-State campaign in the Southeast to eradicate the screwworm, a pest of livestock. The copilot seat was reversed so an attendant can feed boxes of screwworm flies, made sterile by exposure to radioactive cobalt-60, into an ejection apparatus mounted beneath and extending through the fuselage. The ejection machine, driven by a starter motor from an automobile, ejects the boxes at a given rate, depending upon the speed of flight, and opens them automatically to release the flies. One plane can carry approximately 1500 of the 4¼″5¼″ x 2″-boxes, each one containing about 250 flies. The irradiated flies are released by air and the males mate with females in the native fly population. Continued release of sterile male flies in an infested area thus reduces the nation population. Flies were distributed last year over a maximum of 85,000 square miles in Florida, Georgia, and Alabama.

ARS scientists discovered that aerial spraying with herbicide 2,4,5-T controlled undesirable woody plants on southern pine stands without damage to the pine. These hardwoods—such as black oak, and sweetgum—were a major problem for pine growers in the South.

The hourly cost of dusting or spraying crops from a 150-horsepower, two-seated plane was estimated in an ARS economic study. If the applicator averages 200 hours of flying time annually, the hourly cost would be $28.88, and if his flying time averages 400 hours annually, the hourly cost would be $24.02 for fixed costs such as equipment depreciation, taxes and hangar rental, and $16.86 for variable costs including fuel and oil, maintenance and damage, and ground crew, the study showed.

Areas in Tunisia were sprayed with insecticide by local pilots in the fall of 1959 with help from ARS and the State Department's International Cooperation Administration in order to investigate the effectiveness of various materials and methods for a future Mediterranean fruit fly control program.

Of the more than 133,723 airplanes inspected under USDA quarantine regulations on arrival in the U. S., about one out of every three or four were found to carry unauthorized plant material that could harbor agricultural insect pests and diseases. In cooperation with U. S. Customs, almost 9, 733,000 pieces of airborne baggage were given ARS plant quarantine inspection. Animal quarantine inspectors found and destroyed 1,762 packages or 5,810 pounds of airborne, prohibited foreign meats and by-products which might carry insects and diseases into this country.

AIR COORDINATING COMMITTEE

During 1959 the United States was host to the Twelfth Session of the International Civil Aviation Organization which was held in San Diego, California, from June 16 to July 9. This was the first full scale session of the Organization since 1956. Among the decisions taken by delegates from 63 of the 74 member states was one designed to find a means of financing some of the Air Navigation facilities urgently needed for jet transport operations. Another decision called for study by ICAO of the technical, economic and social consequences of the development of supersonic aircraft. Decisions were also made with respect to the elimination of serious air navigation deficiencies as well as in the facilitation, statistical, legal and administrative fields.

The special COM/OPS/RAC (Communications, Operations, Rules of the Air and Air Traffic Control) meeting held at ICAO headquarters in Montreal early in the year was perhaps one of the most important (to U. S. aviation) International Technical Conferences of all time. This meeting was called to reach conclusions on worldwide standards for short distance air navigation aids. The meeting was to consider the U. S. VORTAC vs. the British DECCA systems. Since the U. S. Rho-Theta concept was being seriously challenged by the British hyperbolic system, the Committee found it necessary to make thoroughly comprehensive preparations for the meeting. As a result, the U. S. VOR-TACAN-DME system was adopted in spite of strong British efforts in support of the DECCA system.

The Committee also prepared positions and recommended U. S. Delegations for eleven other International Technical Conferences which were held in various parts of the world under ICAO auspices. Of considerable significance domestically, the Committe coordinated comprehensive plans for the Weather Bureau and the Air Force for expanding and modernizing our aviation weather forecasting services to meet jet age requirements.

The Airport Use Panel continued to have the responsibility for formulating and coordinating policies and actions necessary with regard to the planning, construction, modification and maintenance of civil and military airports throughout the nation. The Panel completed action on a total of eighty-seven airport cases involving problems of joint civil/military use and problems in connection with the establishment of new facilities. To insure inter-agency planning and to minimize any conflict between the defense agencies and other interested segments of aviation, the Panel reviewed and coordinated the Fiscal Year 1960 construction programs of the three military services. To keep in touch with the national airport situation during this period, Panel members attended various conferences of airport executives and associations held throughout the country.

In the economic area during the year 1959, a United States policy was formulated on problems arising from the disposal abroad of piston transport aircraft being replaced by turbojet and turboprop equipment. While the report pointed out that private enterprise should take the initiative with respect to the disposal and leasing of used aircraft, it was agreed that the Export-Import Bank would assist private enterprise in financing the sale of used aircraft on much the same terms as new aircraft.

The Department of Commerce undertook the establishment of arrangements for liaison between Government agencies and private enterprise in order that the information needs of each in connection with aircraft disposal and financing problems may be satisfied so far as po:)le through a single focal point. The defense establishment agreed in principle that surplus military transports similar to civil transport aircraft would be withheld from the commercial market, subject to certain exceptions, in order that their possible disposal would not unduly prejudice the sale of civil transport planes or materially depress their prices. Finally, the report recommended that a further detailed study should be made by an appropriate Governmental agency or organization of the entire surplus aircraft problem. It outlined special study areas that might be conducive to the solution of the problem.

The Committee continued to advise the Export-Import Bank with respect to proposals for financing the sale abroad of United States manufactured aircraft and related equipment. It also continued its activity in ICAO with regard to deficiencies in air navigation services and facilities necessary to safe, regular, efficient and economical operation of international air transport throughout the world, as well as active participation in joint financing arrangements covering such air navigation facilities and services on international routes.

The Subcommittee on Facilitation of International Civil Aviation (FAL) developed the United States position with respect to Facilitation Matters for the Twelfth Session of the ICAO Assembly held in San Diego in June 1959. In addition, the Subcommittee prepared specific guidance on facilitation matters for the United States delegation to the Third Session of the European Civil Aviation Conference (ECAC), held in Strasbourg, France, on March 9, 1959. The member agencies of the Subcommittee, in support of the United States policy to simplify the movement of border-crossing traffic, revised their regulations, administrative practices and procedures, as follows:

New regulations of the Department of State, designed to speed the issuance of visas for people who want to visit the United States, were issued to become effective January 1, 1960.

The use of port receptionists by the Immigration and Naturalization Service was extended to the preinspection operation at Montreal and would later be extended to additional ports of entry. Also, preinspection was established for flights originating in Vancouver, Canada. On August 1, 1959, Customs-

Immigration-Agriculture preclearance was established at Nassau in the Bahama Islands for crew and passengers traveling by aircraft destined for the United States. With the admission of Hawaii to statehood, the Immigration and Naturalization Service's inspection of flights leaving Hawaii for the mainland was discontinued.

Customs clearance at the Honolulu Airport was speeded up as a result of new baggage examination facilities which include "supermarket" examination counters and an enlargement of the Customs office space.

The Subcommittee approved a Standing Working Group as a means to provide coordination among the inspection agencies, other Government departments concerned, and industry, to review plans for new or altered facilities for Customs, Immigration, Public Health, and Agriculture, at domestic airports handling international traffic in order to insure the adequacy of such plans to speed up border-crossing formalities.

The Federal inspection agencies at New York International Airport, in order to relieve congestion, arranged to enter and clear commercial aircraft carrying only cargo in the cargo area of the airport. Private aircraft bound for Canada, under certain conditions, may clear United States Customs by telephone. Customs has provided that discharged non-resident crew members returning home are allowed to retain their personal effects duty free up to $200 in value.

In 1959, under the Committee's policy for equality of treatment in the production of civil transport aircraft with that of similar military aircraft, four quarterly programs prepared by the Aircraft Claimant Subcommittee were approved by the Committee. These programs covered the construction and delivery of 798 multi-engined civil aircraft as follows:

1959	287
1960	327
1961	156
1962 (First Quarter)	28
	798

Of this total, 443 aircraft were ordered by domestic airlines, 184 by foreign airlines, and 171 were on manufacturers' production orders.

During the year 1959, in the legal area, coordination on the various pending draft conventions was effected amongst the interested Government agencies and with non-Governmental groups. The draft Convention on the Legal Status of the Aircraft, which was formulated by the Subcommittee on the Legal Status of the Aircraft in Montreal in September 1958, was the major business on the agenda of a meeting of the ICAO Legal Committee at Munich, Federal Republic of Germany, in August 1959. The United States took a position that the scope of the Convention should be limited to those offenses which would involve or may lead to acts of violence endangering the safety of the aircraft, or its passengers, crew or cargo.

The draft Convention on Hire, Charter and Interchange, which was prepared in Tokyo, Japan, 1957, was also an active subject of the Committee's work in 1959. The Committee recommended that the draft be referred back to an ICAO Legal Subcommittee because of certain ambiguities. The Committee also reaffirmed the United States policy taken earlier in ICAO that discussion by the ICAO Legal Committee of problems relating to sovereignty and associated legal privileges and rights in the upper levels of the atmosphere and outer space would be premature at this time.

Finally, the Committee reviewed the draft Convention on Aerial Collisions. The United States now favors the adoption of a draft Convention on this subject because of the unfortunate increase of mid-air collisions. However, the United States still opposes the principle of a single forum jurisdiction which is contained in the present draft. Since the draft Convention was adopted by an ICAO Legal Committee back in 1954, the limits of liability contained therein are based on piston-type aircraft. The United States, while it does not oppose the concept of limited liability, believes that the presently suggested limit is unrealistic in the turbojet age and should be scaled upward.

ATOMIC ENERGY COMMISSION

During 1959, the Atomic Energy Commission continued research and development on the use of nuclear energy for rocket and ramjet propulsion, for manned aircraft, and for auxiliary power for space missiles systems.

Project Rover is the study of nuclear rocket propulsion which is being conducted by the Los Alamos Scientific Laboratory, operated for the Commission by the University of California. The initial experimental reactor, named KIWI-A after the flightless New Zealand bird, was given power tests during July at the Jackass Flat area of the Nevada Test Site. KIWI-A was a heat-exchanger device operating on an open cycle, in which the propellant, heated in the reactor core, is expended to the atmosphere through a nozzle. Following the tests the experimental reactor was disassembled and the components are being studied by LASL scientists. The studies are expected to help develop more advanced reactors which ultimately may propel a rocket.

Project Pluto is a study 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 is building the Tory-II reactor, a non-flyable experimental reactor, in the Jackass Flat area of the Nevada Test Site.

Another device developed by the Commission was Snap III, a nuclear electric power device, weighing five pounds, four and three-quarter inches in diameter and five and one-half inches high, capable of converting into five watts of electricity the radiation emitted by one-third of a gram of radioactive material. Snap III is a "proof-of-principle" device. It takes its name from the Commission program under which it was developed—Systems for Nuclear Auxiliary Power. Objective of the program is the development of sources of auxiliary electric power for space missile systems. Two basic approaches are being followed. The first, designated SNAP-I and being developed by the Martin Company, Baltimore, Maryland, under Commission contract, will use the heat from a radioactive isotope to operate a generator. The second, designated SNAP-II and being developed by Atomics International, Canoga Park, California, will use the heat from a reactor to operate a turbo-electric generator. Emphasis, in this effort, has been placed in developing fully reliable minimum size space reactors that will operate in a space environment.

In the manned aircraft propulsion program, investigations were continued on two basic systems, the direct cycle and the indirect cycle. The General Electric Co., Evendale, Ohio, is under contract to the Commission to develop reactors for the direct-cycle system and Pratt & Whitney, Hartford, Connecticut, is under contract to the Commission to develop reactors for the indirect-cycle system. In the direct-cycle system, compressed air is heated in a reactor core and is exhausted directly through an engine turbine and exhaust nozzle. No heat exchanger is used. In the indirect-cycle system, compressed air is heated as it passes through a heat-exchanger system containing liquid-metal coolant from a reactor. The Commission's Oak Ridge National Laboratory provided general support for both the direct and indirect cycle programs, with emphasis on shielding problems. The design of a Shield Test Air Facility was started in June for construction at the Commission's National Reactor Testing Station in Idaho.

CRAF contract is signed by Theodore Hardeen (left), James H. Douglas and Charles S. Thomas (right).

DEFENSE AIR TRANSPORTATION ADMINISTRATION

During 1959 the program of DATA moved forward in all major areas of responsibility for the most efficient mobilization of civil aviation and its facilities and resources.

Allocation of civil air transport aircraft to the Civil Reserve Air Fleet (CRAF) provided a continuing military airlift supplement and the 1959 allocation reflected an increase in military support requirements as established by the war plans of the Joint Chiefs of Staff. With the introduction of longer range jet aircraft, the actual number of aircraft allocated to the CRAF decreased from approximately 300 to 236 aircraft, at the same time meeting the increased airlift requirements of the military in the passenger category. There still existed a deficit in military cargo requirements. Allocation orders designating by N number the CRAF current fleet were promulgated by the Administrator of DATA, Theodore Hardeen, Jr., and were published in the Federal Register.

Agreement was reached on the basic formula for a standby contract between the air carriers and DOD and the Administrator of DATA participated in Pentagon ceremonies marking the signing of the first CRAF contract by TWA.

Formal establishment of the CRAF Operations Boards, Pacific and Atlantic, was completed and these Boards, comprised of airline representatives, the military, and DATA, were activated during the year. Planning for partial activation of CRAF resulted in the development of basic suggested principles under which a portion of the air carrier fleet would perform under contract to the military in a limited war or other emergency situation. For the purpose of expediting Border Clearance of CRAF personnel immediately following D-day, agreement was reached with all interested agencies.

The first Test Exercise of CRAF was conducted in August. This was called Exercise Snowflake and the entire CRAF organization was put to a test which was both realistic and extensive. One of the most important and basic principles of CRAF planning was the rapid mobilization of a fully equipped fleet ready to go as soon as possible but not later than 48 hours following D- day. Exercise Snowflake was a decided success and resulted in recommendations for further detailed refinements which would assure the fullest utilization of the CRAF potential.

DATA responsibilities included planning for the War Air Service Pattern (WASP) which is that part of the total airlift of the civil air carriers which would be required for a war economy. An Air Priorities System with policies jointly determined by the Departments of Commerce and Defense would assure that essential air traffic would move on routes designated by the CAB. An analysis of deficit and surplus routes and equipment was undertaken jointly by DATA, CAB and the airline industry, and a standby order was issued covering specific services to be performed by the airlines in the event of an emergency.

In addition to plans for the use of scheduled and non-scheduled airline aircraft for the CRAF and WASP, DATA continued the development of the NEDA (National Emergency Defense Airlift) plan for the use of business and privately owned multi-engine aircraft over the weight of 12,500 pounds in support of civil defense and other vital missions under emergency conditions. This planning was coordinated with OCDM with the cooperation of aircraft owners and the appropriate State and local officials.

Under Title XIII of the Federal Aviation Act of 1958 the Secretary of Commerce was given the power to provide Aviation War Risk Insurance. This power was delegated to the Defense Air Transportation Administrator. To implement this program, DATA issued a general order and initiated an interim binder program giving air carriers protection in the event of war. During the last months of fiscal year 1959 the general order was under revision so that no premium insurance could be provided for CRAF aircraft. An indemnity agreement was entered into between the Secretary or Defense and the Secretary of Commerce providing that Defense would repay to Commerce any amounts paid under the no-premium CRAF insurance. At year's end this agreement was waiting expected favorable action by the President.

The Administrator of DATA served as the Chairman of the United States delegation to the Civil Aviation Planning Committee of NATO to carry out the Department's responsibilities for mobilization of international civil aviation. A DATA staff member was also the representative on The Planning and Logistics Working Group of the CAPC. Two meetings of the Committees were held in Paris, France during 1959.

FEDERAL COMMUNICATIONS COMMISSION

During 1959, FCC continued to regulate which portions of the radio spectrum could be made available for radio communication and navigation facilities to aircraft operators, aeronautical enterprises and organizations which required radio transmitting facilities for safety or other necessary purposes.

Stations aboard aircraft are utilized for communication and navigation. Included are special uses such as flight testing. Ground stations include aeronautical enroute, aeronautical fixed, operational fixed, aeronautical advisory, aeronautical utility mobile, airdrome control, flight test, flying school, radio navigation, aeronautical public service aircraft, aeronautical metropolitan station, aeronautical search and rescue mobile stations, and Civil Air Patrol. There were more than 77,000 licenses and over 123,000 transmitters authorized in the aviation services at the close of the year as contrasted with less than 700 licenses in 1935.

The Commission participated in the work of various coordinating and policy-making groups in the administration of the non-government aviation services. The most critical area in this respect was the continuing demand for additional radio usage which must be accommodated within the available radio frequency spectrum. Administrative steps to assure maximum utilization of available facilities were taken during the year through contact with the providers and users of radio in the aviation services.

Coordination was maintained through such groups as the Radio Technical Commission for Aeronautics (RTCA), the Air Coordinating Committee (ACC), and internationally through the International Civil Aviation Organization (ICAO).

In October, FCC took steps to waive the citizenship requirement and license certain aliens to operate radio on aircraft. More than 400 applications had been received by year-end for aircraft radio operation by aliens.

FISH AND WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

During fiscal year 1959, the Fish and Wildlife Service operated a fleet of 51 aircraft composed of 28 Pipers (Supercubs, Pacers, and J3Cs), 11 Grum-

Forest Service's Grumman Widgeon takes winter inventory of ducks.

man Gooses, 10 Cessna 180s, one DC-3, and one Navion. Seventeen are based in the continental United States and 34 in Alaska.

Aircraft of the Service was used by its Bureau of Commercial Fisheries and Bureau of Sport Fisheries and Wildlife on game and fish law enforcement work; waterfowl, big-game, and fishery assignments; agricultural development work on the national wildlife refuges, including seeding of wildlife food and spraying for the control of noxious vegetation; predator control; collection of fishery statistics; for aerial reconnaissance and evaluation of wildlife areas; and for handling logistics to isolated encampments.

All employees of the Service who pilot Service aircraft must hold Letter of Flight Authority. During fiscal year 1959, 85 employees held such authority. These employees are Civil Service-qualified for their jobs as Game Management Agents, Biologists, Predator and Mammal Control Supervisors, Refuge Managers, and in a few instances in Alaska as Pilot Mechanics. Generally speaking, the pilot personnel are qualified in wildlife and in fishery management work and their flying is an added accomplishment that enables them to use the arcraft as a tool in their work, just as they would use an automobile or an outboard motorboat.

Maintenance and repair of Service aircraft operating in the United States was handled through commercial shops. In Alaska the Service maintained overhaul and repair shops of its own, supplemented by commercial facilities.

FOREST SERVICE
DEPARTMENT OF AGRICULTURE

The Forest Service used aircraft in 1959 to protect and manage 181 million acres of national forests in 39 states and Puerto Rico. Airplanes and helicopters were also used on special land utilization areas, cooperative forestry projects, and in phases of forest research. Principal aircraft uses included: fire detecting and suppressing, transporting men and supplies, controlled insect spraying, special range and forest reseeding projects, and aerial surveys and map making.

Airplanes and helicopters played a major part in fire control in 1958, flying 26,417 hours, and carrying 25,220 passengers and 1,500,000 pounds of cargo. This was an increase of 5,480 hours and 10,253 passengers over 1957. Eighty-two percent of this activity was accomplished by commercial and pricately-owned aircraft. The use of helicopers in fire suppression increased 51 percent over 1957. Records show a total of 3,746 flying hours, and the transportation of 11,508 persons and 362,642 pounds of cargo. This increase in helicopter use was largely due to the availability of new models with greater load capacity for high altitude landings and take offs.

The results of a helicopter initial attack study in Montana, started in 1958, were good and the program was continued. A method of deploying helicopters and heliports in forest areas was developed. This method of attack enabled fewer men to handle more fires, reduced travel time, eased fireman fatigue, and speeded up their return to home base.

The Angeles National Forest in California also maintained a trained helicopter team for primary use in inaccessible fire areas. To support this and other fire attack programs, helicopters were used to lay fire hose, cascade small quantities of fire retardants, drop helijumpers—specially trained helicopter-jumping fire fighters—and take part in scouting, and equipment and personnel shuttling operations.

More fixed-wing aircraft were also used by the Forest Service in fire control than ever before. Aerial techniques were greatly improved largely as a result of previous experience. Particular emphasis was placed on safety through better organization and equipment, improved pilot requirements, and radio communication.

Air tankers, in support of ground fire fighters, provided direct attack against fires by cascading chemical fire retardants on critical spots. This method has now been expanded from Western regions to all other Forest Service regions.

As with other methods of aerial attack against forest fires, smokejumpers participated in more forest fire suppression work than in any other year. A combined air attack program against forest fires using smokejumpers, helicopters, and air-dropped retardants has now become the most effective means of controlling forest fires in remote mountain areas.

In forest pest control, aircraft was most effective in combating various foliage destroying insects including the spruce budworm, Douglas-fir tussock moth, Saratoga spittlebug, and several other species. During 1959, aerial application of insecticides by the Forest Service, state, and private owners was limited to 175,000 acres. This is in sharp contrast to projects totaling over one million acres each during the past several years. This reduction resulted partly from successful pest control projects of past years, and partly from concentration on controlling bark beetles, which respond only to ground level attack methods.

Research continued to improve the effectiveness and reduce costs of aerial spraying. Special emphasis during the year was placed on spray atomization from large aircraft such as the TBM and B-18. These and similar airplanes were used extensively in forest spraying throughout the country.

Aircraft, as in recent years, were valuable aids in inspecting forests for early signs of insect outbreaks. Normally, fixed-wing aircraft were adequate for aerial insect detection surveys, but helicopters proved to be extremely useful in special situations.

During fiscal year 1959, airplanes played a prominent part in range management. Approximately 50,000 acres of national forest western rangeland were sprayed with herbicides to eliminate undesirable plants.

In the Intermountain Region, about 30,000 acres were sprayed by fixed-wing aircraft, mostly to control sagebrush. The Region accomplished much of this work through the use of a converted Navy torpedo bomber. This plane minimized the loading and ferrying time, and permitted the Region to take advantage of all favorable weather conditions. Costs for the operation averaged from $2.25 to $3.50 per acre.

The Northern Region used a helicopter during the summer to control approximately 11,000 acres of sagebrush and wyethia on the Beaverhead National Forest in Montana. This was the first time a helicopter had been used to control undesirable plants on national forest ranges in this Region. Reports indicated good results were obtained.

An interesting development in Forest Service aviation concerns the world's largest carnivore—the Alaska Brown Bear. Aerial and foot surveys have been conducted, in cooperation with the Alaska Department of Fish and Game and the Bureau of Sport Fisheries and Wildlife, to compare bear population records with those of past years.

Helicopters have converted this arduous, time consuming survey to a quick and enjoyable task. Now a two-man helicopter team is flown upstream above the salmon runs, which are easily seen from the air. The men proceed downstream by foot, measuring and counting bear tracks, until they meet the helicopter at tidewater. Having collected pertinent data, they determine the number and size of the bears, then fly to the next survey area.

NATIONAL AIR MUSEUM
SMITHSONIAN INSTITUTION

In a further attempt to fulfill its responsibility to the Nation, the National Air Museum was in process of planning all-new exhibits for the Aircraft Building, which was being completely remodeled. It was planned that the building would be opened to the public on April 1, 1960. Latest exhibition techniques were being applied in the design so that the story of aviation will be displayed in the most authentic detail.

This new exhibit was planned only as an interim project, looking forward to the erection of the new Air Museum building on the Mall. The Museum staff was involved in planning with the architects for this building, which was anticipated to be the finest aviation museum in the world. Even though not all of the aircraft and other specimens in the National Aeronautical Collection can be accomo-

Air Museum receives Jupiter C missile and Explorer I satellite.

dated, even in the large building, a much greater number than ever before will go on display.

In addition to its routine work, the National Air Museum also sponsored the Lester D. Gardner lecture given in Washington by Grover Loening. A Summer Insitute in Aviation Education for Science Teachers was conducted in cooperation with American University, which brought together a "faculty" of outstanding lecturers from the National Aeronautics and Space Administration, the Federal Aviation Agency, and the United States Weather Bureau. As a part of the Institute, visits were made to Washington National Airport, Anacostia Naval Air Station, and Davidson Field at Fort Belvoir. Each student was given a ride in various types of aircraft, including helicopters, and was permitted to witness specialized operations not available to the general public.

Outstanding among the many accessions received by the Museum in 1959 were: the Lockheed Sirius used by Mr. and Mrs. Charles Lindbergh on exploratory flights to the Orient and the South Atlantic; the personal memorabilia of Glenn L. Martin; the experimental components used in the rocket researches of Dr. Robert Goddard; a Jupiter C missile with the "Explorer I" satellite on the nose; the Ryan X-13 "Vertijet"; and a super-detailed model of a monoplane built in 1911 by the Johnson brothers of Terre Haute, Indiana.

One of the most important additions to the growing reference files was the acquisition of 30,000 historical aviation photographs.

POST OFFICE DEPARTMENT

Preliminary figures covering the domestic airmail service indicated that the Post Office Department handled approximately 1,370,000,000 pieces of airmail and air parcel post, weighing in excess of 96,900,000 pounds, during the fiscal year ending June 30, 1959.

At the close of the same fiscal year period, 55 air routes were being operated by 33 air carriers over a network totaling 248,951 miles.

Service mail pay amounted to some $38 million for the 94,783,000 mail ton-miles of transportation accorded. This sum was exclusive of subsidy mail payments received by certain air carriers.

Transportation of first class mail by air, which is conducted on an experimental basis by the Department, continued throughout the fiscal year period with 24 carriers participating and a total of 229 cities being served in 35 states and the District of Columbia.

An increase of approximately 23 percent over previous year figures was recorded in the volume of foreign airmail from the United States, to and from U. S. possessions and territories, and to and from U. S. military post offices in foreign countries. Most of the increase was attributable to military airmail.

Foreign flag carriers transported approximately 11 percent of the total foreign air mail from the United States to other countries, except Canada. Separate figures show that Canadian flag carriers transported approximately 60 percent of the airmail destined to Canada.

Twenty United States flag carriers were operating at the close of fiscal year 1959. The total route miles in international and overseas service for the 20 carriers amounted to some 350,000 miles.

WEATHER BUREAU
DEPARTMENT OF COMMERCE

Basic Weather Bureau service to aviation in 1959 was focused on the warnings and forecasts prepared by 27 Flight Advisory Weather Service (FAWS) Centers in the 50 states. Highly trained meteorologists at these centers issued area, terminal, and winds aloft forecasts at regular intervals for periods of 12 to 24 hours in advance. In addition, the flash advisory service which had been on an experimental basis was placed on a fully operational basis whereby FAWS centers issue special advisories concerning potentially hazardous weather developments, which are distributed to Air Traffic Communications Stations of the Federal Aviation Agency (FAA) for broadcast direct to aircraft in flight.

In February a new High Altitude Forecast Service was started as a routine function for turbine-powered aircraft operations. Forecasts were issued four times daily by seven Centers located at Idlewild, Washington, Miami, San Francisco, Anchorage, Honolulu, and San Juan. Forecast centers located in the contiguous (continental) states exchange and distribute forecasts from a new landline facsimile circuit which is connected to 14 other jet airports throughout the country.

Specially designed, semi-automatic, closed-circuit television briefing systems were procured for installation at five of the principal international flight departure centers. Installations were made at New York and Miami late in 1959, and additional installations were planned for operation at San Juan, Chicago, and San Francisco. These closed circuit TV briefing systems will program a series of charts for areas covering long-range and high-altitude flight operations before the TV viewer, together with an oral discussion of the significant features of the charts and their bearing on flight operations.

Eight new continuous transcribed aviation weather broadcasts on FAA L/MF radio facilities were started during the year, bringing the total to ten. Ultimate plans call for a national network of 87 broadcasts operated in cooperation with the FAA. These broadcasts provide pre-flight weather information to pilots, especially to those at outlying areas where no weather facilities are available, and simultaneously provide pilots in flight with an aerial description of weather developments, together with actual reports from at least eight airports within a radius of about 250 miles.

In cooperation with the FAA, the Weather Bureau participated in a number of studies designed to determine the extent to which weather factors affect air traffic management at congested terminal areas. Also, the Weather Bureau was cooperating in FAA studies designed to bring out the details of Aviation Weather Service requirements attendant to the principal phases of instrument and visual flight operations on a nationwide basis.

Significant progress was made in providing the pilot with information specifically describing conditions in the critical final approach zone. Additional installations of sensitive equipment designed to measure cloud height and visibility automatically at the approach end of instrument runways were completed at many vital terminals across the country. Runway visual range, a unique application of the visibility instrumentation which gives horizontal visual guidance to the landing pilot in terms of visibility of high intensity runway lights, was operational at a few major air terminals with many more installations planned.

A field study and evaluation of the approach visibility parameter was concluded at Newark Airport, New Jersey, by a Weather Bureau research group in cooperation with the Air Force and the FAA. The design of an operationally valuable system for determining the slant visual range of the pilot on final approach was completed using the end-of-runway equipment mentioned above as basic components.

Automatic weather stations were in an advanced stage of development. One of the most comprehensive of such stations was activated at Galveston, Texas, on July 19, 1959. Design work was being conducted which should provide the capability for automatically observing such additional elements as sea-level pressure, cloud cover, cloud height, and the occurance of the various forms of precipitation.

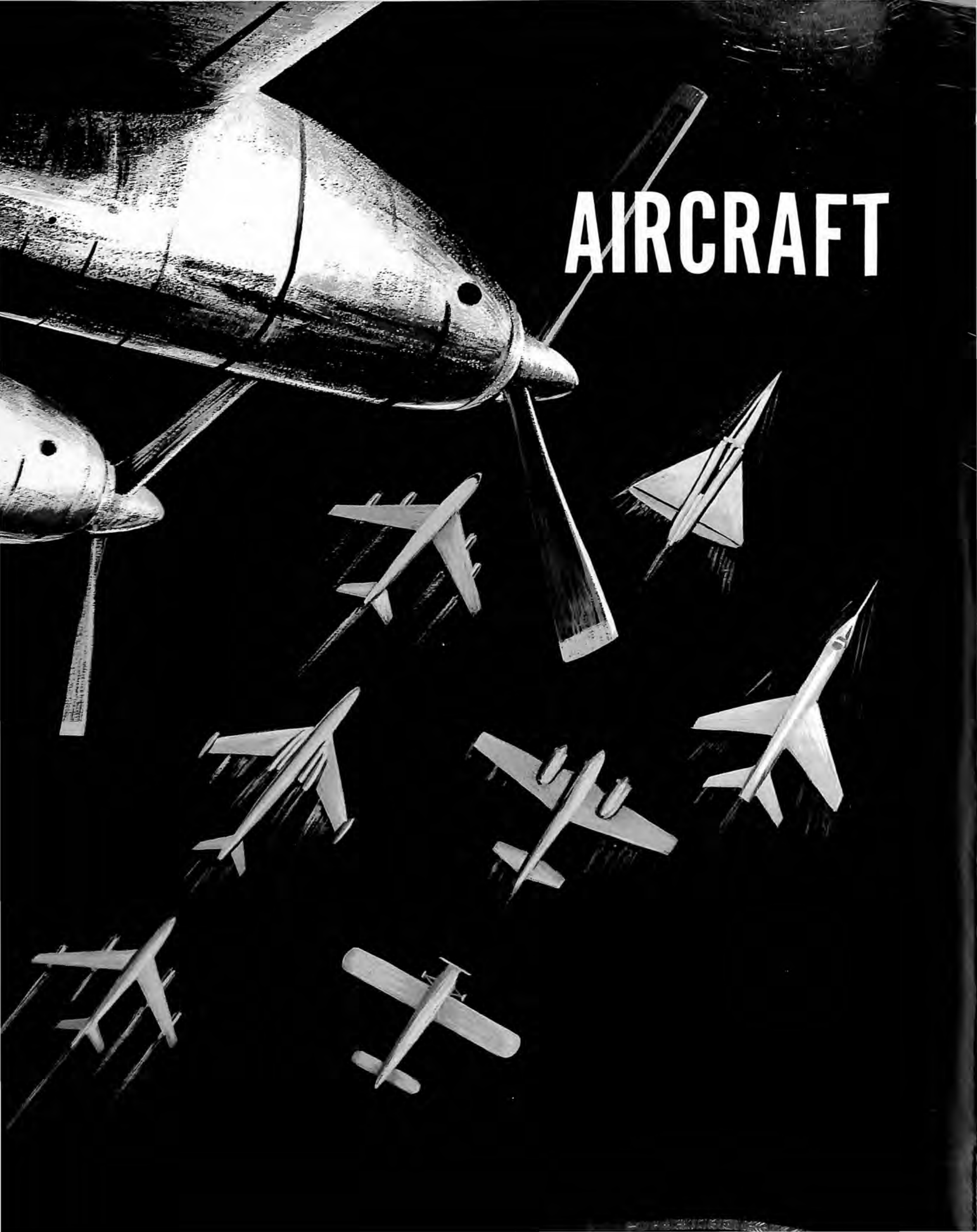
Forty-two improved radiotheodolites were procured for winds aloft observations. These are automatic tracking, wind direction-finding sets operating on 1680 mc. By the end of calendar year 1959, 28 sets were expected to be in operation.

The Weather Bureau used a C-45H twin-motored Beech aircraft to conduct forecaster familiarization flights, to monitor the effectiveness of aviation weather observations and forecasts, and to survey storm damage and floods. Two DC-6As were leased and one B-57 was obtained from the Air Force for hurricane research.

Under agreement with, and with financial support from, the National Aeronautics and Space Administration the Weather Bureau organized a Meteorological Satellite Section which is housed in quarters near the National Meteorological Center. The responsibilities of this group included the design of meteorological experiments for satellite research and the devising of techniques for making meteorological measurements, taken by earth satellites, available for current weather forecasting operating by the National Meteorological Center.

As of October 1, 1959, the Weather Bureau was operating meteorological radar equipment at 80 locations throughout the United States, with 16 more locations planned during the next year.

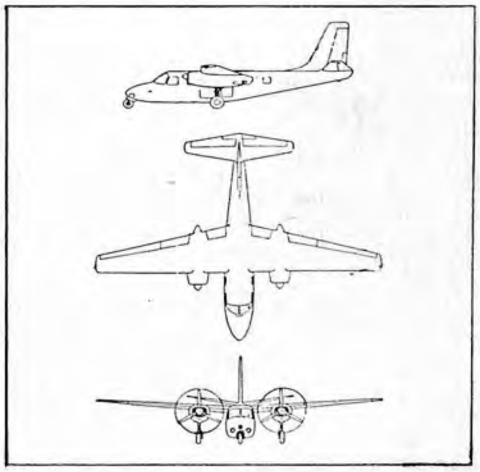
AIRCRAFT



AERO DESIGN & ENGINEERING CO.
BETHANY, OKLAHOMA

IN PRODUCTION

Aero Design Model 680-E



REMARKS

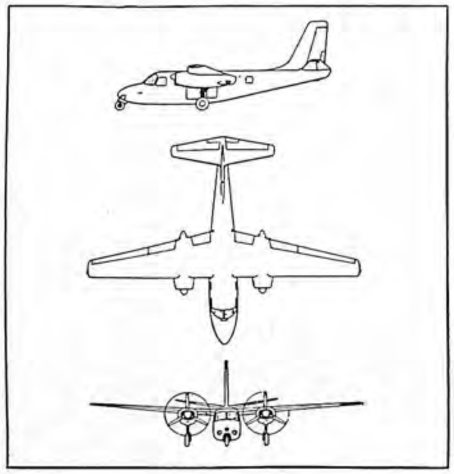
Model 680-E introduces new payload capacity for executive aircraft. With the wide span found on the high aspect-ratio wing, the 680-E offers outstanding performance and greater loads without sacrifice of long range. The use of the supercharged engines gives the 680-E top performance, plus outstanding single-engine capabilities. The model features a luxurious interior, available in several color combinations and offers either four, five, or six place seating configurations. The company's Model 720, Alti-Cruiser, specifications differ from the 680-E with a 5230 pounds empty weight.

SPECIFICATIONS

Span 49.56 ft.; Length 35 ft. 1¼ in.; Height 14 ft. 9 in.; Empty Weight 4475 lb. (5230 lb. Model 720); Wing Loading 29.5 lb per sq. ft.; Engine GSO-480-B1A-6 Lycoming, 340 hp normal rates, or 340 hp at 3400 rpm takeoff; Fuel Capacity 223 gal.; Propeller 3 Blade 93" Hartzell; Wing Area 255 sq. ft.; Aileron Area 19.80 sq. ft.; Flap Area 21.20 sq. ft.; Fin Area 24 sq. ft.; Rudder Area 15.60 sq. ft.; Stabilizer Area 33.06 sq. ft.; Elevator Area 20.54 sq. ft.

PERFORMANCE

Maximum Speed 255 mph at 340 hp at 3400 rpm at 7000 ft.; Cruise Speed 85 mph; Rate of Climb 1525 fpm at Sea Level; Service Ceiling 25,360 ft.; Absolute Ceiling 25,700 ft.; Range with Maximum Payload 1400 mi.; Range with Maximum Fuel Load 1500 mi.



REMARKS

The new Aero Commander 560E is designed to help today's executive meet the ever increasing demand on his time. The high speed and long-range performance of this five-seven place twin-engine executive aircraft make possible one stop, high speed coast-to-coast flights, in a single day. Model 500 is also in production, using a Lycoming O-540 engine.

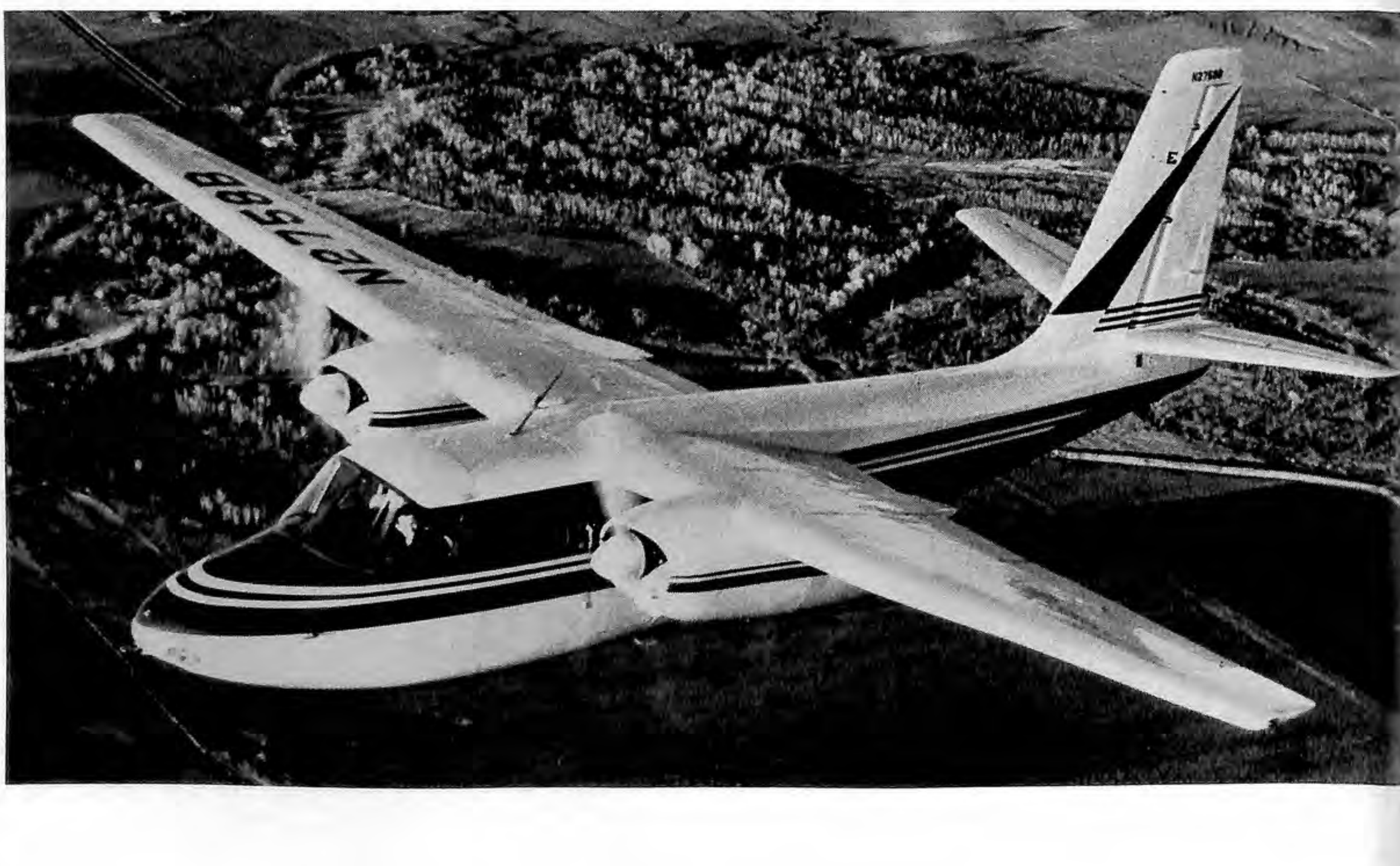
SPECIFICATIONS

Span 49.56 ft.; Length 35 ft. 2 in.; Height 14 ft. 9 in.; Empty Weight 4300 lb.; Gross Weight 6500 lb.; Overload Gross Weight 6500 lb.; Wing Loading 24.7 lb. per sq. ft.; Power Loading 10.9 lb. per bhp; Engines Two Lycoming GO-480-D1A 260 each hp normal rated, or 275 each hp at 3400 rpm takeoff; Fuel Capacity 223 gal.; Propeller Hartzell 3-blade; Wing Area 254 sq. ft.; Aileron Area 20.52 sq. ft.; Flap Area 32.70 sq. ft.; Fin Area 38.20 sq. ft.; Rudder Area 15.40 sq. ft.; Stabilizer Area 33.06 sq. ft.; Elevator Area 20.54 sq. ft.

PERFORMANCE

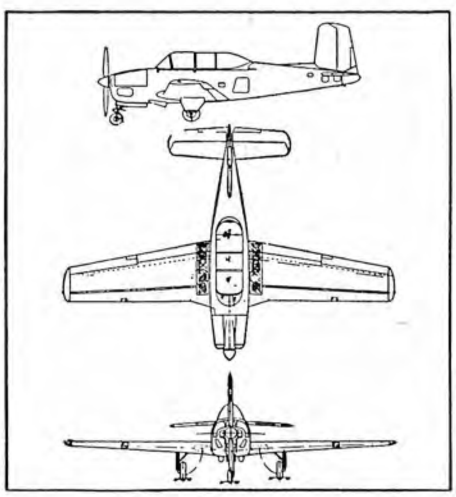
Maximum Speed 222 mph at Sea Level; Cruise Speed 210 mph at 70 percent hp at 10,000 ft.; Stall Speed 66 mph; Rate of Climb 1450 fpm at Sea Level (2 engines); Service Ceiling 22,500 ft. (2 engines); Range with Maximum Payload 1625 mi. with 30 min. reserve; Fuel Capacity 223 gal.

Aero Commander 560E



BEECH AIRCRAFT CORP.
WICHITA 1, KANSAS

Beechcraft T-34 Mentor



REMARKS

The T-34 Mentor, developed by Beech as a private venture, has now been adopted as the official primary trainer for the U. S. Air Force, U. S. Navy, and the air services of Argentina, Mexico, Spain, Turkey, Venezuela, Chile, Colombia, El Salvador, and Japan. The Beechcraft T-34B is the official primary trainer of the U. S. Navy. This airplane is a modified version of the USAF T-34A also used by the air services of many foreign nations. First production aircraft deliveries to the Navy began in December, 1954.

SPECIFICATIONS

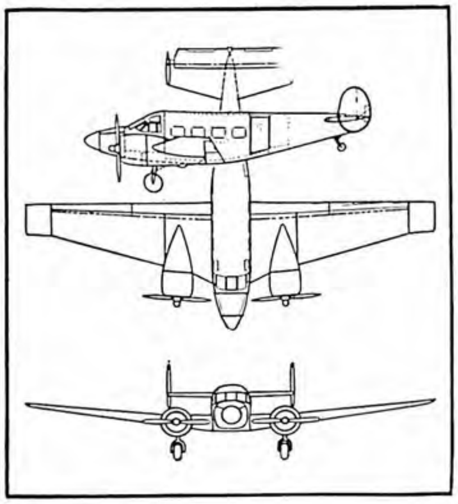
Span 32 ft. 10 in.; Length 25 ft. 11 in.; Height 9 ft. 7 in.; Empty Weight 2246 lb.; Gross Weight (T-34A 2950 lb.; T-34B 3000 lb.); Wing Loading 16.75 lb. per sq. ft.; Power Loading 13.2 lb. per bhp; Engine Continental O-470-13, 225 hp at 2600 rpm; Fuel Capacity 50 gal.; Propeller Beech constant speed; Gear tricycle; Wing Area 177.6 sq. ft.; Aileron Area 11.5 sq. ft.; Flap Area 23.3 sq. ft.; Fin Area 10.39 sq. ft.; Rudder Area 6.54 sq. ft.; Stabilizer Area 22.25 sq. ft.; Elevator Area 15 sq. ft.

PERFORMANCE

Maximum Speed 187 mph at 225 hp at 2600 rpm at Sea Level; Cruise Speed 170 mph at 135 hp at 2300 rpm at 10,000 ft.; Landing Speed 55 mph; Rate of Climb 1120 fpm at Sea Level; Service Ceiling 18,200 ft.; Range with Maximum Payload 727 mi. at 10,000 ft., 60 percent power.

REMARKS

The eight-place Super 18 is an improved and larger version of the standard Model 18, first put on the market in 1937. Current models feature external drag reduction plus interior refinements. More than 6850 units in commercial and military configurations of the Model 18 series have been built to date. Equipping the Super 18 with three-blade Hartzell propellers, coupled with other alterations, increases allowable gross weight to 9700 pounds, which permits a 450-pound increase in useful load, and improves the rate of climb. The Super 18 is also produced with two-blade Hamilton-Standard propellers in a 9300-pound gross weight version.



SPECIFICATIONS

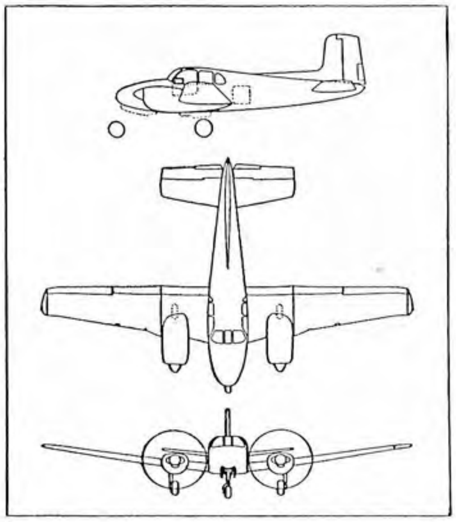
Span 49 ft. 8 in.; Length 35 ft. 2½ in.; Height 9 ft. 6 in.; Empty Weight 6000 lb.; Gross Weight 9700 lb.; Wing Loading 26.9 lb. per sq. ft.; Power Loading 10.78 lb. per bhp; Engines Two Pratt & Whitney R-985 AN-14B 450 hp at 2300 rpm takeoff; Fuel Capacity 318 gal.; Propeller Hartzell hydromatic 3-blade, 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 86 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 Super 18

Beechcraft G50 Twin Bonanza



REMARKS

The Model G50 Twin-Bonanza, a six-place executive transport, is equipped with supercharged engines and fuel injection for improved performance. Increasing the Model G50's gross weight limit to 7150 pounds and useful load by 167 pounds is accomplished while increasing both service ceiling and maximum range. The Model D50B Twin-Bonanza, with high-compression 285 horsepower engines, is also in production.

SPECIFICATIONS

Span 45 ft. 3⅜ in.; Length 31 ft. 6½ in.; Height 11 ft. 4 in.; Empty Weight 4443 lb.; Gross Weight 7150 lb.; Wing Loading 25.2 lb. per sq. ft.; Power Loading 10.9 lb. per bhp; Engines Two Supercharged Lycoming IGSO-480-A1A6 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.

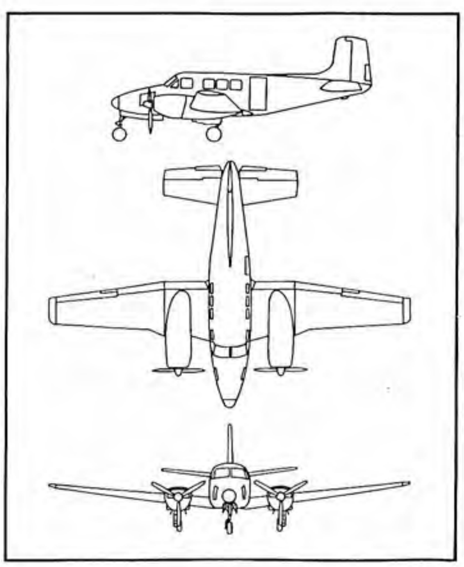
PERFORMANCE

Maximum Speed 240 mph at 320 hp at 3200 rpm at 12,000 ft.; Cruise Speed 228 mph at 238 hp at 2750 rpm at 15,200 ft.; Landing Speed 84.5 mph; Rate of Climb 1320 fpm at Sea Level; Service Ceiling 28,300 ft.; Range with Maximum Fuel Load 1720 mi.

Beechcraft L-23F Command Transport

REMARKS

Designed to meet a military requirement for a larger multi-purpose 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. Production of the six-place L-23D, military version of the Model F50 Twin-Bonanza business plane, for the Army also continued during the year. More than 200 L-23s have been delivered to the Army. Beechcraft has remanufactured under Army contract a total of 93 A and B versions of the L-23 into the L-23D configuration. The L-23D is the first Army plane equipped with a weather avoidance radar system.

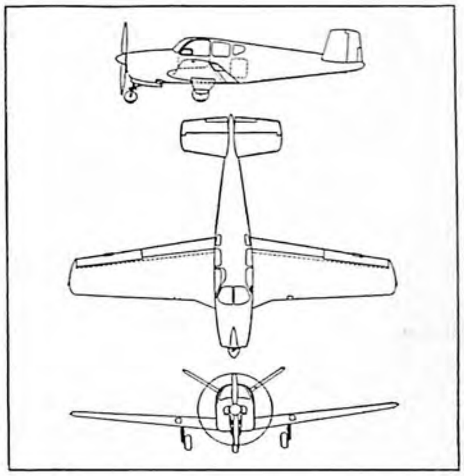


SPECIFICATIONS

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 rpm at 16,800 ft.; Landing Speed 80 mph; Rate of Climb 1380 fpm at Sea Level; Service Ceiling 27,100 ft.; Absolute Ceiling 28,500 ft.; Range with Maximum Payload 1550 mi.; Range with Maximum Fuel Load 1550 mi.



REMARKS

The four-place Bonanza was first flown December 22, 1945. More than 6100 of the high-performance Bonanzas have been manufactured since that date. Popular with the business executive, the Bonanza also has had a successful feederline operational history. The Model K35, equipped with fuel injection, has a 10-gallon increase in fuel capacity with resultant 185-mile increase in maximum range.

SPECIFICATIONS

Span 32 ft. 10 in.; Length 25 ft. 2 in.; Height 6 ft. 6½ in.; Empty Weight 1832 lb.; Gross Weight 2950 lb.; Wing Loading 16.05 lb. per sq. ft.; Power Loading 11.8 lb. per bhp; Engine (standard) Continental IO-470-C with fuel injection, 250 hp at 2600 rpm, all operations; Fuel Capacity 49 gal. (68 gal. with auxiliary tank); Propeller Beech hydraulically controlled, variable pitch; Gear tricycle, fully retractable; Wing Area 177.6 sq. ft.; Fin-Stabilizer Area 23.8 sq. ft.; Rudder-Elevator Area 12 sq. ft.

PERFORMANCE

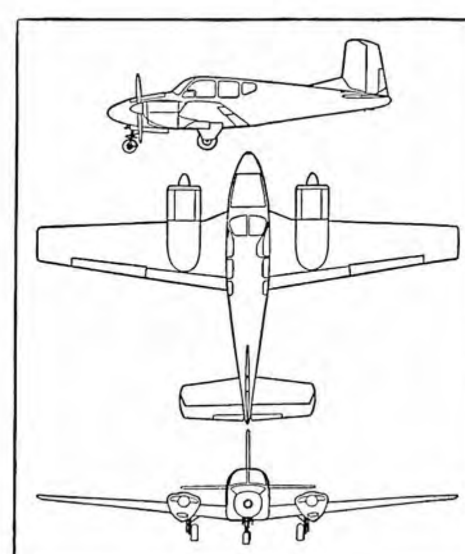
Maximum Speed 210 mph at 250 hp at 2600 rpm at Sea Level; Cruise Speed 200 mph at 187.5 hp at 2450 rpm at 7000 ft.; Landing Speed 59 mph; Rate of Climb 1170 fpm at Sea Level; Service Ceiling 20,000 ft.; Maximum Range 1245 mi. at 10,000 ft. at 180 mph.

Beechcraft K35 Bonanza

Beechcraft Model 95 Travel Air

REMARKS

First flown on August 6, 1956, the Travel Air marked Beechcraft's entry into the four-place, twin-engine business airplane field. In two years of utilization as an executive transport, the Travel Air has become noted for its quiet flight, ease of handling and operational economy.



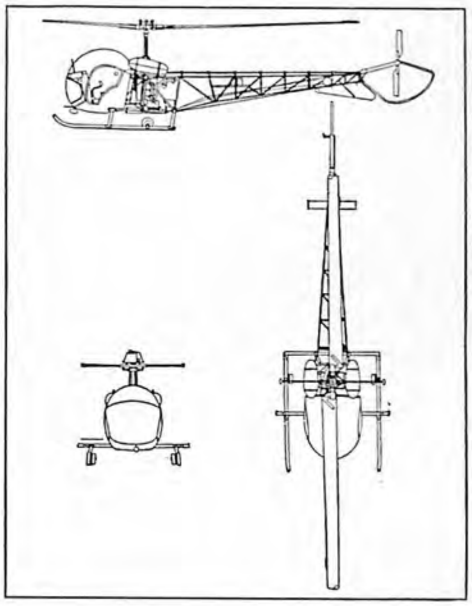
SPECIFICATIONS

Span 37 ft. 10 in.; Length 25 ft. 4 in.; Height 9 ft. 6 in.; Empty Weight 2570 lb.; Gross Weight 4000 lb.; Wing Loading 20.6 lb. per sq. ft.; Power Loading 11.1 lb. per bhp; Engines Two Lycoming O-360-A1A, 180 hp normal rates; Fuel Capacity 112 gal.; Propeller 72 in. 2-blade Hartzell, hydraulically controlled, continuously variable pitch, full feathering; Wing Area 193.8 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 rpm at 7500 ft.; Landing Speed 70 mph; Rate of Climb 1360 fpm at Sea Level; Service Ceiling 19,300 ft.; Absolute Ceiling 20,900 ft.; Range with Maximum Fuel Load 1410 mi.

BELL HELICOPTER CORP.
FORT WORTH, TEXAS



REMARKS
The Model 47G-2 has hydraulic cyclic boost control as standard equipment. This is similar to automotive power steering and greatly improves the flight handling characteristics while reducing pilot fatigue. Standard equipment includes complete VFR flight and engine instruments, 28/volt/50amp generator, electric starter, ground handling wheels, heavy-duty batter, and synchronized elevator. The 47G-2 is shown in the 3-view drawing on this page.

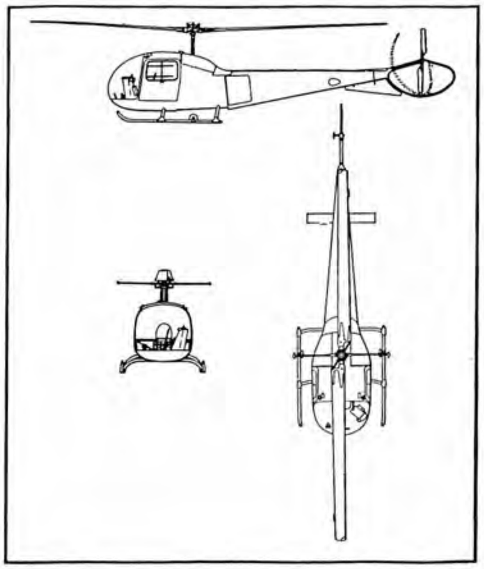
The 47G-2 (H-13H) model has a Lycoming VO-435 engine, giving it increased weight, speed, and range. An excellent hot-weather, high altitude helicopter, capable of hovering in ground effect at more than 10,000 feet with maximum gross weight. The three-place commercial model is ideal for crop dusting and spraying patrol, and survey, rescue, and mercy missions. The military employs it for evacuation, observation, reconnaissance, wire-laying, training, and other duties. Both civilian and military models are available with a wide assortment of auxiliary kits.

SPECIFICATIONS
Main Rotor Diameter 35 ft. 1 in.; Length 30 ft. 5 in.; Height 9 ft. 5 in.; Empty Weight 1564 lb.; Maximum Gross Weight 2450 lb.; Power Loading 9.4 lb. per bhp; Engine One Lycoming VO-435, 200 hp normal rated, or 200 hp at 3200 rpm takeoff; Fuel Capacity 43 gal.

PERFORMANCE
Maximum Speed 100 mph at Sea Level; Cruise Speed 85 mph at 2000 ft.; Landing Speed 0 mph; Rate of Climb 805 fpm at Sea Level at Maximum Gross Weight; Service Ceiling 12,300 ft. at G.W.; Absolute Ceiling 13,200 ft. at G.W.; Range with Maximum Fuel Load 238 mi.

Bell 47G-2; H-13H (Army)

Bell 47J; H-13J (Air Force); HUL-1 (Navy and Coast Guard)



REMARKS

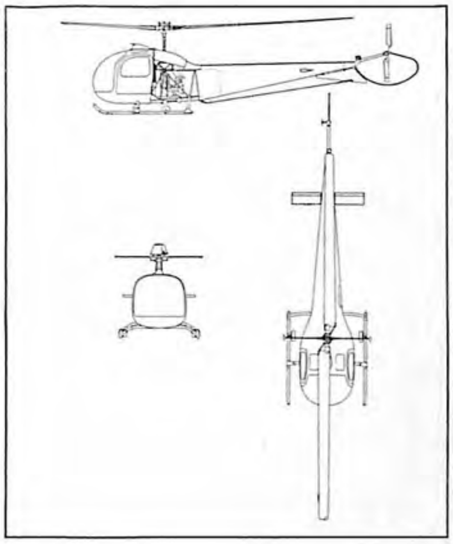
The Model 47J Ranger carries a pilot and three passengers. Streamlining of tail boom, fuel tanks, cabin, and arched skid gear, plus hyraulic boost control, synchronized elevator, and Bell's semi-rigid rotor system combine to produce a helicopter with exceptional stability and flight handling characteristics. The commercial Ranger comes with standard or deluxe passenger interiors and can be equipped with an internal hoist in a matter of minutes without use of special tools. The Air Force version, designated the H-13J, is used by the Presidential Staff. Navy and Coast Guard models of the Ranger are called the HUL-1 and are employed as utility helicopters with the fleet.

SPECIFICATIONS

Main Rotor Diameter 37 ft. 2 in.; Length 32 ft. 5 in.; Height 9 ft. 4 in.; Empty Weight 1615 lb.; Gross Weight 2565 lb.; 47J also available with 2800 lb. gross weight; Power Loading 10.8 lb. per bhp; Engine One Lycoming VO-435, 220 hp normal rated, or 240 hp at 3200 rpm takeoff; Fuel Capacity 34 gal. (48 gal. tanks are optional).

PERFORMANCE

Maximum Speed 105 mph at 500 ft.; Cruise Speed 99 mph at 5000 ft.; Rate of Climb 840 fpm at Sea Level at G.W.; Service Ceiling 13,500 ft. at G. W.; Absolute Ceiling 15,200 ft. at G. W.; Range with Maximum Fuel Load 222-304 mi.



REMARKS

In the fall of 1958 Bell Helicopter Corporation completed a Navy contract for production of 18 HTL-7s. The ship is a fully-integrated instrument trainer in the rotary-wing field. It follows design lines of the Navy's utility model Bell HUL-1 with exception of the cabin, which features dual controls and side-by-side seating for student and instructor.

SPECIFICATIONS

Main Rotor Diameter 37 ft. 2 in.; Length 31 ft. 8 in.; Height 9 ft. 3.6 in.; Empty Weight 1916 lb.; Gross Weight 2450 lb.; Power Loading 9.4 lb. per bhp; Engine One Lycoming VO-435, 220 hp normal rated, or 240 hp at 3200 rpm takeoff; Fuel Capacity 34 gal.

PERFORMANCE

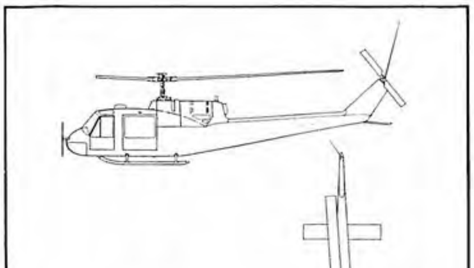
Maximum Speed 103 mph at 3000 ft.; Cruise Speed 90 mph at 5000 ft.; Rate of Climb 1075 fpm at Sea Level at G.W.; Service Ceiling 15,750 ft.; Range with Maximum Fuel Load 198 mi.

Bell HTL-7 (Navy)

Bell HU-1A Iroquois (Army)

REMARKS

The HU-1 Iroquois has been called by Bell an aerial hotrod. The turbine-powered helicopter can outclimb some World War II fighter planes, and 60 seconds after a pilot enters the cabin he can have the craft in flight one mile away. The Iroquois can carry from six to eight people, including crew. It's a single-rotor ship with conventional tail rotor and is powered by a free-turbine Lycoming T-53 engine, 860 horsepower derated to 770 at 6400 rpm. At its Fort Worth plant Bell is producing an undisclosed quantity of the HU-1 under a multi-million-dollar contract being administered by the Air Force.



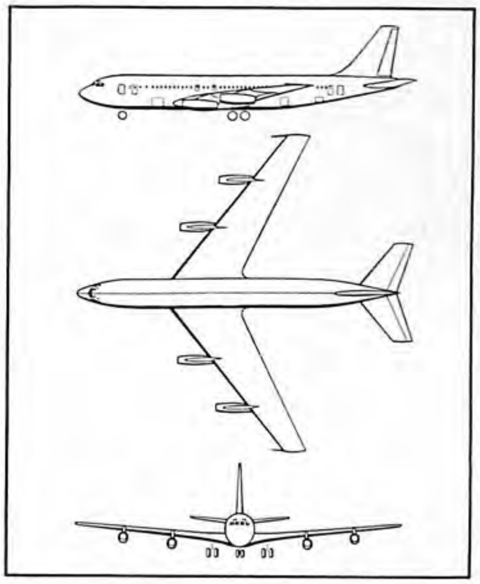
SPECIFICATIONS

Main Rotor Diameter 44 ft.; Length 42 ft. 8 in.; Height 11 ft. 4 in.; Empty Weight 3790 lb.; Engine One Lycoming T-53, 770 hp normal rated at 6400 rpm.

PERFORMANCE

Maximum Speed 142 mph; Cruise Speed 115 mph at Sea Level; Hovering Ceiling 14,400 ft.; Range with Maximum Fuel Load 210 mi.

BOEING AIRPLANE CO.
SEATTLE 14, 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 transoceanic 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 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 six Boeing jet airliners; the others are the 707-120, the 707-220, the 707-320, the 707-420 and the 720. 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 will be powered by Pratt & Whitney JT4 turbojet engines, larger and of greater thrust than the JT3.

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 (-120)

Span 130 ft. 10 in.; Height 38 ft. 5 in.; 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

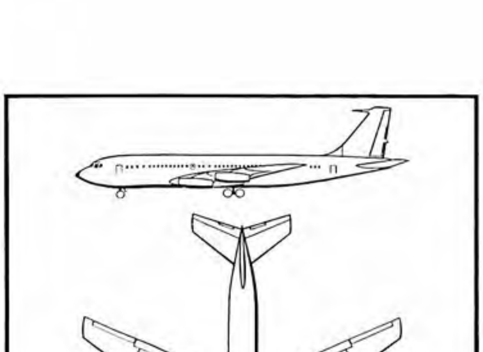
Cruise Speed 591 mph; Cruising Altitude 25,000 to 40,000 ft.

Boeing 707 Model 120 Jet Transport

Boeing 720 Jet Transport

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 througout 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, 149-passenger tourist arrangement.

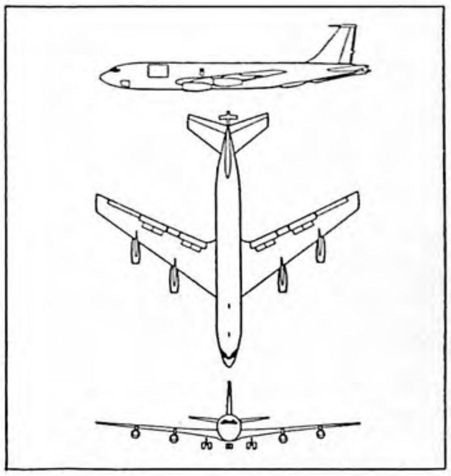


SPECIFICATIONS

Span 130 ft. 10 in.; Length 136 ft. 2 in.; Height 38 ft. 5 in.; Empty Weight 103,145 lb.; Engines Four Pratt & Whitney JT3C-7; Fuel Capacity 11,500 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.



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.

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 KC-135 Jet Tanker-Transport

Boeing B-52G Missile Platform Bomber

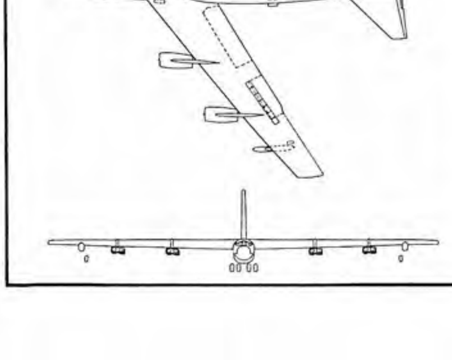
REMARKS

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 will continue through 1960 when it will be replaced by the new H model, in pre-production at year-end.

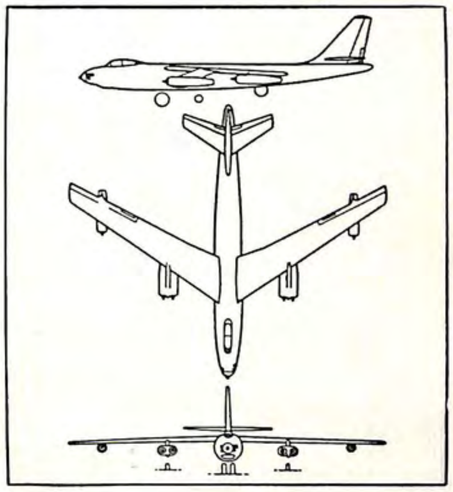


SPECIFICATIONS

Span 185 feet; Length 157 ft. 6.9 in.; Sweepback 35 deg.; Height 40 ft. 8 in.; Weight more than 450,000 lb.; Engines Eight Pratt & Whitney J57-43W 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 6,000 miles.



REMARKS

The first XB-47 flight took place December, 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.

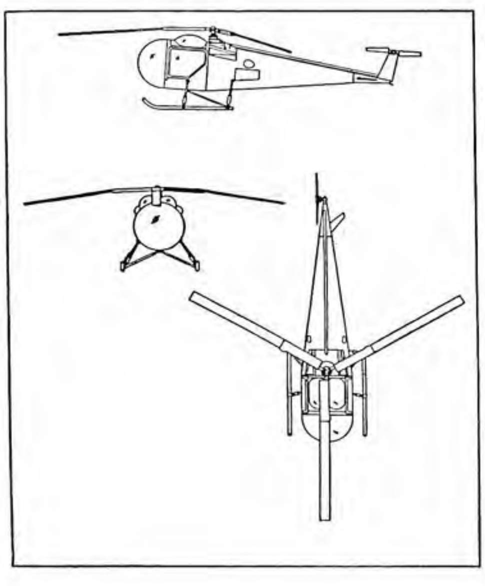
PERFORMANCE

Maximum Speed more than 600 mph; Service Ceiling over 40,000 ft.; Range more than 3000 mi.

Boeing RB-47E Medium Bomber

BRANTLY HELICOPTER CORP.
FREDERICK, OKLAHOMA

Brantly B-2



REMARKS

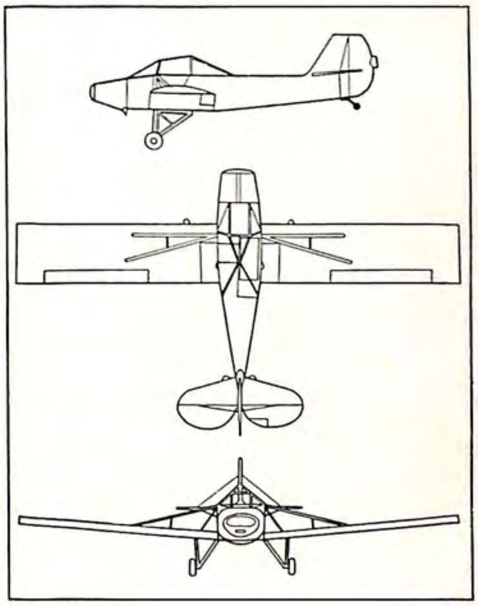
Type certificate 2H2 was awarded to the Brantly Helicopter Corporation, Frederick, Oklahoma, on April 27, 1959. 15 Model B-2 helicopters had been delivered at year-end.

SPECIFICATIONS

Height 6 ft. 11.75 in.; Empty Weight 990 lb.; Rotor Diameter 23.9375 ft.; Wing Loading 3.58 lb. per sq. ft.; Power Loading 9.04 lb. per bhp; Engines VO 360 AIA Lycoming, 177 hp normal rated; Fuel Capacity 31 gal.

PERFORMANCE

Maximum Speed 100 mph at 138 hp at 2900 rpm at Sea Level; Cruise Speed 90 mph at 110 hp at 2900 rpm at Sea Level; Rate of Climb 1580 fpm at Sea Level; Service Ceiling 9600 ft.; Absolute Ceiling 10,300 ft.; Range with Maximum Fuel Load 300 mi.



REMARKS

Fuel tanks are in the wing panels for added safety and increased capacity. This model is a very high performing agricultural airplane. CallAir also manufactures the A-5 agricultural plane, identical in outward appearance to the A-6. Maximum speed of the A-5 is 100 miles per hour; optional equipment includes canopy, starter, generator, spray equipment or dust equipment or a combination of both which is quick change. Both the models A-6 and A-5 are designed especially to give maximum pilot protection in the event of an accident.

SPECIFICATIONS

Span 35 ft. 5¼ in.; Length 23 ft. 9½ in.; Height 7 ft. 10 in.; Empty Weight 1170 lb.; Wing Loading 12.63 lb. per sq. ft.; Power Loading 13.05 lb. per bhp; Engine Lycoming O-360-C1A, 180 hp normal rates; Fuel Capacity 40 gal.; Propeller Constant Speed; Wing Area 186.1 sq. ft.; Aileron Area included sq. ft.

PERFORMANCE

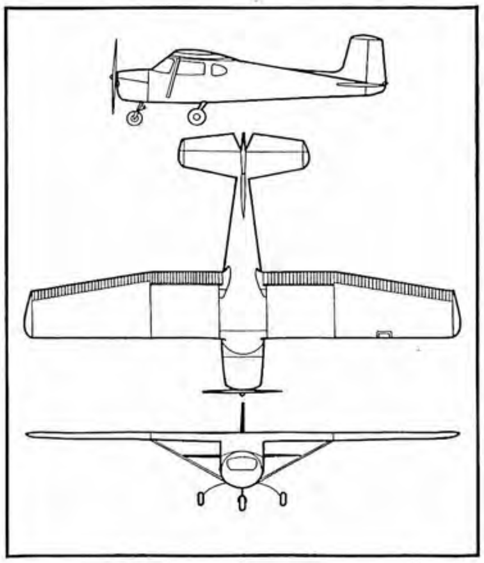
Maximum Speed 120 mph at 180 hp at 2700 rpm at 6000 ft.; Cruise Speed 110 mph at 75 percent hp at 6000 ft.; Landing Speed 42 mph; Rate of Climb 1100 fpm at 6000 ft.; Service Ceiling 18,000 ft.; Range with Maximum Payload 350 mi.; Range with Maximum Fuel Load 350 mi.

CallAir A-6 Agricultural Airplane

CESSNA AIRCRAFT CO.
WICHITA 14, KANSAS

Cessna 150 High-Wing Monoplane

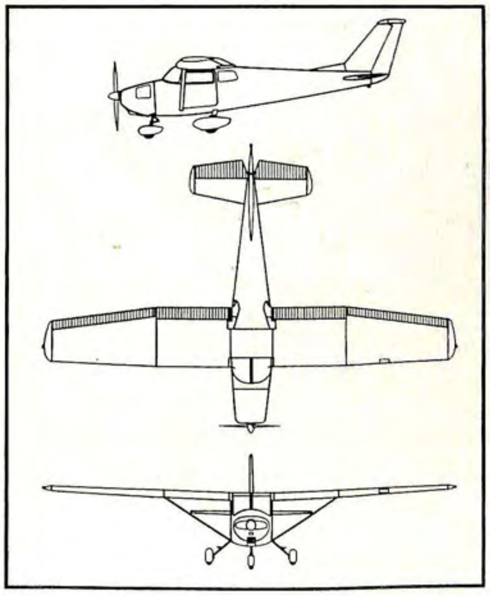
REMARKS
Cessna Model 150 marks the company's re-entry into the two-place market after seven years absence. The 150 was designed for use as a trainer, for charter and rental, and as a two-place business airplane. 600 orders were booked the first day the plane was introduced. Patroller version with extended range, transparent doors and message chute also available. The 150 is available in three models: the standard, the trainer, and the "inter-city" commuter.



SPECIFICATIONS
Span 33 ft. 4 in.; Length 21 ft. 6 in.; Height 6 ft. 11 in.; Empty Weight 946 lb.; Wing Loading 9.4 lb. per sq. ft.; Power Loading 15 lb. per bhp; Engine One Continental O-200-A (4-cylinder), 100 hp Max or continuous, or 100 hp at 2750 rpm takeoff; Fuel Capacity 26 gal.; Propeller Sensenich M69CK-52; 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 124 mph at 100 hp at 2750 rpm at Sea Level; Cruise Speed 121 mph at 70 percent hp at 2650 rpm at 9000 ft.; Landing Speed 54 mph flaps up—50 mph flaps down; Rate of Climb 740 fpm at Sea Level; Service Ceiling 15,300 ft.; Range with Maximum Fuel Load 520 mi. at max. cruise; range 630 mi. using 43 percent power at 10,000 ft. (economy cruise).

Cessna 172



REMARKS

The four-place all-metal model 172 was introduced in 1956 with new "Land-O-Matic" gear to make flying easier primarily for businessmen learning to fly. The low center of gravity allowed by the new type gear provides excellent maneuverability, ease of landing, and ground handling. The all-metal airplane is also equipped with "Para-Lift" flaps for greater lift on takeoff runs and slow, easy descent when landing. More than 3000 have been manufactured and delivered since the airplane was first introduced. The 172 holds the world endurance flight record.

SPECIFICATIONS

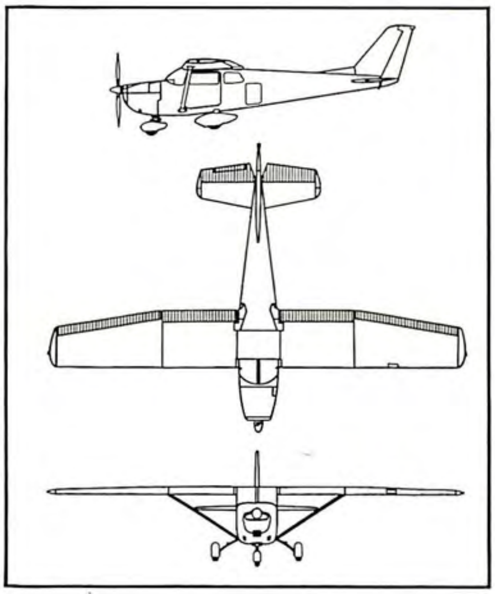
Span 36 ft.; Length 26 ft. 4 in.; Height 8 ft. 11in.; Empty Weight 1252 lb.; Gross Weight 2200 lb.; Wing Loading 12.6 lb. per sq. ft.; Power Loading 15.2 lb. per bhp. Engine Continental O-300-C (six cylinder), 145 hp; Fuel Capacity 42 U. S. gal.; Propeller McCauley all-metal fixed pitch; Wing Area 174 sq. ft.

PERFORMANCE

Maximum Speed 140 mph at 145 hp at Sea Level; Cruise Speed 131 mph at maximum recommended cruise, 8000 ft. at 70 percent power; Rate of Climb 730 fpm at Sea Level; Service Ceiling 15,100 ft.; Range with Maximum Payload 545 mi. or 4.2 hours at 131 mph true air speed; Range with Maximum Fuel Load 790 mi. or 8.3 hours with true air speed of 95 mph.

REMARKS

The four-place Model 175 was introduced in 1958 to expand the low price field and to offer a faster and higher performance airplane between the Cessna 172 and the Cessna 180-182 and Skylane. A new companion model, the Skylark, will be offered in 1960. The 175 is equipped with a new geared engine and a new type floating cowl suspension that offers unusually quiet and vibration-free operation. The airplane is also certificated for ski and float installations.



SPECIFICATIONS

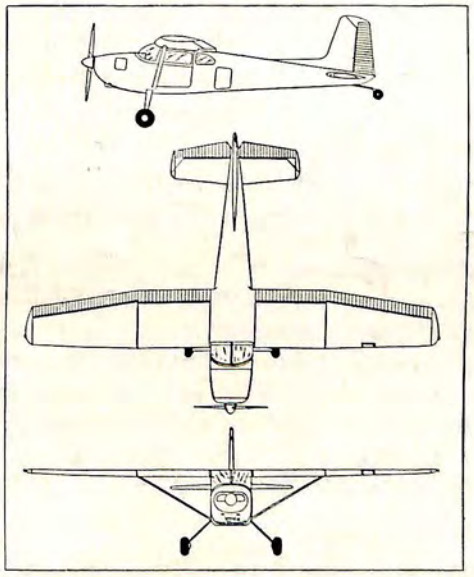
Span 36 ft:; Length 26 ft. 4 in.; Height 8 ft. 6 in; Empty Weight 1339 lb.; Wing Loading 13.5 lb. per sq. ft.; Power Loading 13.4 lb. per bhp; Engine One Continental GO-300-C six-cylinder, 175 hp at 3200 rpm takeoff; Fuel Capacity 52 gal.; Propeller McCauley FC 8467; Wing Area 175 sq. ft.; Aileron Area 18.30 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 147 mph at 175 hp at 3200 rpm at Sea Level; Cruise Speed 140 mph at 70 percent hp at 10,000 ft.; Landing Speed 53 mph flaps down—62 flaps up; Rate of Climb 850 fpm at Sea Level; Service Ceiling 15,900 ft.; Range at max. cruise speed 590 mi.; Range at economy cruise (max. range) 39 percent power at 10,000 ft. 755 mi.

Cessna 175 Four-Place Monoplane

Cessna Model 180



REMARKS

The Model 180 was first introduced by Cessna in 1953. Since that time it has attained world-wide recognition as a high-performance bush country airplane and is being used all over the world. The 180 is certificated for skiis and amphibian as well as standard floats. It is widely used in Alaska, Canada, and Central and South America in areas of rugged terrain.

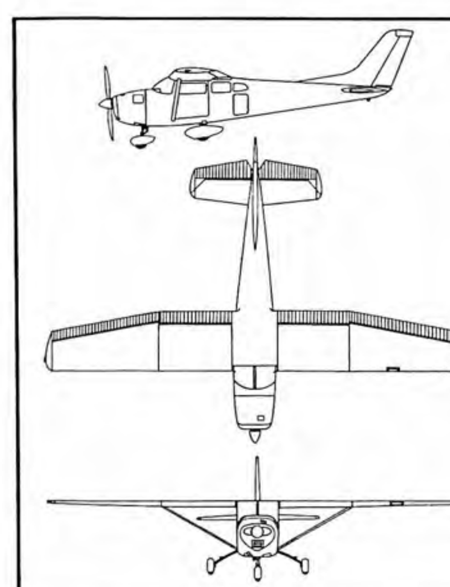
SPECIFICATIONS

Span 36 ft.; Length 26 ft.; Height 7 ft. 6 in.; Empty Weight 1530 lb.; Gross Weight 2650 lb.; Wing Loading 15.1 lb. per sq. ft.; Power Loading 11.5 lb. per bhp; Engine Continental O-470-L, 230 hp at 2600 rpm; Fuel Capacity 65 gal.; Propeller All-Metal constant speed; Wing Area 174 sq. ft.

PERFORMANCE

Maximum Speed at Sea Level 170 mph; Cruise Speed 160 mph; Rate of Climb 1130 fpm at Sea Level; Cruising Range 675 mi.; Service Ceiling 21,500 ft.; Maximum Range 845 mi.

Cessna Skylane



REMARKS

The Skylane is a deluxe version of the four-place 182, also being produced by Cessna, and sells fully equipped for a package price. The standard airplane is equipped with a full-panel, overall three-tone exterior paint design, tinted glass and wheel speed fairings. The new model was first introduced in 1958. The 182 was introduced in 1956 and more than 2,100 have been produced.

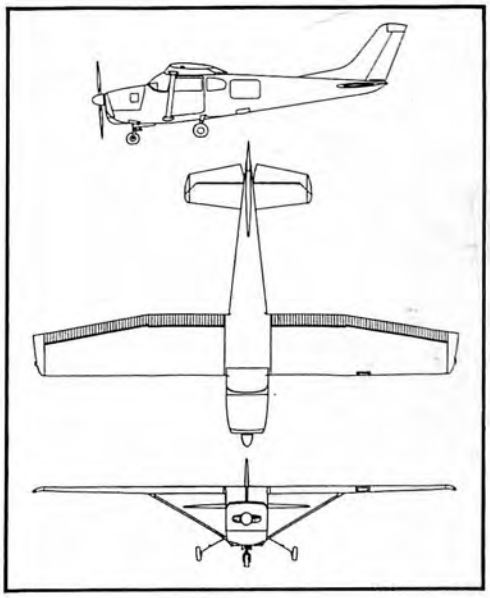
SPECIFICATIONS

Span 36 ft.; Length 27 ft. 1 in.; Height 9 ft. 9 in.; Empty Weight 1632 lb.; Wing Loading 15.1 lb. per sq. ft.; Power Loading 11.5 lb. per bhp; Engine One Continental O-470-L six-cylinder, 230 hp at 2600 rpm take-off; Fuel Capacity 65 gal.; Propeller Hartzell or McCauley all-metal constant speed; Wing Area 174 sq. ft.; Aileron Area 18.30 sq. ft.; Flap Area 21.23 sq. ft.; Fin Area 11.20 sq. ft.; Rudder Area 6.95 sq. ft.; Stabilizer Area 20.94 sq. ft.; Elevator Area 13.92 sq. ft.

PERFORMANCE

Maximum Speed 170 mph at 230 hp at 2600 rpm at Sea Level; Cruise Speed 160 mph at 70 percent hp at 8000 ft.; Landing Speed 62 mph flaps up-56 mph flaps down; Rate of Climb 1030 fpm at Sea Level; Service Ceiling 19,800 ft.; Range at Maximum cruise 70 percent power at 8000 ft. 675 mi.; Maximum Range 845 mi.

Cessna Model 210



REMARKS

An all new model, the 210 was introduced as an addition to Cessna's 1960 commercial line. It is a single-engine airplane with a combination of high wing and retractable landing gear. The 210 fits into the Cessna line between the Skylane and the twin Model 310D.

SPECIFICATIONS

Span 36.5 ft.; Length 26.4 ft.; Height 8.15 ft.; Empty Weight 1735 lb.; Wing Loading 16.5 lb. per sq. ft.; Power Loading 11.2 lb. per bhp; Engine Continental IO-470-E (fuel injection), 260 hp at 2625 rpm takeoff; Fuel Capacity 65 gal.; Wing Area 175.5 sq. ft.; Aileron Area 18.30 sq. ft.; Flap Area 21.23 sq. ft.; Fin Area 11.20 sq. ft.; Rudder Area 6.95 sq. ft.; Stabilizer Area 20.94 sq. ft.; Elevator Area 14.03 sq. ft.

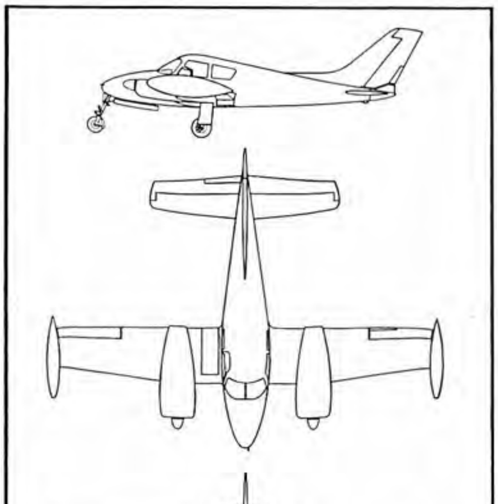
PERFORMANCE

Maximum Speed 199 mph at 260 hp at 2625 rpm at Sea Level; Cruise Speed 190 mph at 75% power at 7000 ft.; Landing Speed 59 mph; Rate of Climb 1300 fpm at Sea Level; Service Ceiling 20,700 ft.; Absolute Ceiling 22,400 ft.; Range at Maximum Cruise 755 mi.; Maximum Range at Economy Cruise 1100 mi.

Cessna 310D

REMARKS

Outstanding performance and 220-mile-per-hour cruise are standard on this five-place model. Oxygen and 30-gallon auxiliary fuel system are available as optional equipment. The new 310D was to be introduced in January, 1960. Comfort and convenience changes plus new "flight sweep" styling of the vertical fin are included in the new 310D model.

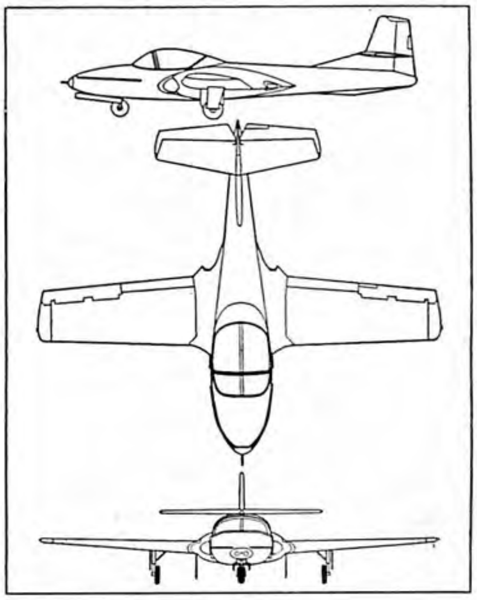


SPECIFICATIONS

Span 36 ft.; Length 29.5 ft.; Height 9.93 ft.; Empty Weight 3037 lb.; Gross Weight 4830 lb.; Wing Loading 27.6 lb. per sq. ft.; Power Loading 9.3 lb. per bhp; Engines Two Continental IO-470-Ds 260 hp with fuel injection rated at 2625 rpm; Fuel Capacity 100 gal. carried in wing tip tanks, no inboard fuel as standard; Propeller constant speed full feathering; Gear tricycle; Wing Area 175 sq. ft.

PERFORMANCE

Maximum Speed at Sea Level 242 mph; Cruise Speed 220 mph; Rate of Climb 1800 fpm; Service Ceiling 21,300 ft.; Range with Maximum Payload 825 mi.; Maximum Range with Auxiliary Fuel 1440 mi.



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. The T-37B, with higher thrust engines and increased communication and navigation equipment, entered Air Force service in November, 1959.

SPECIFICATIONS

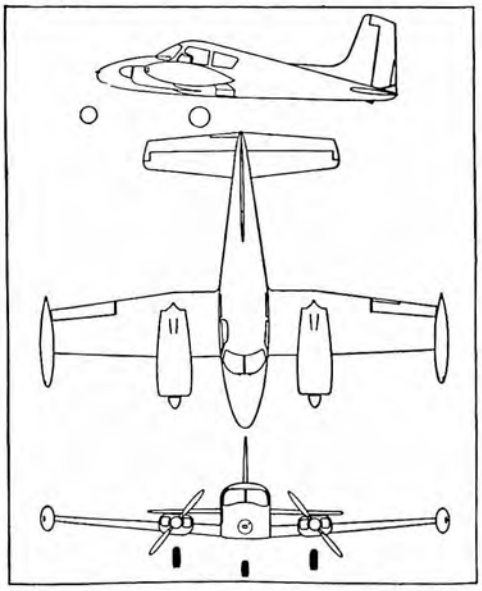
Span 33 ft. 9 in.; Length 29 ft. 3 in.; Height 9 ft. 2 in.; Empty Weight 4061 lb.; Wing Loading 35.7 lb. per sq. ft.; Power Loading 3.2 lb. per lb. of thrust; Engines Two Continental J69-T25s, 880 lb. thrust normal rated, or 1025 lb. thrust at 21,730 rpm takeoff; Fuel Capacity 321 gal.; Wing Area 183.9 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 T-37B Trainer

Cessna U-3A



REMARKS

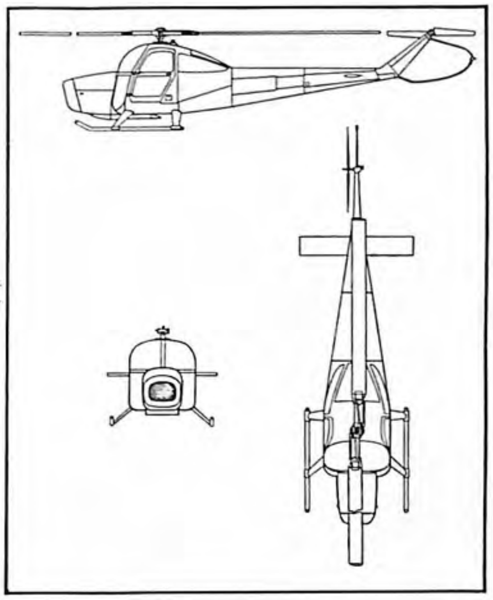
The U-3A is an off-the-shelf version of the Cessna Model 310 and was purchased by the Air Force to meet the need for low-cost and low-maintenance administrative and light cargo transportation. Air Force has purchased 160 of the light twins.

SPECIFICATIONS

Span 36 ft.; Length 26 ft.; Height 10 ft. 6 in.; Empty Weight 3146 lb.; Gross Weight 4830 lb.; Wing Loading 27.6 lb. per sq. ft.; Power Loading 10.05 lb. per bhp; Engines Two Continental O-470-M, 240 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 14.08 sq. ft.; Rudder Area 11.78 sq. ft.; Stabilizer Area 32.15 sq. ft.; Elevator Area 22.1 sq. ft.

PERFORMANCE

Maximum Speed 230 mph at 240 hp at 2600 rpm at Sea Level; Cruise Speed 210 mph at 70 percent hp at 2300 rpm at 8000 ft.; Landing Speed 95 mph (single-engine go around); Rate of Climb 1590 fpm at Sea Level; Service Ceiling 20,000 ft.; Absolute Ceiling 21,300 ft.; Range with Maximum Fuel Load 1125 st. mi.



REMARKS

Cessna introduced a new helicopter, embodying inherent stability characteristics comparable to those of a fixed wing aircraft, to the armed forces in mid-1959. The new helicopter, designated the CH-1C, represents a substantial technical advancement which qualifies the ship for instrument flight operation without the necessity for electronic stabilizing devices. In addition to its instrument capability, the CH-1C was designed for reconnaissance-observation, light personnel transport, and instrument training missions. It is a four-place helicopter with a maximum gross weight of 3100 pounds. It was officially approved by the FAA and issued a type certificate in late July, 1959. It is currently being demonstrated to all branches of the military service.

SPECIFICATIONS

Rotor Diameter 35 ft.; Power Loading 11.5 lb. per bhp; Engine Continental Motor FSO-470-A, 270 (net) hp normal rated, or 270 (net) hp at 3000 and 3200 rpm takeoff; Fuel Capacity 60 plus 30 aux. gal.

PERFORMANCE

Maximum Speed 122 mph; Cruise Speed 100-122 mph at S. L.; Rate of Climb 1030 fpm at 8000 ft.; Service Ceiling 15,200 ft.; Absolute Ceiling 15,600 ft.; Range with Maximum Payload 262 mi.; Range with Maximum Fuel Load 400 mi.

Cessna CH-1C Helicopter

CHAMPION AIRCRAFT CORP.
OSCEOLA, WISCONSIN

Champion Sky-Trac

REMARKS
Sky-Trac by Champion for 1959 is a brand new 140 hp two or three-place ship which cruises at 125 miles per hour, turns on a dime, has stall speed of 42 miles per hour, has a 719 pound payload and can take off or land over a 50-foot obstacle fully loaded. It is completely adaptable for spray use, for floats or skis.

SPECIFICATIONS
Span 33 ft. 5 in.; Length 22 ft. 1 in.; Wing Loading 9.69 lb. per sq. ft.; Power Loading 12.22 lb. per bhp; Engine One Lycoming 0290-D2-B, 135 hp normal rates, or 140 hp at takeoff; Fuel Capacity 37 gal.; Propeller metal; No flaps.

PERFORMANCE
No data available.

REMARKS
Tri-Traveler by Champion for 1959 features tandem seating, extreme visibility, complete dual controls, new handsome interiors in harmony with exteriors, airline-type full gyro instrument panel, short landing and takeoff even without flaps, hydraulic brakes, improved no-bounce tricycle gear with fully steerable nose wheel that locks straight in flight.

SPECIFICATIONS
Span 35 ft. 2 in.; Length 21 ft. 8 in.; Height 8 ft. 8 in.; Empty Weight 968 lb.; Wing Loading 8.8 lb. per sq. ft.; Power Loading 16.5 lb. per bhp; Engine One 4-cylinder Continental model, 90C-12F, 90 hp normal rates, or 95 hp at takeoff; Fuel Capacity 26 gal.; Propeller metal; No flaps.

PERFORMANCE
Maximum Speed 135 mph; Cruise Speed 108 mph; Landing Speed 40 mph; Rate of Climb 900 fpm.

Champion Tri-Traveler

CHANCE VOUGHT AIRCRAFT, INC.
DALLAS, TEXAS

REMARKS
The Crusader III, a Mach 2-plus, highly automated, all-weather fighter, is serving the National Aeronautics and Space Administration in studies of noise problems in supersonic aircraft, automatic pilot projects and high speed tracking by radar. Designed into the plane, which made its first flight June 2, 1958, is an advanced automatic flight control system and an airborne missile control system which allows the pilot maximum concentration on his mission. The aircraft can climb, cruise, orbit and hold a heading at the push of a button. In appearance the F8U-3 resembles the F8U-1 but is of a completely re-engineered design. It is larger, has a longer pointed nose, forward swept airscoop and, like the F8U-1 and 2, a two-position wing, a feature of the Crusader series. Supplementing the wing is a boundary layer control system. Two movable ventral fins located near the tail extend horizontally in low-speed flight and are turned downward at a nearly 90 degree angle to give additional stability at the very high Mach numbers at which the aircraft operates.

SPECIFICATIONS
Span 39 ft. 11.4 in.; Length 58 ft. 8.8 in.; Height 16 ft. 4.5 in.; Engine Pratt & Whitney J75.

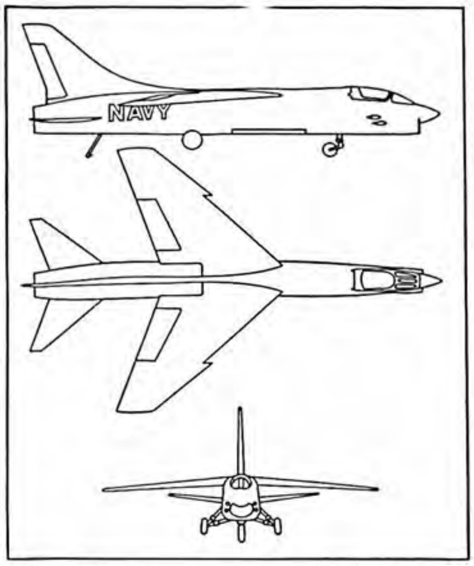
PERFORMANCE
Maximum Speed above Mach 2.

Chance Vought F8U-3

REMARKS

The first production model F8U-2 made its initial flight at the Chance Vought Aircraft 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 to provide added stability at the higher speeds at which the F8U-2 operates 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 32 2.75-inch rockets. The F8U-2 is operational in Fleet units.

The 1000-mile-an-hour-plus F8U-1 Crusader currently is operating with Fleet squadrons both on land and at sea. The high-performance aircraft, in production at Chance Vought Aircraft at Dallas, added to its list of honors by winning for the Navy and Vought the Collier Trophy in December, 1957, and earning for Vought in March, 1958, the first Certificate of Merit awarded by the Navy Bureau of Aeronautics. The F8U-1 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 32 2.75-inch rockets.



SPECIFICATIONS

Span 35 ft. 8 in.; Length 54 ft. 2.75 in.; Height 15 ft. 9.1 in.; Engine Pratt & Whitney J57 P-16.

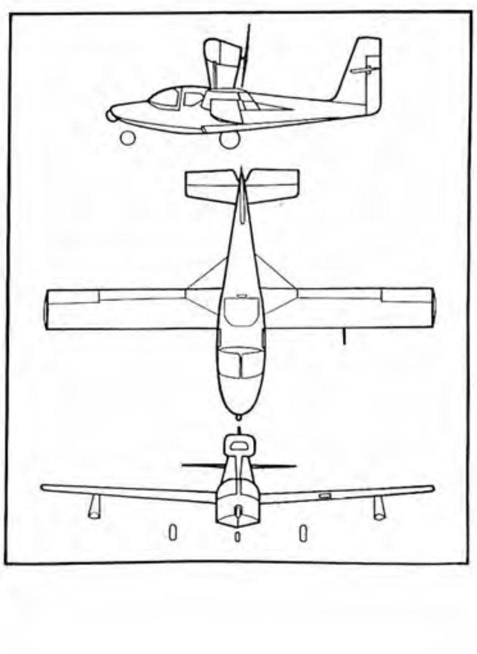
PERFORMANCE

Maximum speed approaching Mach 2.

Chance Vought F8U-2

COLONIAL AIRCRAFT CORP.
SANFORD, MAINE

Colonial C-2 Skimmer IV



REMARKS

The four-place model C-2 is a single-engine amphibian in production. Excellent short-field capabilities, along with extreme stability during water operation, are key features of the Skimmer. The fuel tank is located in the hull, behind the baggage compartment. Landing gear and flaps are hydraulic and the nose wheel, when retracted, extends partially from the bow serving as nose bumper.

SPECIFICATIONS

Span 34 ft. 2 in.; Length 23 ft. 6 in.; Height 9 ft. 4 in.; Empty Weight 1525 lb.; Gross Weight 2350 lb.; Wing Loading 15 lb. per sq. ft.; Power Loading 13 lb. per bhp; Engine One Lycoming O-360, 180 hp normal rates; Fuel Capacity 40 gal.; Propeller Hartzell Metal-Blade; Wing Area 156 sq. ft.

PERFORMANCE

Maximum Speed 136 mph at 180 hp at 2700 rpm at 8000 ft.; Cruise Speed 130 mph at 135 hp at 2400 rpm at 8000 ft.; Landing Speed 52 mph; Rate of Climb 800 fpm at Sea Level; Service Ceiling 15,000 ft.; Absolute Ceiling 18,000 ft.; Range with Maximum Payload 500 mi.; Range with Maximum Fuel Load 600 mi.

CONVAIR, A DIVISION OF GENERAL DYNAMICS CORP.

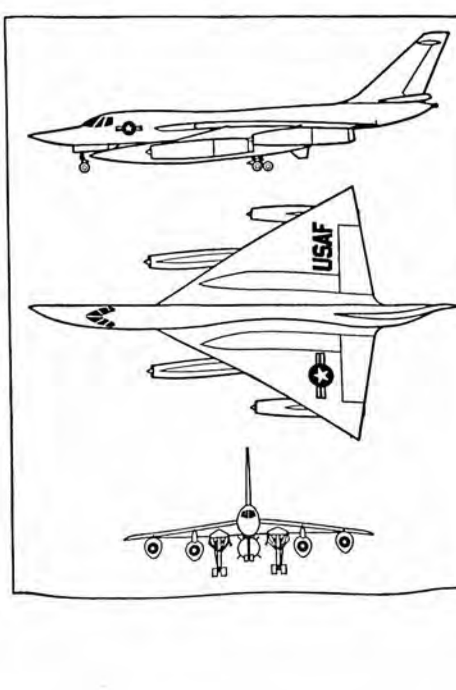
SAN DIEGO 12, CALIFORNIA

Convair B-58 Hustler

REMARKS

Flight testing of the supersonic B-58 Hustler bomber was intensified during 1959, with both Convair-Fort Worth and the B-58 Task Force at nearby Carswell Air Force Base conducting various phases of the program. The test fleet of aircraft logged several hundred hours of supersonic flight time and conducted numerous system tests, pod drops, and refueling missions. In one series of flight tests, the B-58 successfully demonstrated its ability to sneak under radar defenses to strike at enemy bases by making a hedge-hopping flight of 1400 miles from Fort Worth to Edwards Air Force Base, California, flying at 700 miles per hour at less than 500 feet above ground.

First tactical model of the B-58 was scheduled for delivery to the Air Force Strategic Air Command in October 1959. The Mach 2 B-58 was first flown November 11, 1956. Developed by Convair for the Air Force, the bomber carries its strategic striking power in a missile-like pod under the fuselage. The pod may carry additional fuel, lethal bombs, reconnaissance cameras, or electronic counter-measures equipment. The Hustler employs the Convair-pioneered delta wing for speed and stability, even in the thin air of the stratosphere.

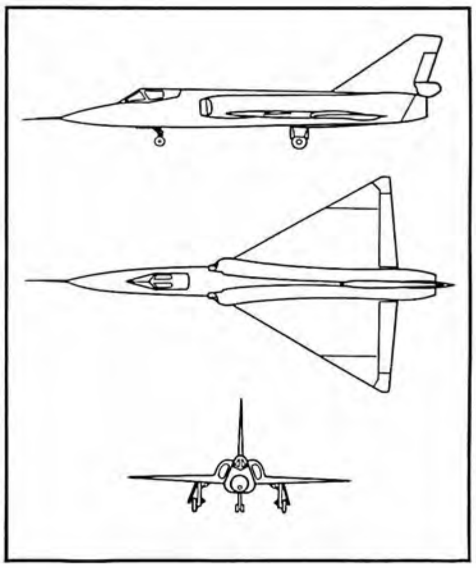


SPECIFICATIONS

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 50,000 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).



REMARKS

The single-seat F-106A carries Hughes Falcon GAR-3 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.

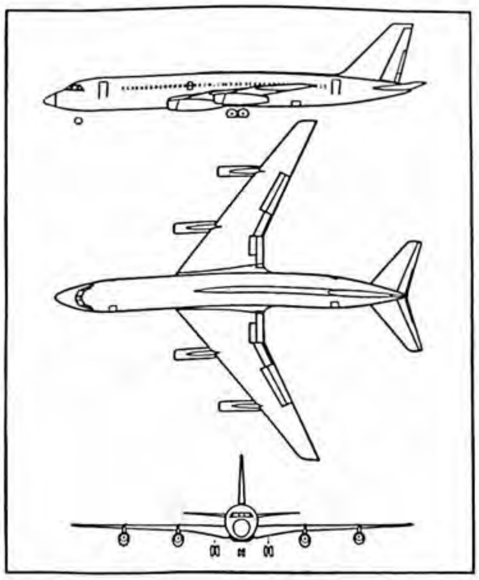
PERFORMANCE

Maximum Speed Mach 2 plus; Landing Speed 166.75 mph (All other details are classified); Ceiling above 50,000 ft.

Convair F-106A Delta Dart Interceptor

REMARKS

The basic Convair 880 was designed specifically for favorable operating costs on flights ranging from 300 miles up to transcontinental distances. The intercontinental Convair 880 retains the basic 880's medium-range capability and economy and also embodies the extra fuel capacity needed to extend the aircraft's range to transoceanic service. Both Convair 880s can cruise at 615 miles per hour. Range of the basic 880, with first-class payload and normal fuel reserves, is 3450 statute miles. The additional fuel capacity of the intercontinental 880 extends its range with normal fuel reserves to 4210 statute miles. In a first-class, four-abreast seating arrangement, Model 880 carries 88 passengers. In its five-across standard coach seating, it will carry 110 persons. First flight of the basic Convair 880 was January 27, 1959, that of the intercontinental in the fall of 1960. Initial 880 airline service will begin in the spring of 1960, following exhaustive Convair and Federal Aviation Agency flight tests utilizing three production aircraft.



SPECIFICATIONS

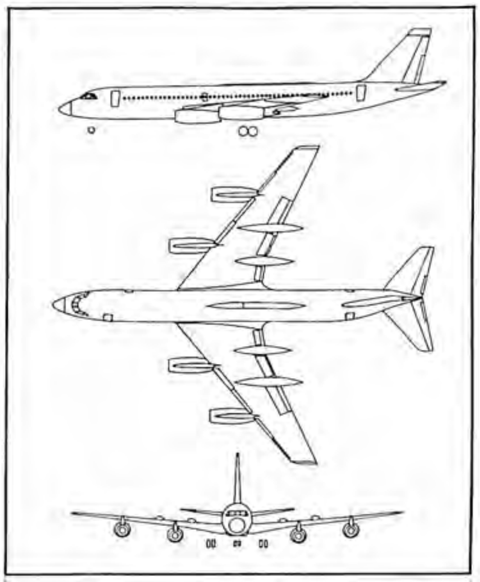
Span 120 ft.; Length 129 ft. 4 in.; Height 36 ft. 3.7 in.; Empty Weight 84,300 lb.; Wing Loading 92.25 lb. per sq. ft. at maximum to weight of 184,500 lb.; Engines Four General Electric CJ805-3 turbojet, each with 11,200 lb. thrust; optional, General Electric CJ805-3B with 11,650 lb. static thrust; Fuel Capacity 10,770 gal.; Wing Area 2000 sq. ft.; Rudder Area 82.4 sq. ft.; Elevator Area 88.3 sq. ft.; Horizontal Tail Area 395 sq. ft.; Vertical Tail Area 295 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 3700 fpm at Sea Level; Service Ceiling 40,000 ft., 8000 ft. cabin altitude at 40,000 ft. airplane altitude, 8.2 psi cabin pressure differential; Range with Maximum Payload 3450 s. mi.; Range with Maximum Fuel Load 3450 s. mi., reserve fuel for 200 nautical mi. plus ¾ hr.

Convair 880 Commercial Jet Transport

Convair 600 Jet Transport



REMARKS

The Convair 600 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 4400 miles or premium speed trips up to 2860 miles. The CJ-805-23 engines, which power the 600, 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. Also helping to make possible the tremendous speed of Model 600 is use of four "speed capsules." 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 600's large fuel capacity comes from the fact that these speed capsules also function as fuel tanks. The plane can seat 96 first-class passengers in the regular four-across, wide-aisle, deluxe version and in the six-place lounge. A five-across, standard coach seating arrangement can accommodate 121 passengers. American Airlines has ordered 25 Convair 600 jet airliners and has taken an option on an additional 25. Swissair and SAS have ordered nine with an option for four more. Deliveries will begin in March, 1961.

SPECIFICATIONS

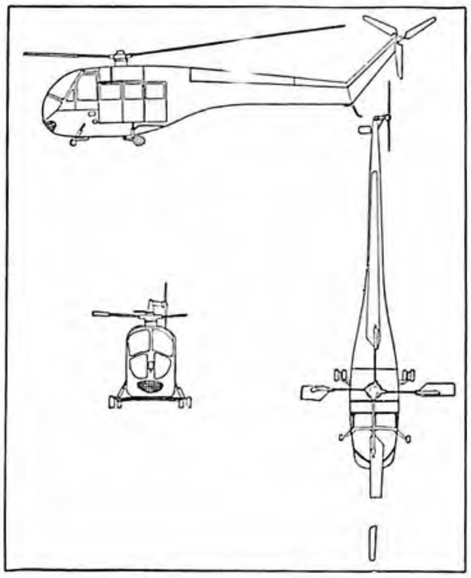
Span 120 ft.; Length 139 ft. 5 in.; Height 39 ft. 6 in.; Empty Weight 110,750 lb.; Wing Loading 106 lb. per sq. ft. at maximum to weight 238,200 lb.; Engines Four General Electric CJ805-23 aft-fan turbojet, each with 16,100 lb. static thrust; Fuel Capacity 15,110 gal.; Wing Area 2250 sq. ft.; Rudder Area 82.4 sq. ft.; Elevator Area 98.0 sq. ft.; Horizontal Tail Area 426.5 sq. ft.; Vertical Tail Area 295 sq. ft.

PERFORMANCE

Maximum Speed 635 mph at maximum cruise thrust at 21,500 ft.; Cruise Speed 570 mph at Mach 0.86 at 35,000 ft.; Landing Speed 137 mph, 1.3 Stall Speed, Landing Weight 151,000 lb.; Rate of Climb 3200 fpm at Sea Level; Service Ceiling 40,000 ft., 8000 ft. cabin altitude at 40,000 ft. airplane altitude, 8.2 psi cabin pressure differential; Range with Maximum Payload 4250 mi.; Range with Maximum Fuel Load 4400 mi., reserve fuel for 200 nautical mi. plus ¾ hr.

DOMAN HELICOPTERS, INC.
DANBURY, CONNECTICUT

REMARKS
The Doman LZ-5 features a simplified rotor system that is completely enclosed, self-lubricated, and simple in appearance, fabrication, and operation. Blade flapping and drag hinges, dampers, and grease fittings, long employed in conventional rotors, are completely eliminated on the Doman. All moving parts, including controls, are located within the rotor head and protected from the elements. No post-flight maintenance is required. Equipped with an eight-cylinder 400 horsepower Lycoming engine, the LZ-5 has a FAA certified gross weight of 5200 pounds and will carry a payload of one ton, a payload gross weight ratio unmatched by any other helicopter up to 12,000 pounds gross weight.



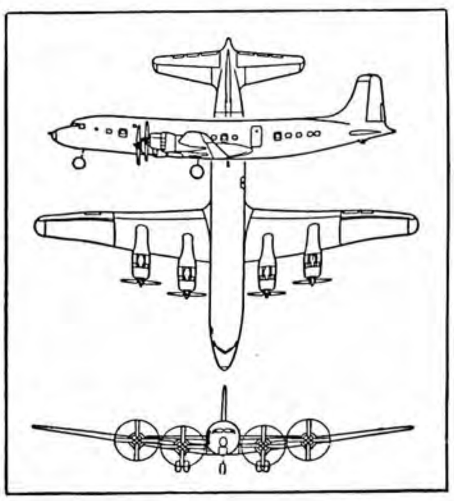
SPECIFICATIONS
Length 38 ft.; Height 10 ft. 5 in.; Empty Weight 3250 lb.; Main Rotor Diameter 48 ft.; Tail Rotor Diameter 10 ft.; Engine Lycoming SO-580-A1B, 400 hp at 3300 rpm takeoff; Fuel Capacity 119 gal.

PERFORMANCE
Maximum Speed 100 mph; Cruise Speed 81 mph; Range with Standard Fuel Load 486 mi.

Doman LZ-5

DOUGLAS AIRCRAFT CO., INC.
SANTA MONICA, CALIFORNIA

Douglas DC-6B Transport



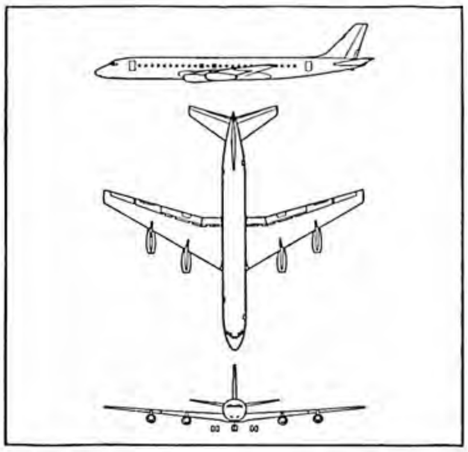
REMARKS
The DC-6A and DC-6B transports are enlarged versions of the DC-6s which first flew February 15, 1946. First step in the evolution was the DC-6A Liftmaster first flown on September 29, 1949. This was followed by the DC-6B, first flown February 10, 1951. Twenty-seven of the world's leading airlines have purchased 270 airplanes of the DC-6B configuration and 12 commercial airlines have ordered more than 44 of the DC-6A cargo carriers. Commercial sales of the DC-6 are past the 500 mark. The military has ordered the DC-6A series, designated C-118 by the Air Force and R6D-1 by the Navy. These can be converted to troop transports or hospital planes. 54 to 102 passengers.

SPECIFICATIONS
Span 117 ft. 6 in.; Length 106 ft. 6 in.; Height 28 ft. 8 in.; Empty Weight 58,340 lb.; Gross Weight 107,000 lb.; Wing Loading 73.1 lb. per sq. ft.; Power Loading 10.7 lb. per bhp; Engines Four Pratt & Whitney R-2800-CB-17, 2500 hp normal rated; Fuel Capacity 5512 gal.; Propeller Hamilton Standard full feathering reversible pitch; Gear tricycle, two sets of dual-type main wheels; Wing Area 1463 sq. ft.; Aileron Area 89 sq. ft.; Flap Area 229.4 sq. ft.; Fin Area 93.4 sq. ft.; Rudder Area 49 sq. ft.; Stabilizer Area 210.9 sq. ft.; Elevator Area 108.9 sq. ft.

PERFORMANCE
Maximum Speed 360 mph at 1750 hp at 2300 rpm at 18,700 ft.; Cruise Speed 315 mph at 1200 hp at 2300 rpm at 22,400 ft.; Landing Speed 106 mph; Rate of Climb 1100 fpm at Sea Level; Service Ceiling 21,900 ft.; Range with Maximum Payload 3393 mi.; Range with Maximum Fuel Load 4968 mi.

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

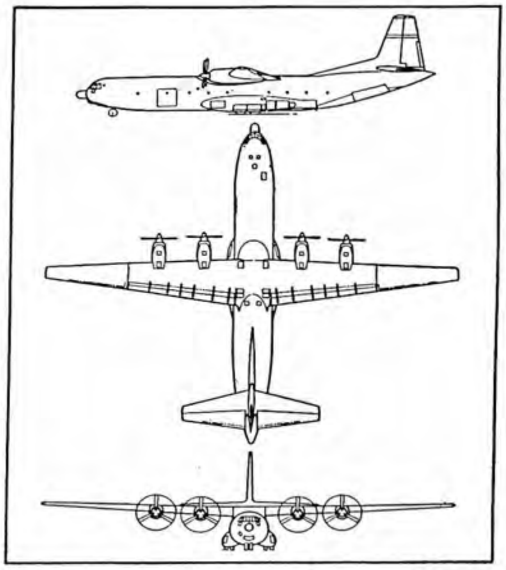
Span 142 ft. 5 in.; Length 150 ft. 6 in.; Height 42 ft. 4 in.; Empty Weight domestic 122,698 lb., intercontinental 128,082 lb.; extended range 130,539 lb.; T. O. Gross Weight domestic 273,000-276,000 lb., intercontinental 300,000 lb.; extended range 310,000 lb.; Wing Loading 96.1-107 lb. per sq. ft.; Engines Four turbojet: Fuel Capacity domestic 114,400 gal., intercontinental 151,000 gal.; Wing Area 2770.6 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 392 sq. ft.; Elevator Area 167.1 sq. ft.

PERFORMANCE

Speed 550 to 600 st. mph; Stall Speed at Maximum Landing Weight 116 to 119 st. mph; Design Landing Weight 189,000 to 199,500 lb.; Cruise Altitude 25,000 to 40,000 ft.; Takeoff Distance 7600 to 10,200 ft.; Payload 32,000 to 40,000 lb.; Range 5690 to 6050 st. mi.

Douglas DC-8 Jet Transport

Douglas C-133B Heavy Cargo Transport



REMARKS

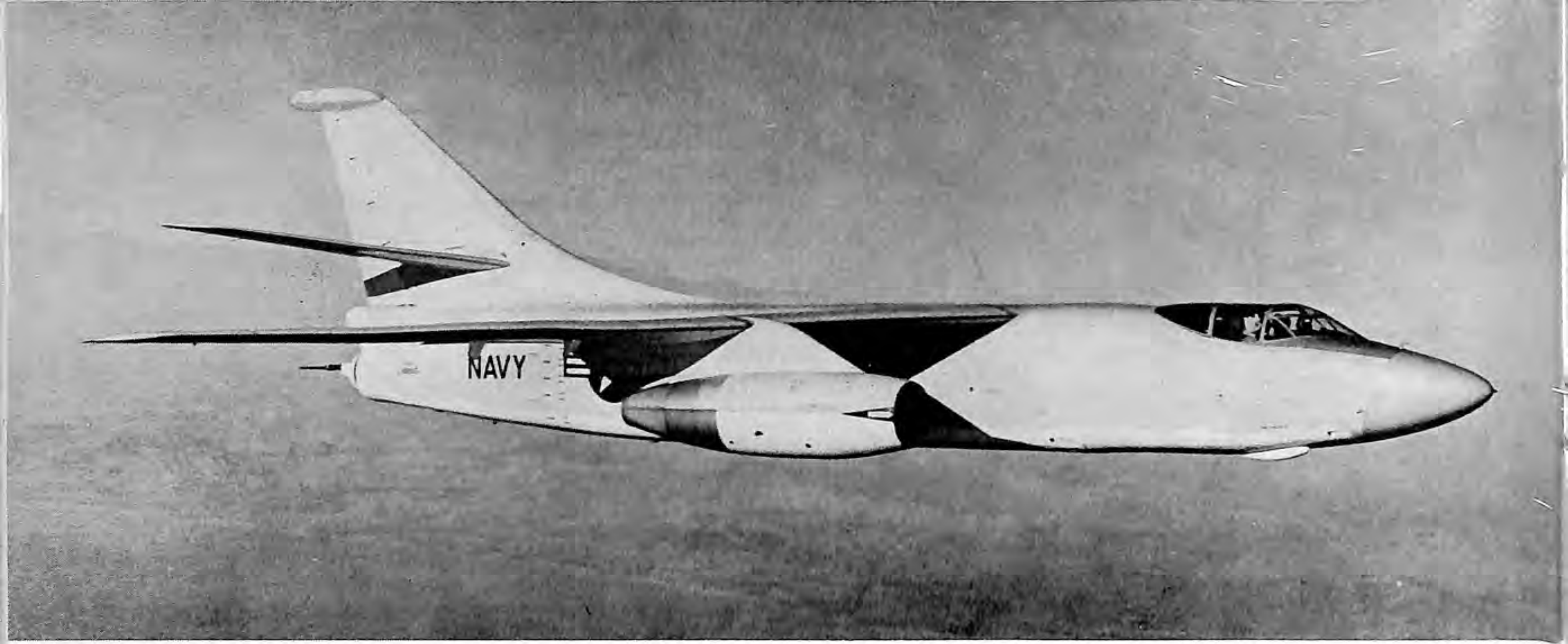
The C-133A and C-133B are capable of transporting any missile in the United States Arsenal, including the giant intercontinental ballistic missiles. It also can carry virtually all of Army field force equipment. Costly disassembly of large vehicles and equipment is unnecessary, and vehicles are ready 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. 3 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, 5600 eshp normal rated, or 7350 eshp at 11,000 rpm takeoff, Fuel Capacity 18,236 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

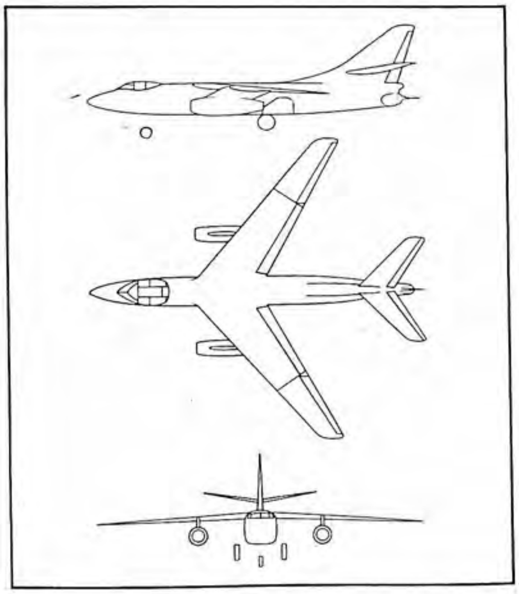
Maximum Speed 312 knots at Military Power at 286,000 lb. gr. wt. at 8700 ft.; Cruise Speed 284 knots at 95 percent normal rated power at altitudes varying from 17,200 ft. at 280,000 lb. to 35,000 ft. at 140,000 lb.; Landing Speed 117 knots at 250,500 lb.; Rate of Climb 1280 fpm at S. L. MIL power, at 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 2000 n. mi., 90,704 lb. cargo; Range with Maximum Fuel Load 3820 n. mi., 43,976 lb. cargo; Design Range 3500 n. mi., 51,889 lb. cargo.



Douglas A3D-2 Skywarrior Attack Bomber

REMARKS

Continuing in production at Douglas, El Segundo Division, A3D-2 Skywarriors are now flying in carrier squadrons as the Navy's most potent single striking force. The twin- jet bomber, mightiest ever to operate from an aircraft carrier, 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 counter-measures, and the A3D-2T, 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.)

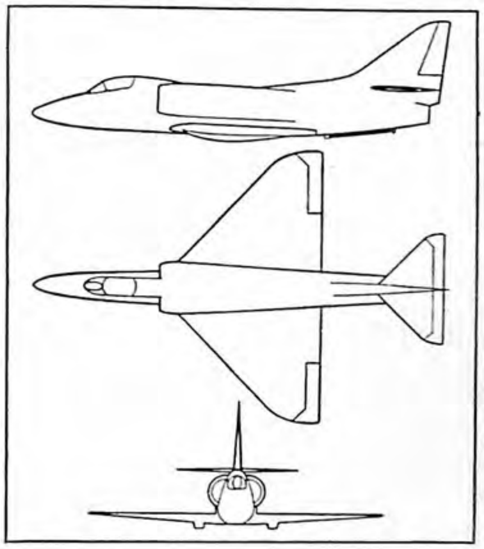


SPECIFICATIONS

Span 72 ft. 5 in.; Length 75 ft. 7 in.; Height 22 ft. 8 in.; Normal Gross Weight 70,000 lb.; Engines Two Pratt & Whitney J57s. Guns Two (auto. tail turret) 20 mm.; Crew Three (basic).

PERFORMANCE

Range more than 2500 n. mi. Other data classified.



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. The newest Skyhawk attack bomber now in production for the Navy and Marine Corps is the A4D-2N, equipped with advanced electronic instrumentation for all-weather navigation and weapon delivery.

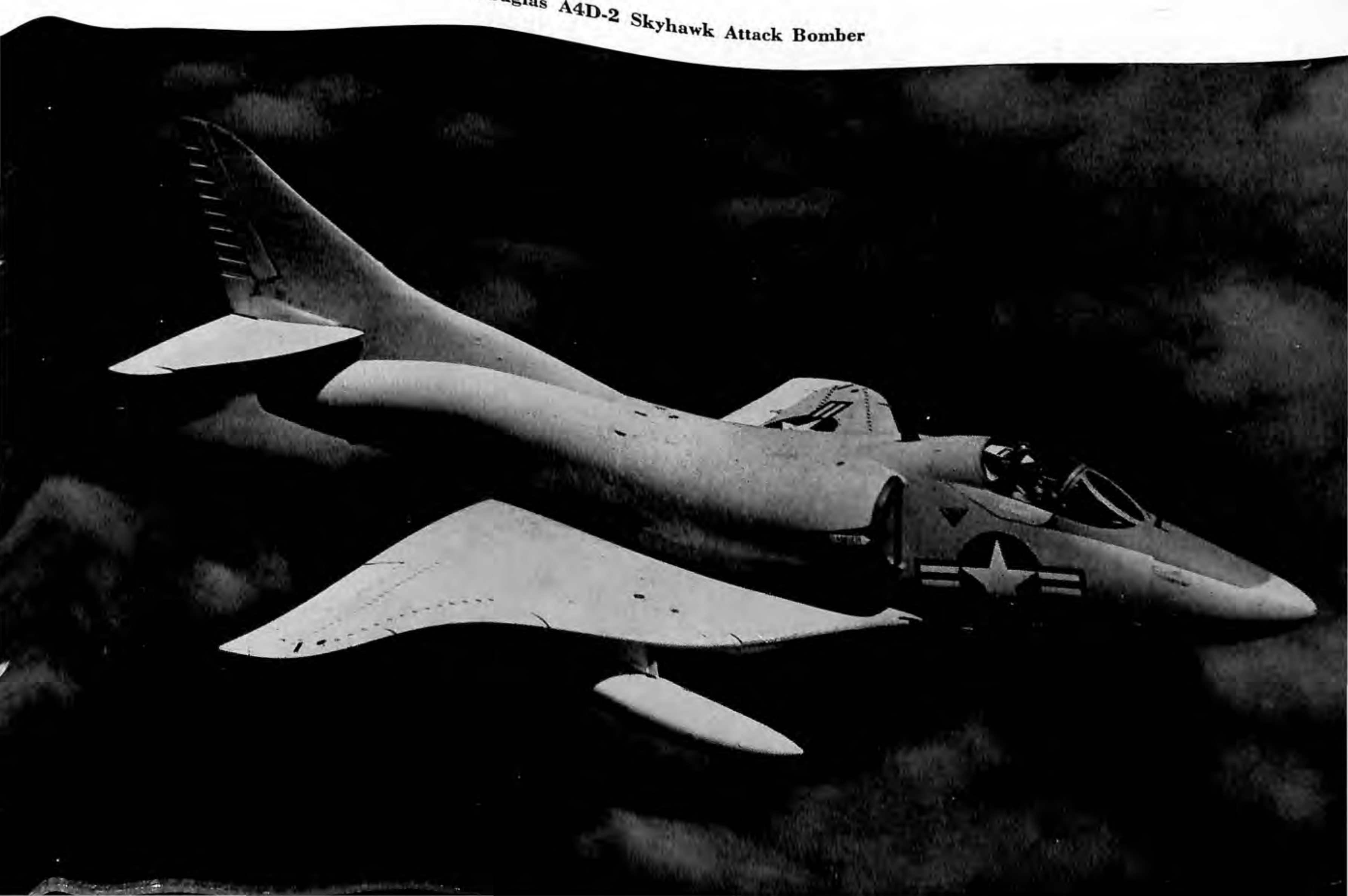
SPECIFICATIONS

Span 27 ft. 5 in.; Length 39 ft. 4 in.; Height 15 ft.; Gross Weight 15,000 lb. Engine Wright J65; Guns Two 20 mm.; Bomb-rocket-missile capacity 5000 lb.

PERFORMANCE

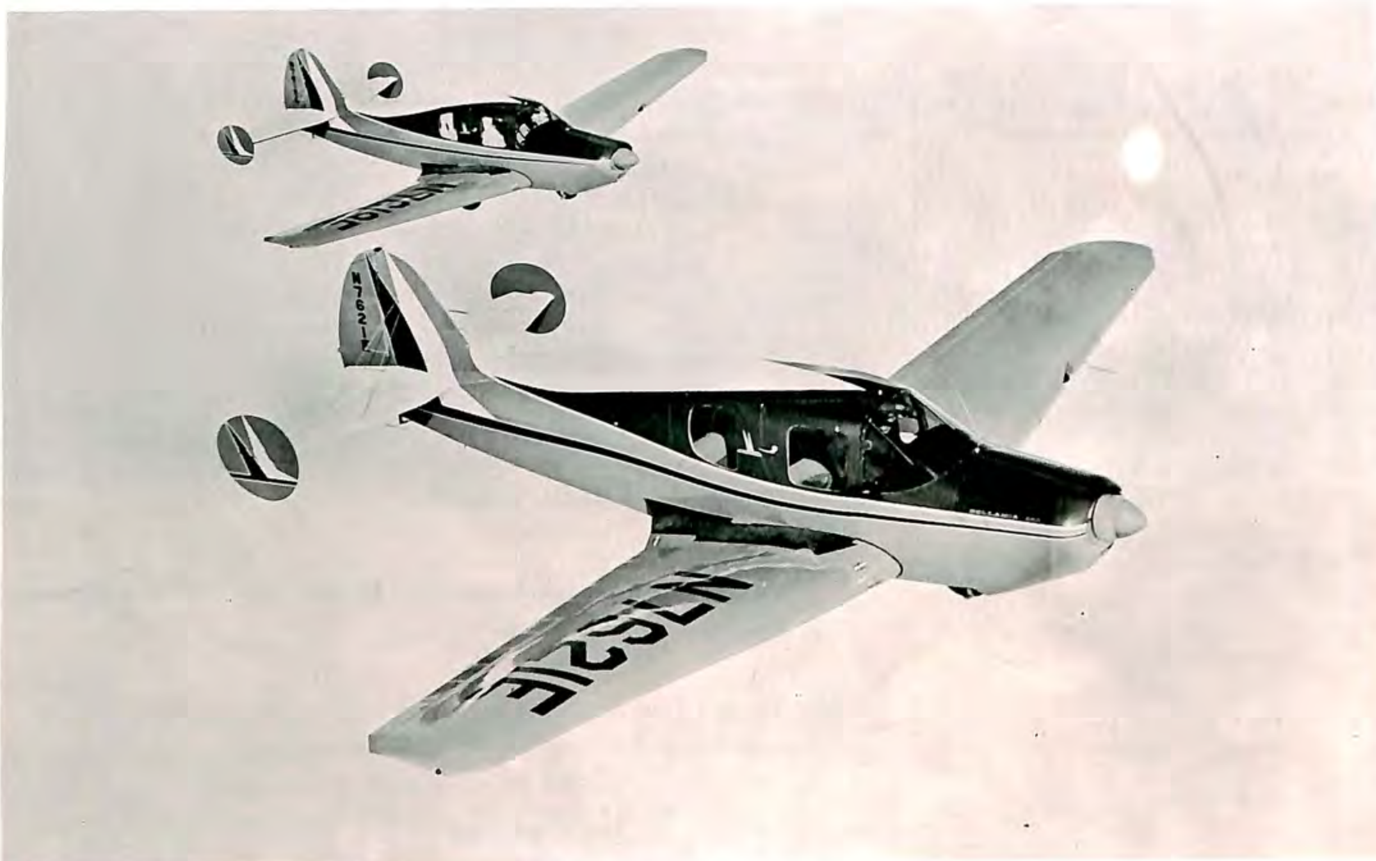
Range Transcontinental; Speed 600-700 mph class; Climb comparable to fighters.

Douglas A4D-2 Skyhawk Attack Bomber



DOWNER AIRCRAFT INDUSTRIES, INC.

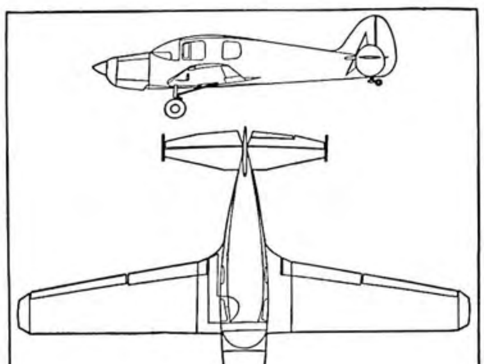
ALEXANDRIA, MINNESOTA



Downer-Bellanca 260

REMARKS

The name of the company was changed from Northern Aircraft, Inc. to Downer Aircraft Industries, Inc. effective January 1, 1959. Production of the Bellanca 260 was begun March, 1959. First flight of the prototype was on November 16, 1958. FAA type certification was secured on February 20, 1959, and first production airplane was delivered March 6, 1959. Current production rate is three airplanes each week. The Bellanca 260 is the descendant of a long line of Bellanca airplanes dating back to 1918.



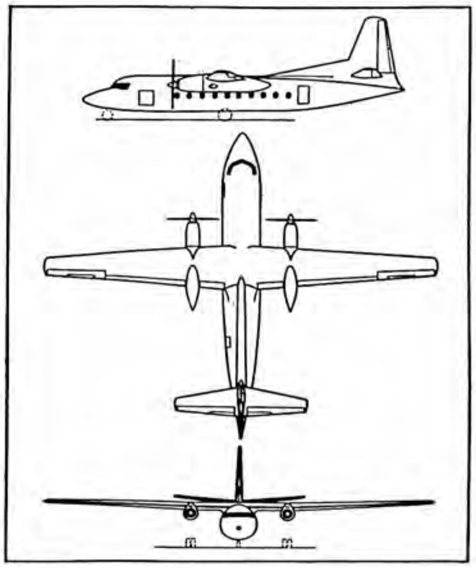
SPECIFICATIONS

Span 34 ft. 2 in.; Length 22 ft. 11 in.; Height 6 ft. 4 in.; Empty Weight 1690 lb.; Wing Loading 16.7 lb. per sq. ft.; Power Loading 10.4 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 9200 ft.; Cruise Speed 203 mph at 195 (75%) hp at 2450 rpm at 9200 ft.; Landing Speed 49 mph; Rate of Climb 1750 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.

FAIRCHILD AIRCRAFT AND MISSILES DIV.
FAIRCHILD ENGINE & AIRPLANE CORP.
HAGERSTOWN, MARYLAND



REMARKS

The Fairchild F-27 turbine-powered aircraft was placed in scheduled airline service when West Coast Airlines introduced F-27 service on its Northwest Pacific routes on September 28, 1958. In November, the first F-27 business propjet was delivered to the General Tire & Rubber Company. Designed for the medium and short-range requirements of regional airlines, the F-27 propjetliners offer interior seating arrangements for 36, 40 and 44 passengers. It introduces a number of passenger comforts in addition to vibrationless propjet power and speed. The pressurized F-27 is completely airconditioned by a self-contained system on the ground as well as in flight. The high-wing configuration provides inherent stability and makes possible faster ground loading and off loading. The deck is only 43 inches from the ground, at truck bed height, eliminating the need for special cargo loading equipment. As a business transport, the F-27 offers 300-mile-per-hour speeds, cross-country range and the same short takeoff and landing capability as its airline sister ship. The F-27 is available with either Rolls-Royce RDa 6/Mark 511 or Rolls-Royce RDa 7/Mark 528 propjet engines. At year-end, F-27s were being produced at the rate of five aircraft per month.

SPECIFICATIONS

Span 95 ft. 2 in.; Length 77 ft. 2 in.; Height 27 ft. 6 in.; Empty Weight 22,652 lb. (RDa 6), 24,520 lb. (RDa 7); Wing Loading 48 lb. per sq. ft.; Engine Rolls-Royce Dart RDa 6/Mark 511, 1600 shp at 14,500 rpm takeoff (Rolls Royce Dart RDa 7/Mark 528, 1910 shp at 15,000 rpm takeoff); Fuel Capacity 1320 gal. (Airline), 1660 gal. (Business); Propeller Rotol, four-blade, constant speed; Wing Area 754 sq. ft.; Aileron Area 37.6 sq. ft.; Total Flap Area 136.90 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.

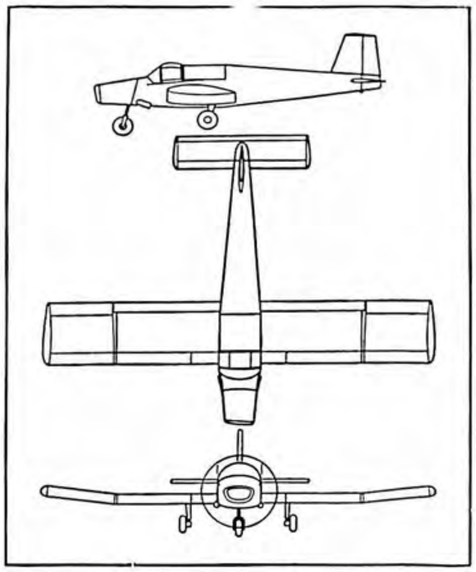
PERFORMANCE

Cruise Speed RDa 6/Mark 511, 280 mph at 13,600 rpm at 20,000 ft. (RDa 7/Mark 528, 300 mph at 14,000 rpm at 20,000 ft.); Rate of Climb 1335 fpm at Sea Level (Dart 6), 1920 fpm (Dart 7); Service Ceiling 32,000 ft.; Range with Maximum Fuel Load 2150 mi. (Business), 1700 mi. (Airline).

Fairchild F-27 Propjet Transport

FLAIR AVIATION CO.
EL MONTE, CALIFORNIA

REMARKS
The Flair 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 1890 lb.; Wing Loading 11.9 lb. per sq. ft.; Power Loading 15.5 lb. per bhp; Engine Continental O-470-N, 240 hp normal rates; Wing Area 294 sq. ft.

PERFORMANCE
Maximum Speed 130 mph; Cruise Speed 110 mph at 75 percent normal rated power at Sea Level; Rate of Climb 745 fpm at Sea Level; Service Ceiling 17,000 ft.; Range with Maximum Payload 410 mi.

Flair (Formerly Fletcher) FU-24 Utility

GOODYEAR AIRCRAFT CORP.
AKRON 15, OHIO

Goodyear ZPG-2W

REMARKS

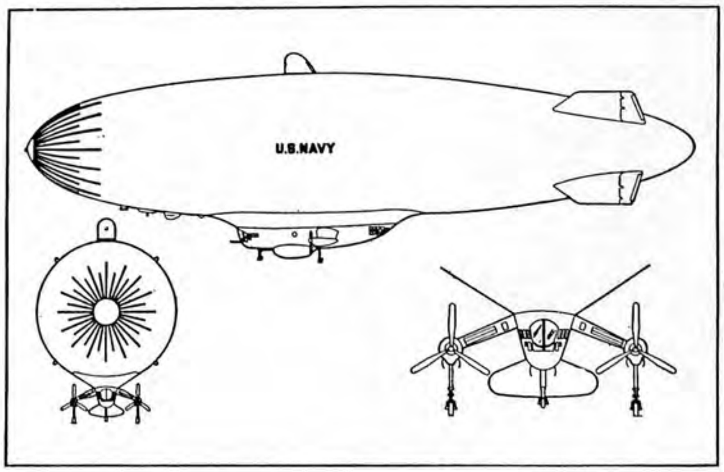
In early 1955, the Goodyear Aircraft-built Navy ZPG-2W was flown for the first time. The ship, a modified version of existing Goodyear ZPG-2 airships designed for antisubmarine warfare service, incorporates electronic features designed specifically for aircraft early warning missions. The blimp's most unusual visible feature is a radome mounted on top of the envelope. This bubble houses special electronic devices for aircraft detection. Within the envelope is a large airborne radar reflector.

SPECIFICATIONS

Width 75 ft.; Length 343 ft.; Height 108 ft.; Empty Weight 52,780 lb.; Engines Two Wright R1300, 700 hp normal rates, or 800 hp at 2600 rpm takeoff; Fuel Capacity 3220 gal. without auxiliary tanks; Propeller Curtiss Electric; Envelope Volume 1,000,000 cu. ft.; Fin Area (Four) 2070 total sq. ft.; Rudder Area (Four) 988 sq. ft.

PERFORMANCE

Maximum Speed 70 knots; Cruise Speed 50 knots; Rate of Climb 2200 fpm at Sea Level.



Goodyear ZPG-3W

REMARKS

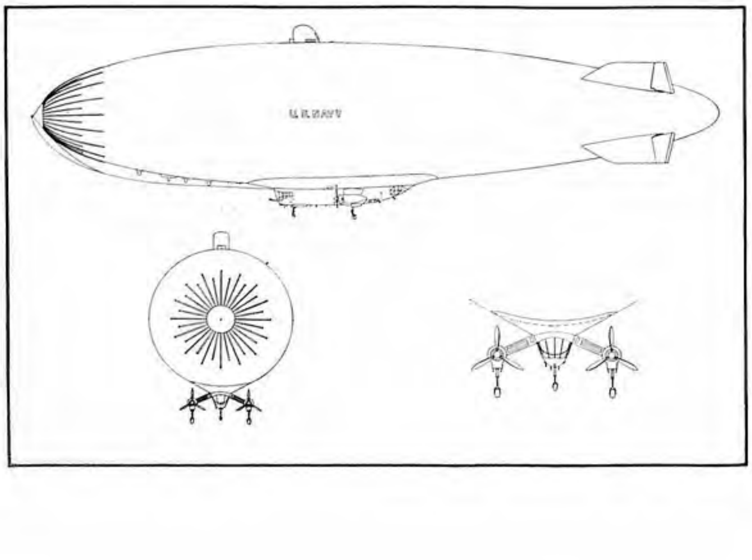
First of a new and larger class of non-rigid airships built for Navy use in Airborne Early Warning (AEW) picket patrol as part of the North American Air Defense Command operation, the Goodyear ZPG-3W was flown for the first time on July 21, 1958. Delivery of the first ZPG-3W to the Navy was made June 19, 1959. The company is constructing an initial order of four blimps. Equipped with latest electronic detection devices, the airship's huge envelope serves as a natural "radome" for a gigantic, internally-mounted radar antenna. Goodyear ZPG-3W is the largest non-rigid airship ever built.

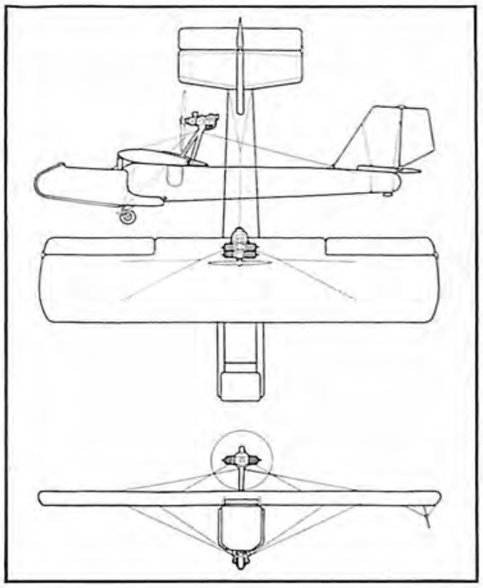
SPECIFICATIONS

Width 85 ft.; Length 403 ft.; Height 118 ft.; Empty Weight 72,000 lbs.; Engines Two Wright R1820-88, 1275 hp at 2500 rpm normal rated, or 1525 hp at 2800 rpm takeoff; Propeller Curtiss Electric; Envelope Volume around 1,500,000 cu. ft.; Fin Area (Four) 2612 total sq. ft.; Ruddervator Area (Four), including tabs, 940 sq. ft.

PERFORMANCE

Cruise Speed 30-60 knots; Rate of Climb 2400 fpm at Sea Level.





REMARKS

The Inflatoplane was born of a need for special-purpose aircraft that are light in weight, have excellent packaging characteristics, are easily transported, and have a rapid package-to-airborne time. Its debut confirms the first practical applications of fabric components to heavier-than-air craft. Because of the inherent buoyancy features of the structural material Airmat, the Inflatoplane equipped with a hydroski can also operate from small lakes and streams with equal facility. Internal air pressures are maintained constant through all altitudes and temperature changes by a continuously driven engine-mounted compressor. Both one and two-place configurations have been produced and delivered to the Office of Naval Research for Field Evaluation by the Navy and the Army.

SPECIFICATIONS

Span 22 ft.; Length 19.7 ft.; Height 6.9 ft.; Package Size 3 ft.-by 3 ft.-by 3.5 ft.; Inflation Pressure 7 psi; Empty Weight 225 lb.; Gross Weight 550 lb.; Wing Loading 5 lb. per sq. ft.; Engine Nelson H-63 42 hp; Fuel Capacity 20 gal.; Propeller U. S. fixed pitch; Wing Area 110 sq. ft.; Landing Gear Unicycle or Hydroski.

PERFORMANCE

Package to Airborne Time 5 minutes; Maximum Speed 72 mph; Cruise Speed 60 mph; Landing Speed 40 mph; Rate of Climb 550 fpm; Clear 50 ft. Obstacle 450 ft.; Service Ceiling 10,300; Absolute Ceiling 13,000; Takeoff Distance, sod, 250; Takeoff Distance, water, 300; Endurance 6½ hours.

Goodyear GA-468 Inflatoplane

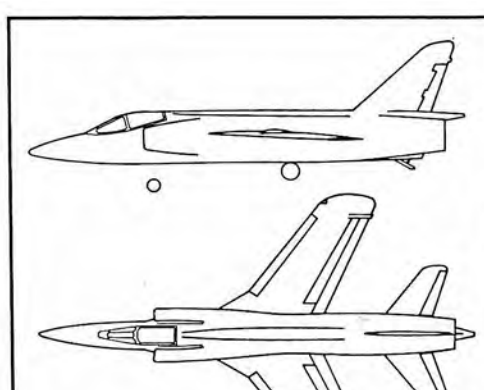
GRUMMAN AIRCRAFT ENGINEERING CORP.
BETHPAGE, LONG ISLAND, NEW YORK

Grumman F11F-1 Super Tiger

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.

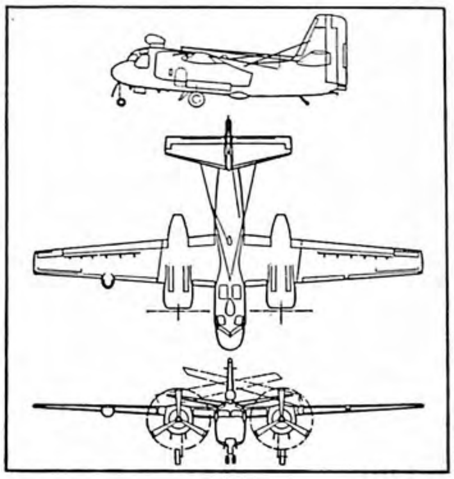


SPECIFICATIONS

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.



REMARKS

The S2F-3 is an anti-submarine carrier aircraft combining search and attack elements. It carries crew of four and has exceptional single-engine performance. It can land and take off from smallest carriers. The S2F-3 is currently undergoing preliminary testing prior to assignment to fleet service, and is basically the same airframe as the S2F-1 with more sophisticated hunter-killer anti-sub navigational aids.

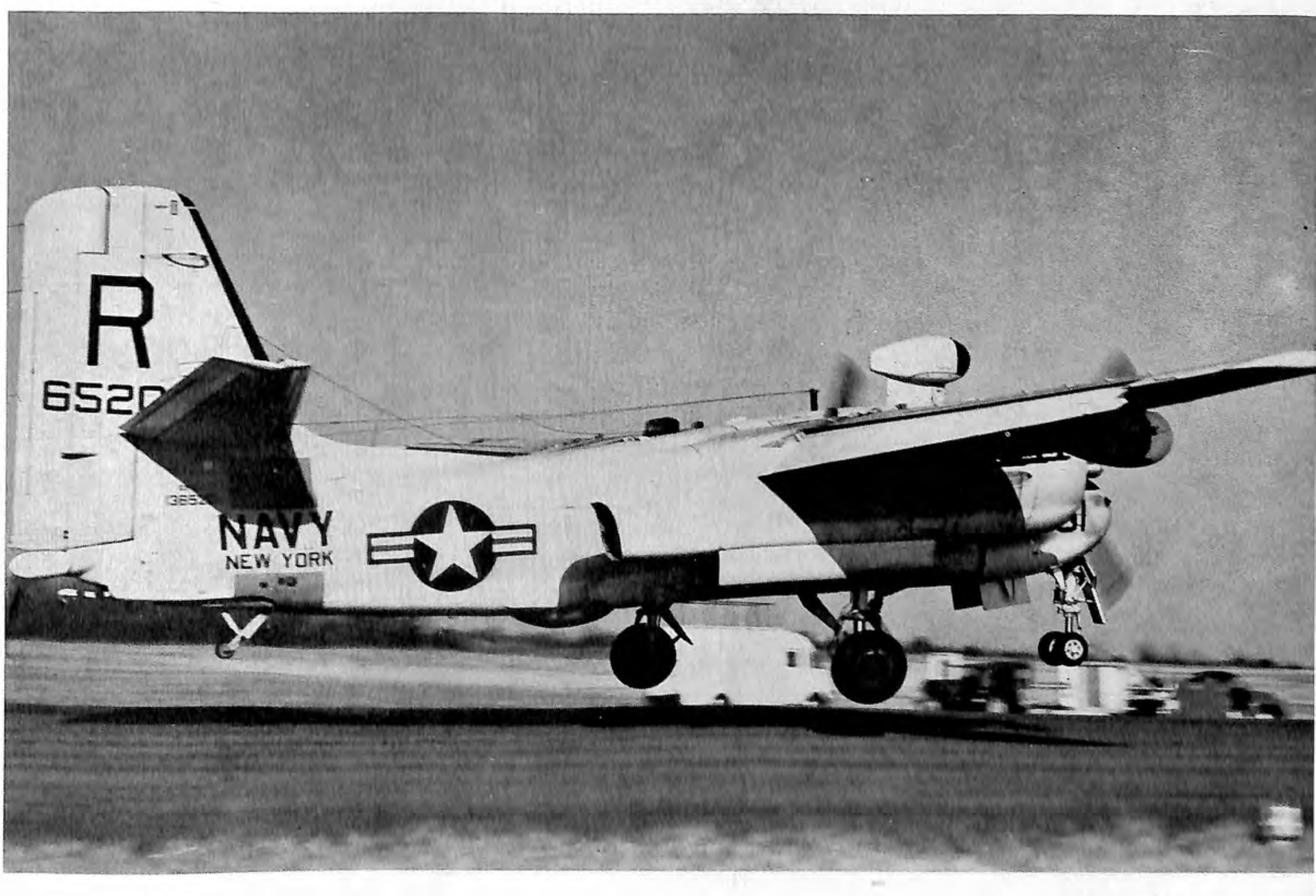
SPECIFICATIONS

Span 69 ft. 8 in.; Length 42 ft. 3 in.; Height 16 ft. 3 in.; Engines Two Wright R1820-82, 1525 hp takeoff.

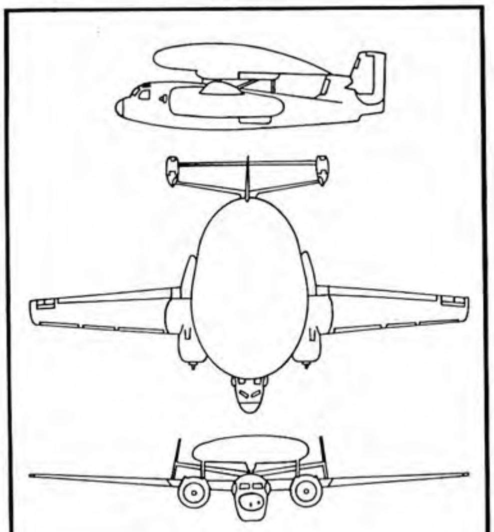
PERFORMANCE

All data are classified.

Grumman S2F-3 Tracker



Grumman WF-2 Tracer Early Warning Aircraft



REMARKS

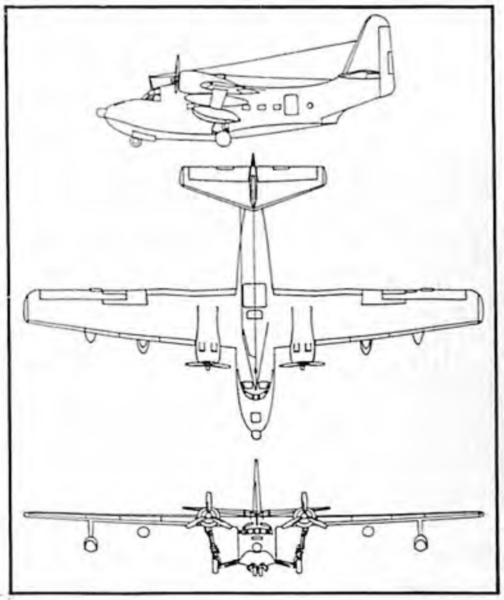
The "saucer-topped" WF-2 Tracer, designed to fill one of the Navy's most important roles in the national defense picture by providing early warning to fleet units of impending attacks by enemy air and sea forces, is a modification of Grumman's S2F Tracker and TF-1 Trader, the three airplanes having basically 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.



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-16A, and is being integrated into Air Force, Coast Guard and Navy service.

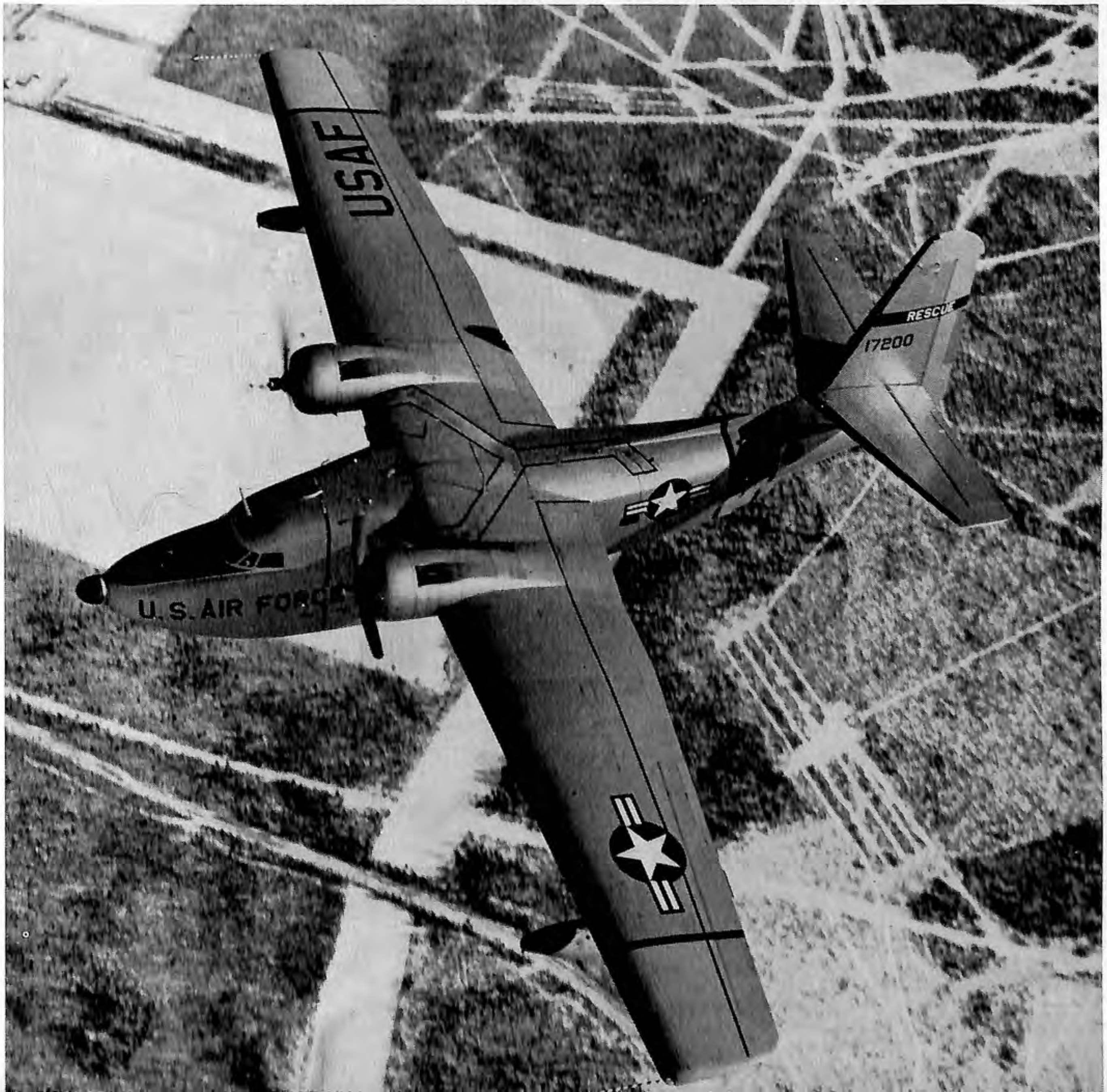
SPECIFICATIONS

Span 96 ft. 8 in.; Length 61 ft. 4 in.; Height 25 ft. 10 in.; Engines Two Wright R-1820-76, 1425 hp takeoff.

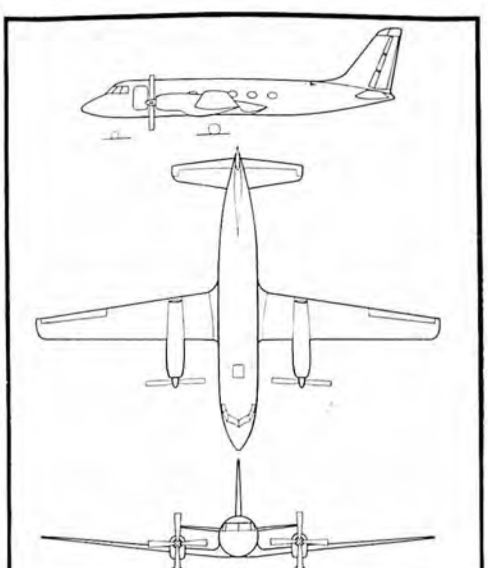
PERFORMANCE

Maximum Speed Military Power-Sea Level 236 mph; Cruise Speed Normal 207 mph.

Grumman SA-16B Albatross



Grumman Gulfstream Executive Transport



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

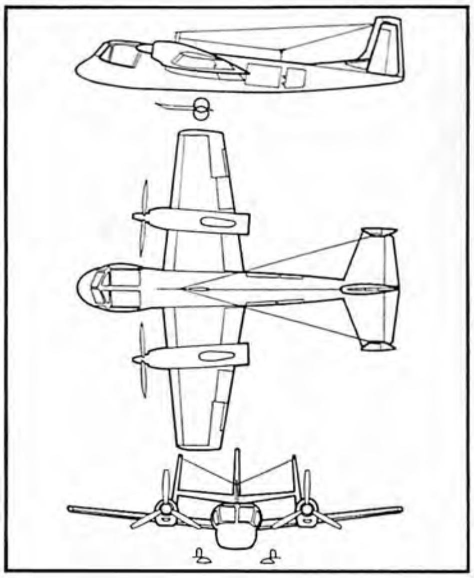
Span 78 ft. 6 in.; Length 64 ft.; Height 22 ft. 9 in.; Engines Two Rolls-Royce Dart RDa 7/2 propjets, 2190 eshp at 15,000 rpm takeoff; Fuel Capacity 1540 gal.; Propeller Rotol.

PERFORMANCE

Maximum Speed 370 mph at 14,400 rpm at 25,000 ft.; Cruise Speed 357 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.

REMARKS

The Mohawk, with an empty weight of 7700 pounds, will be one of the largest fixed-wing airplanes to enter Army service, and will be the first to utilize propjet power. Designed to operate from small unimproved fields, the airplane 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. A "ski-kit" can be installed, enabling the versatile airplane to operate from soft fields, mud, sand or snow.



SPECIFICATIONS

Span 42 ft.; Length 41 ft.; Height 12 ft. 8 in.; Empty Weight 9205 lb.; Wing Loading 35 lb. per sq. ft.; Power Loading 6 lb. per shp; Engines Two Lycoming T53-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 AO-1AF Mohawk Observation Plane

Grumman G-164 Ag-Cat

REMARKS

The Ag-Cat was designed as an "archaic-looking" 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

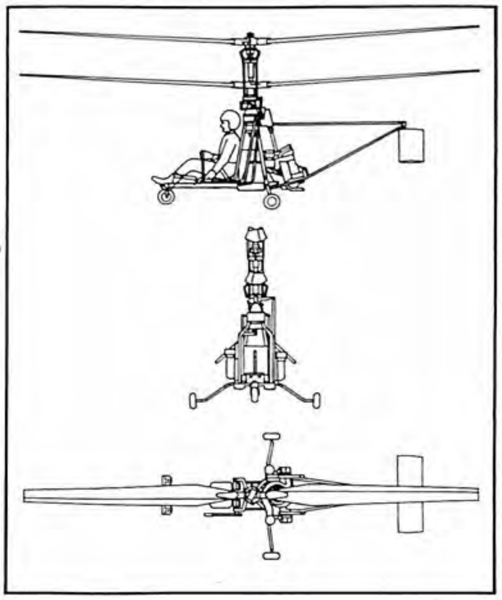
Span 35 ft. 8 in.; Length 24 ft. 6 in.; Height 10 ft. 9 in.; Empty Weight 2127 lb.; Wing Loading 11.3 lb. per sq. ft.; Power Loading 16.8 lb. per bhp; Engines Continental 220, Radial, 220 hp normal rated, or 220 hp at 2075 rpm takeoff; Fuel Capacity 34 gal.; Propeller McCauley; Wing Area 326 sq. ft.; 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.

GYRODYNE COMPANY OF AMERICA, INC.

ST. JAMES, LONG ISLAND, NEW YORK



REMARKS

The YRON-1 is a one-man carrying rotary wing aircraft being evaluated by the Marines for the many tactical uses of which it is capable: liaison, reconnaissance, aerial photography, mine detection, wire laying, resupply and other combat tasks. This helicopter, fully loaded with pilot and fuel, weighs about 700 pounds and has an endurance of over one hour. The Rotorcycle incorporates the coaxial type of rotor system developed and perfected by Gyrodyne. This type of rotor system gives the vehicle outstanding flying qualities and reduces pilot check-out time because of the simplicity of the pilot's task. The Gyrodyne Company has initiated discussions with the Federal Aviation Agency regarding certification of the Rotorcycle for commercial use. Because of the priority of military requirements, however, it is not expected that the commercial version will be available until late 1961.

SPECIFICATIONS

Span 2 ft. 10 in.; Length 11 ft. 5 in.; Height 8 ft.; Empty Weight 430 lb.; Rotor Diameter 17 ft.; Disc Loading 3.03 lb. per sq. ft.; Power Loading 11.1 lb. per bhp; Engine Porsche Type 702/1, 55 hp normal rated, or 62 hp at 4000 rpm takeoff; Fuel Capacity 5 gal.; Disc Area 227 sq. ft.; Stabilizer Area 2.52 sq. ft.

PERFORMANCE

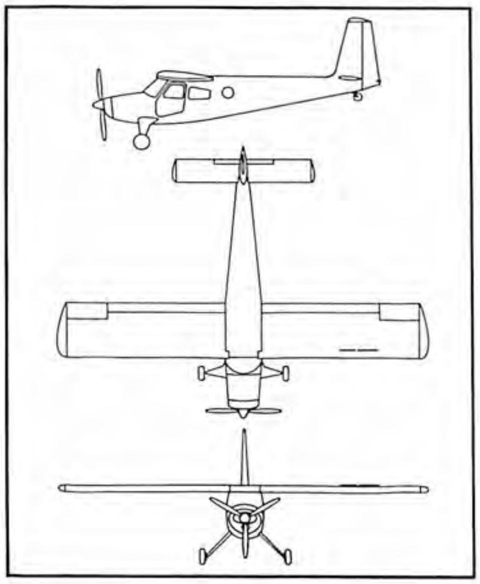
Maximum Speed 68 mph at 55 hp at 4000 engine rpm at Sea Level; Cruise Speed 52 mph at 44 hp at 4000 engine rpm at Sea Level; Rate of Climb 500 vertical fpm at Sea Level; Service Ceiling 6500 ft.; Range with Maximum Payload 60 mi.; Range with Maximum Fuel Load 180 mi.

Gyrodyne YRON-1 Rotorcycle

HELIO AIRCRAFT CORP.
NORWOOD, MASSACHUSSETTS

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

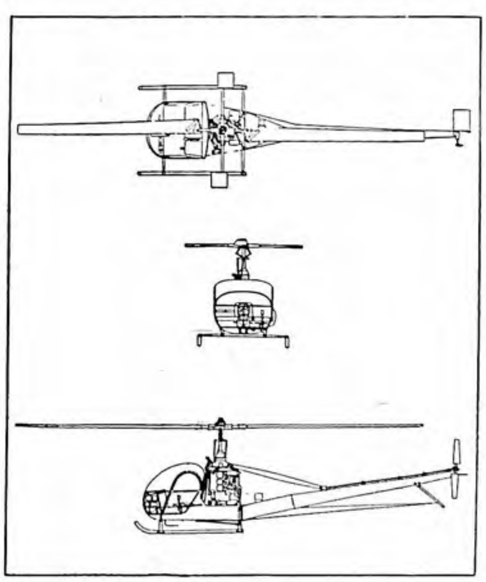
Length 31 ft.; Height 8 ft. 10 in.; Span 39 ft.; Wing Area 231 sq ft.; Empty Weight 2,012 lb.; STOL Gross Weight 3,000 lb. (CAR, Part 3),; Max. Industrial Gross Weight (CAR. Part 8), 3,920 lb.; Engine 6-cycle 295 hp Lycoming GO-480 swinging a 3-bladed 96 in. diameter Hartzell propeller; Fuel Capacity 60 gal., standard; 120 gal., special.

PERFORMANCE

Maximum Speed 176 mph at Sea Level; Cruise Speed 170 mph at 8,200 ft.; Speed 30 mph; Rate of Climb 1,550 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 ft. in zero wind.

Helio H-395 Super Courier

Hiller H-23D (Army)



REMARKS

The H-23D is a three-place, light observation helicopter. Major features of extended overhaul life and reduced maintenance of the H-23D Raven compared with previous models provide greatly reduced operating costs and logistics support. It has high flight and landing load safety factors. Its Lycoming VO-435 engine provides 250 horsepower, which is a 50 horsepower increase over previous models.

SPECIFICATIONS

Main Rotor Diameter 35 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.

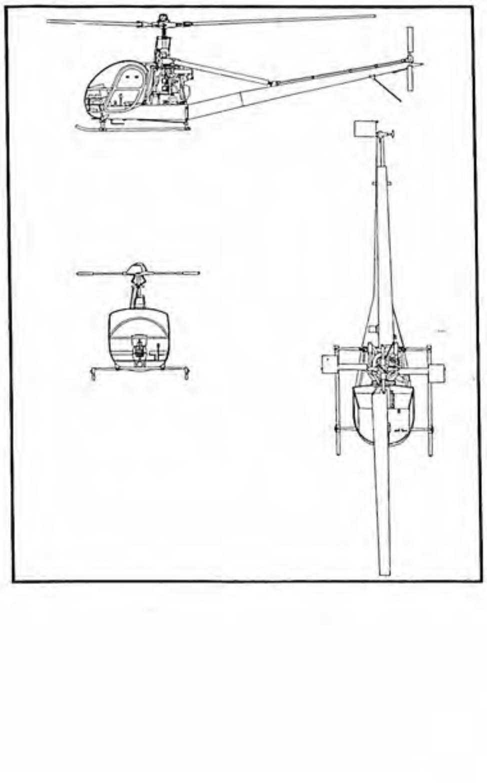
PERFORMANCE

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 Utility Helicopter

REMARKS

The three-place Hiller 12E model utilizes the basic airframe of the Army H-23D, and incorporates in it 55 additional horsepower. This record power in a light utility helicopter yields such performance figures as 1500 feet per minute maximum rate of climb and a hover ceiling in ground effect four times higher than the 12E's civilian predecessor, the 12C. Special accessories designed for the aircraft include: rescue hoist, quick-release cargo hitch, and cargo racks. Useful load is 1000 pounds at normal gross weight. The 12E Hiller entered production in late, 1958.

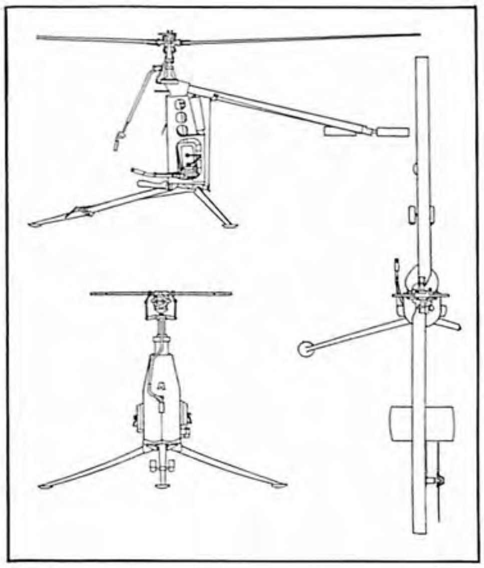


SPECIFICATIONS

Main Rotor Diameter 35 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 8.9 lb. per bhp: Engine One Lycoming VO-540-A1A, 305 hp at 3200 rpm takeoff; Fuel Capacity 46 gal.

PERFORMANCE

Maximum Speed 95 mph at Sea Level; Cruise Speed 87 mph at Sea Level; Rate of Climb 1500 fpm; Hover Ceiling 10,200 ft.; Service Ceiling 15,500 ft.; Absolute Ceiling 16,200 ft.; Range with Maximum Payload 185 mi.; Range with Maximum Fuel Load 400 mi.



REMARKS

Having completed many months of successful prototype demonstration flying in the United States and abroad, Hiller entered into a sub-license agreement with Saunders-Roe, Ltd., of England for the production of an evaluation quantity of ten YROE-1 Rotorcycles. Production was completed late in year and five units were delivered to the Marine Corps for field tests. The remaining five were made available for U. S. and European demonstrations. The YROE-1 is a completely foldable helicopter. One man can assemble and fly the Rotorcycle in less than ten minutes. For ease of flight, the Hiller Rotormatic Control System was incorporated and made adjustable for sensitive or sluggish control reactions depending upon operational needs.

SPECIFICATIONS

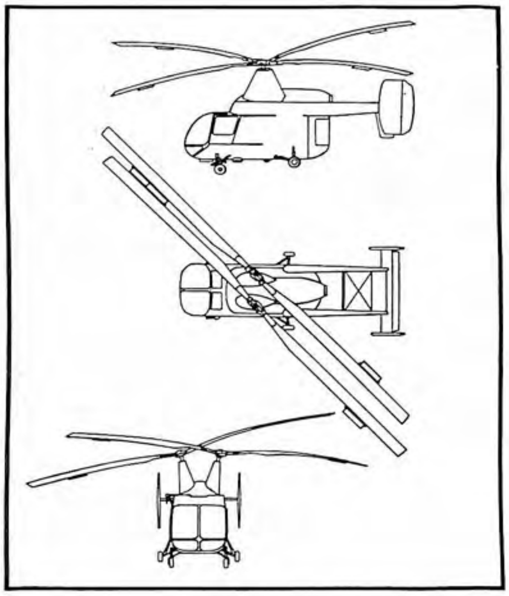
Main Rotor Diameter 18 ft. 6 in.; Anti-torque Rotor Diameter 36 in.; Length 11 ft. 8 in.; Height 7 ft.; Empty Weight 300 lb.; Power Loading 12.4 lb. per bhp; Engine One Nelson H63B, 45 hp at 4000 rpm takeoff; Fuel Capacity 2½ (standard) gal.

PERFORMANCE

Maximum Speed 70 mph at Sea Level; Cruise Speed 52 mph at Sea Level; Rate of Climb 1160 fpm at Sea Level; Service Ceiling 13,200 ft.; Absolute Ceiling 14,000 ft.; Range with Maximum Payload 37 mi.; Range with Maximum Fuel Load 166 mi.

Hiller YROE-1 (Marines) One-Man Rotorcycle

KAMAN AIRCRAFT CORP.
BLOOMFIELD, CONNECTICUT



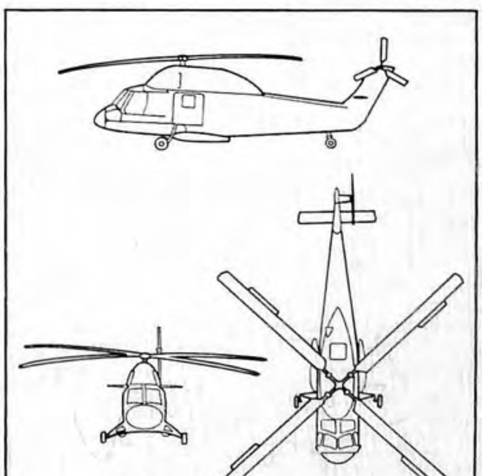
REMARKS
A general utility helicopter to be used by USAF for local base crash rescue, the H-43B, Kaman Huskie, is an outgrowth development of the USAF H-43A, but the Huskie has twice the interior space and twice the payload capacity. The rotor system, as in preceeding models, is a synchropter with two counter rotating, intermeshing main rotors which inherently overcome torque and require no tail rotor. Air Force orders to date call for about 100 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 1300 fpm; Service Ceiling 21,000 ft.; Range with Maximum Payload 228 nautical mi.

Kaman H-43B Huskie

Kaman HU2K



REMARKS

The Navy's new, high-speed utility helicopter, Kaman's HU2K, which went into production this year, was a Navy design-competition winner. It 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 new ship will have retractable landing gear and Kaman's "servo-flap" control system.

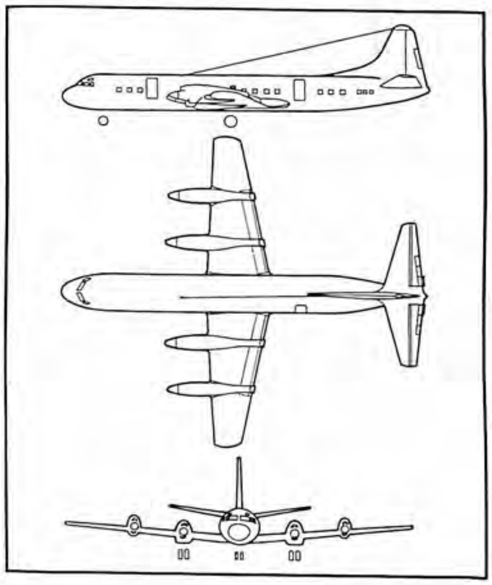
SPECIFICATIONS

Main Rotor Diameter 44 ft.; Span 44 ft.; Length 52 ft. 2 in. (operating); Height 12 ft. 5 in.; Empty Weight 5052 lb.; Power Loading 7.2 lb. per bhp; Engine One YT58-6, 875 hp normal rates, or 1024 hp at 6000 rpm; Military Fuel Capacity 276.0 gal.; Stabilizer Area 15.0 sq. ft.

PERFORMANCE

All data are classified.

LOCKHEED AIRCRAFT CORP.
BURBANK, CALIFORNIA



REMARKS

The first Electra was airborne in 1957. 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 99 passengers. It is powered by four Allison 501 propjet engines developing 3750 horsepower each and Aeroproducts 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, Northwest Orient Airlines, and Capital Airlines.

SPECIFICATIONS

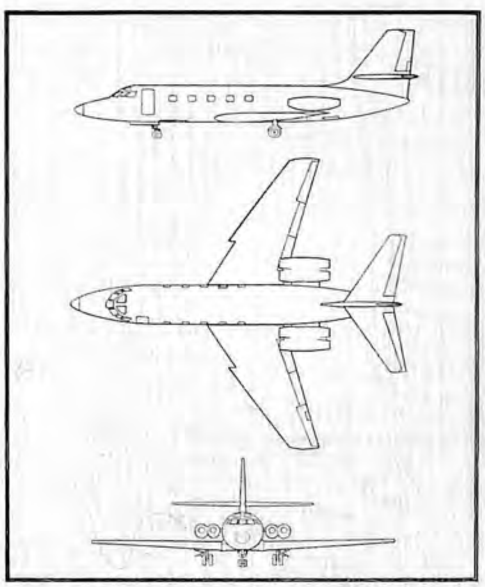
Span 99 ft.; Length 104 ft. 6.5 in.; Height 32 ft. 11 in.; Empty Weight 56,000 lb.; Maximum Gross Weight 116,000 lb.; Engines Four Allison 501 D-13 propjet, 3750 hp normal rated; Fuel Capacity 5520 gal.; Wing Area 1300 sq. ft.

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 2850 mi.; Range with Maximum Fuel Load (900 extra gal.) 3400 mi. with 2½-hr. reserves.

Lockheed Electra

Lockheed JetStar



REMARKS

The Air Force late in the year announced its selection of the Lockheed JetStar, 550-to-600 mile-per-hour jet utility aircraft, for use in training navigator-bombardiers. The fast, air-conditioned, pressurized transport already had been chosen by many corporations as an executive aircraft, as business aviation adopted jets. Originally designed to fill the military requests for off-the-shelf purchase as well as for corporate use, the JetStar prototype made its first flight September 4, 1957 at Edwards Air Force Base, California. With corporate orders mounting, Lockheed in November, 1958 (almost a year before the Air Force picked the JetStar over competing aircraft) decided to put the plane into production at Marietta, Georgia. Two prototypes have flown more than a half-million miles, operating from airport runways built for propeller-driven aircraft throughout the United States and Canada. First production model will fly in July, 1960 and deliveries will begin in January, 1961. Production models will be powered by four Pratt and Whitney JT-12 engines, mounted to the rear fuselage for safety and quietness. The executive version JetStar will seat eight persons and a crew of two. Aside from training navigator-bombardiers, the JetStar will be capable of serving a number of other military missions.

SPECIFICATIONS

Span 53 ft. 8 in.; Length 60 ft. 6 in.; Height 20 ft. 6 in.; Empty Weight 18,500 lb., with external tanks; Wing Loading 71.6 lb. per sq. ft.; Power Loading 3.24 lb. per lb. of thrust; Engines 4 Pratt and Whitney JT-12 axial flow turbojet; 3,000 lb. at 16,350 rpm takeoff; Fuel Capacity 2,630 gal. with two 500 gal. external tanks; Wing Area 542.5 sq. ft.; Aileron Area 24.4 sq. ft.; Flap Area 62.6 sq. ft.; Fin Area 93.75 sq. ft.; Rudder Area 16.45 sq ft.; Stabilizer Area 117.8 sq. ft.; Elevator Area 31.2 sq. ft.

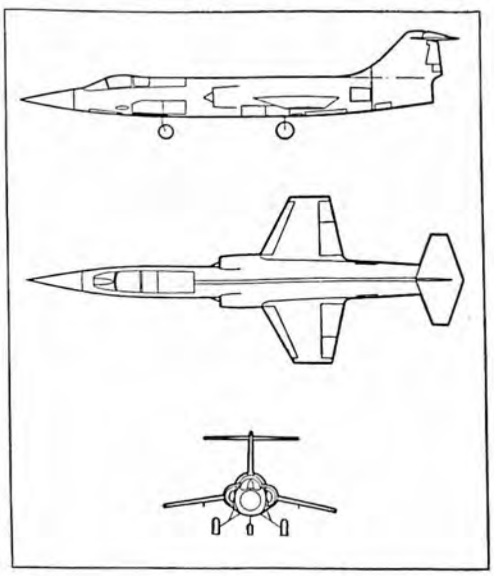
PERFORMANCE

Maximum Cruise Speed 575 mph at Maximum Cruise rpm at 22,350 ft.; Long Range Cruise Speed 512 mph at Cruise rpm at 45,000 ft.; Landing Speed 120 mph; Rate of Climb 3500 fpm at Sea Level; Service Ceiling over 45,000 ft.; Range with Maximum Payload 2740 mi.; Range with Maximum Fuel Load 2900 mi.

Lockheed F-104C Starfighter

REMARKS

Starfighter is the first production fighter to incorporate boundary layer control. It has high short-field landing capability. Razor-thin wings of the Starfighter are thinner even than those on rocket research planes. A felt covering over the wing's leading edge protects ground crewmen when the plane is not flying. F-104A and B models are in service with USAF Air Defense Command; C and D models with Tactical Air Command. Starfighter holds the world's speed record, altitude mark, and seven time-to-climb records. It has been chosen by the West German Air Force and Royal Canadian Air Force as their first-line fighter. Lockheed is also producing the F-104G and F-104-9 models.

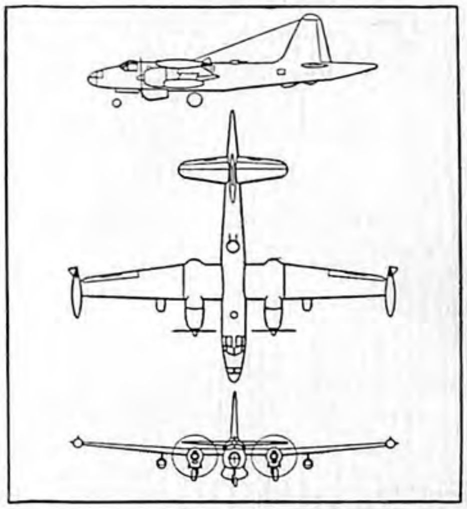


SPECIFICATIONS

Span 21 ft. 11 in.; Length 54 ft. 9 in.; Height 13 ft. 6 in.; Weighs less than any operational jet combat plane; Engine General Electric J79.

PERFORMANCE

Maximum Speed Mach 2 class; Service Ceiling, upper stratosphere.



REMARKS

The P2V-7 is the latest in the Neptune anti-submarine series. Identifying features are the double-bubble canopy, 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 Deepfreeze III at South Pole.

SPECIFICATIONS

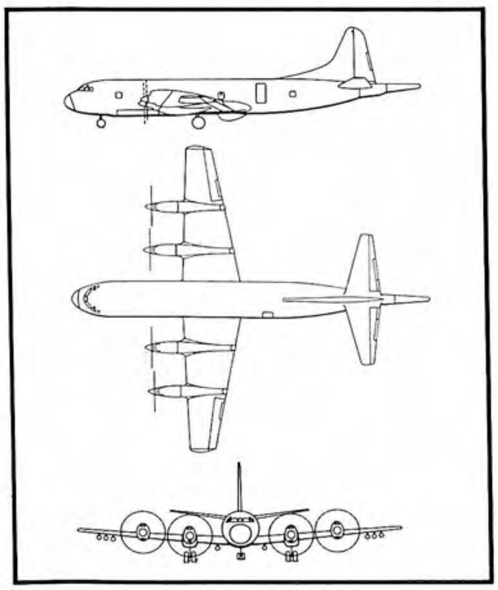
Span 103 ft. 6 in. with tip tanks; Length 91 ft. 5 in.; Height 29 ft. 4 in.; Empty Weight 46,046 lb., with jet pod engines 49,456 lb.; Gross Weight 75,310 lb., with jet pods 78,760 lb.; Engines Two Wright R-3350-32W turbo-compound, 3250 hp, and Two Westinghouse J34 engines in pods, 3400 lb. thrust; Propeller Hamilton Standard four-blade; Wing Area 1000 sq. ft.

PERFORMANCE

Maximum Speed without pods 345 mph; Service Ceiling 23,000 ft. without pods.

Lockheed P2V-7 Neptune

Lockheed P3V-1 ASW Landplane



REMARKS

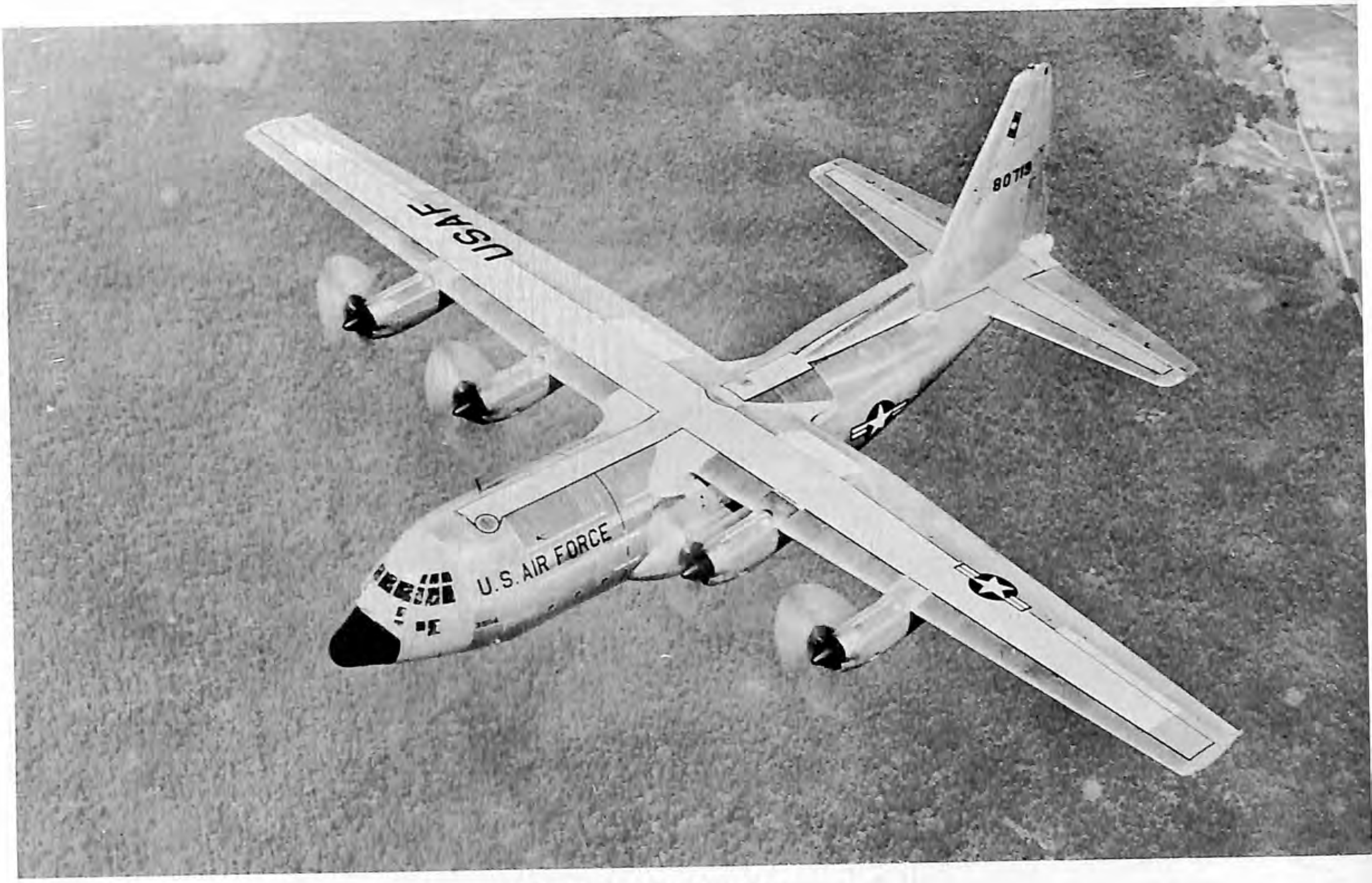
First production order for this aircraft, valued at $79 million, came from the Navy in September, 1959. The P3V-1 cruises about twice as fast as the P2V-7 Neptune and has 40 percent more range. It can search 280,000 square nautical miles of coastal area in a single flight at a cost of about one cent a square mile. It can carry a crew of ten and two and one half tons of communications, navigation and detection equipment.

SPECIFICATIONS

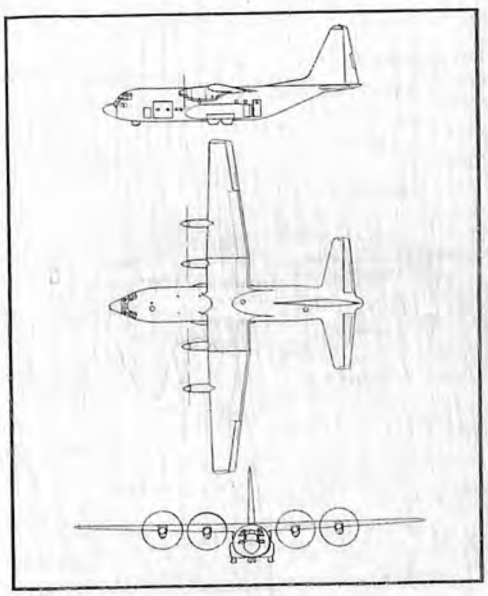
Span 99 ft.; Length 113 ft. 7 in.; Height 32 ft. 9 in.; Wing Loading 77.5 lb. per sq. ft. at 101,500 lb.; Power Loading 6.2 lb. per eshp; Engines 4 Allison T56-A-10W, 4500 hp normal rated; Fuel Capacity 9231 gal.; Propeller 4-bladed 13½ ft.; Wing Area 1300 sq. ft.

PERFORMANCE

Maximum Speed 450 mph; Cruise Speed 405 mph.



Lockheed C-130B Hercules



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 UV-IL 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, 3600 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

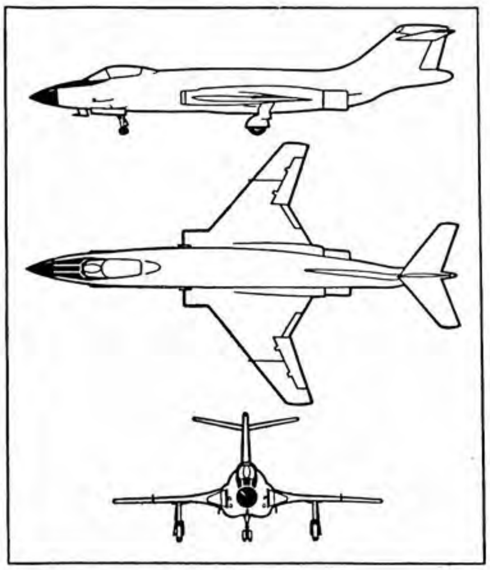
Maximum Speed 370 mph at normal power at 18,000 ft.; Cruise Speed 350 mph; Rate of Climb 2230 fpm at Sea Level; Service Ceiling at Maximum Weight over 28,000 ft.; Range with Maximum Payload 2300 mi.; Range with Maximum Fuel Load 4000 mi.

McDONNELL AIRCRAFT CORP.
ST. LOUIS 3, MISSOURI

McDonnell F-101B Voodoo

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 six ADC squadrons. Production deliveries are scheduled through 1960.

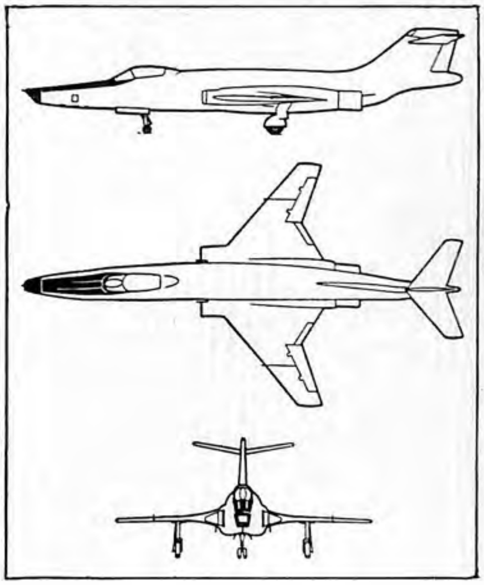


SPECIFICATIONS

Span 39 ft. 8 in.; Length 67 ft.; Height 18 ft.; Empty Weight 26,277 lb.; Engines Two J57-P-13, 10,000 lb. hp normal rated, or 15,000 with AB hp.; Fuel Capacity 2249 gal.; Wing Area 368 sq. ft.

PERFORMANCE

Maximum Speed 1200+ mph.



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

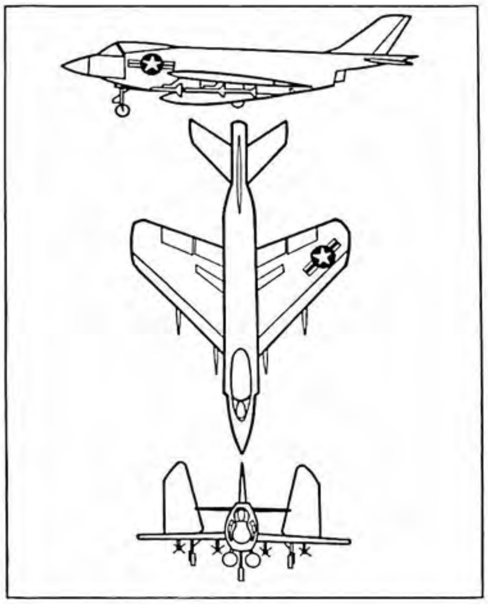
Maximum Speed 1200+ mph.

McDonnell RF-101 Voodoo

REMARKS

The McDonnell F3H Demon is a single place, high performance, general purpose jet fighter for the Navy. The Demon is produced in three versions: the F3H-2, F3H-2N and F3H-2M. In addition to four 2 mm rapid-firing cannon, this versatile airplane carries unusually heavy loads of various external combinations of missiles, rockets, bombs, fuel tanks, and miscellaneous stores depending on the nature of the mission. It combines interceptor speeds and fighter maneuverability with the payload of an attach bomber, has a 45 degree swept wing, designed for supersonic speeds, and its radar assures all-weather and night oprational ability. During 1959, the F3H-2, F3H-2N, and F3H-2M Demons were continuously deployed in the Mediterranean, Caribbean and Far East aboard seven carriers.

While each of the three versions of the Demon carries cannon, rockets and Sidewinder missiles, the F3H-2 is one of the first fighters in the Navy inventory capable of firing the New Sparrow III missile. First deliveries of the Demon were made to an operational squadron on March 7, 1956, less than ten months after the flight of the first production model.



SPECIFICATIONS

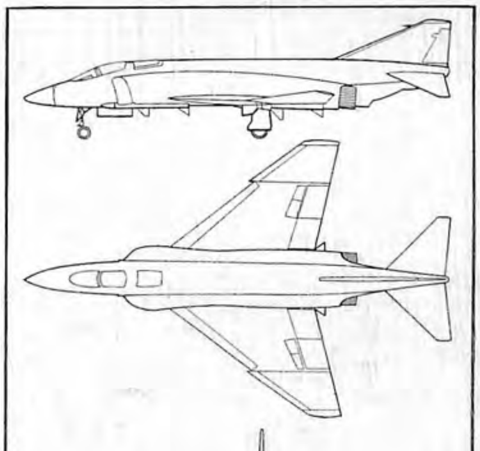
Span 35 ft. 4 in.; Length 58 ft. 11 in.; Height 14 ft. 7 in.; Empty Weight 22,133 lb.; Engine J71-A-2, 14,000 lb. thrust class; Fuel Capacity 1506 gal.; Wing Area 519 sq. ft.

PERFORMANCE

All data are classified.

McDonnell F3H-2 Demon

McDonnell F4H Phantom II



REMARKS

The McDonnell F4H Phantom II, being produced for the Navy, is a fast all-weather fighter with a top speed considerably in excess of twice that of sound. The Phantom II, a supersonic two-seat twin jet interceptor, carries multiple loads of Sparrow III missiles and a load of Sidewinder missiles as well, if desired. The Phantom II is capable of destroying enemy bombers by day or night, in any weather, at supersonic speeds. Squadron deliveries of the F4H will begin in mid-1960. The Navy's flight testing of prototype models has been in progress since September, 1958. The F4H is unique in that it combines outstanding fighter attack capability with its role as an interceptor. In addition to its normal complement of Sparrow III missiles, it is capable of long range delivery of conventional and nuclear bombs. The ability of the F4H to carry a radar operator along with the pilot greatly increases the jet's effectiveness as an all-weather interceptor. The F4H features a 45 degree swept back wing and a horizontal stabilizer that slopes downward at 23 degrees, to provide for superior handling characteristics at all speeds. The plane is 56 feet long with a wing span of 38 feet, five inches. The Phantom II can be refueled in flight by the "probe and drogue" system and uses the "buddy tank" system which allows one F4H to refuel another at supersonic speeds.

SPECIFICATIONS

Engines Two J79-GE-2 with afterburners; two-man crew.

PERFORMANCE

Maximum Speed Mach 2+ at altitude; Service Ceiling upper stratosphere.

McDonnell Model 119

REMARKS

The McDonnell Model 119 is a new jet airplane designed for modern business. It combines airline safety with dollar saving size, and offers speed to meet the challenge of the busy years ahead. The pressurized cabin features a flat floor with full headroom for comfort and safety. Interiors to fulfill corporate needs utilize modern track-mounted furnishings styled by Charles Butler Associates for the Model 119.

SPECIFICATIONS

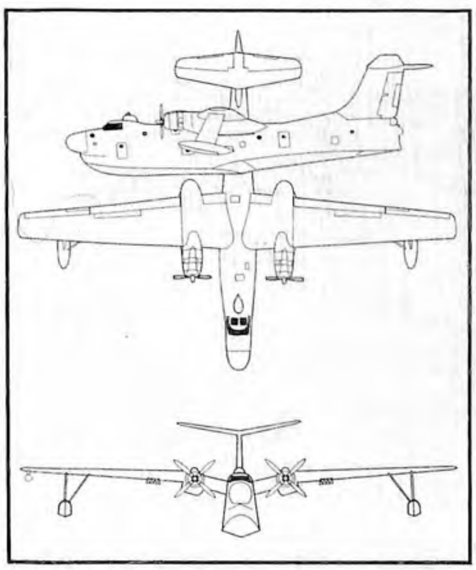
Length 66 ft. 6 in. Span 57 ft. 7 in. Height 23 ft. 8 in. Wing Area 550 sq. ft. Fuselage Diameter 7 ft. 5 in. Cabin Headroom 6 ft. 2 in. Cabin Altitude at 40,000 ft., 7000 ft. Engines Four Pratt & Whitney JT12 Turbojet. Tire Size: Main Landing Gear 30 x 7.7 (Four); Nose Landing Gear 22 x 5.5 (Two). Tread of Main Wheels 15 ft. 9 in. Wheel Base 17 ft. 4 in.

PERFORMANCE

All data are classified.

THE MARTIN CO.
BALTIMORE 3, MARYLAND

Martin P5M-2 Marlin



REMARKS

The Marlin is the free world's front line anti-submarine warfare seaplane in service with both United States and French naval air forces. Production models and U. S. fleet P5M-2s undergoing modernization at Baltimore are being equipped with a new and highly sensitive electronics detection system for prosecuting ASW from an aircraft. System enables quick pilot action by integrating information from all detection devices within the aircraft at one control center. Marlin carries a crew of seven and a substantial load of depth charges, bombs, torpedoes, rockets, and/or mines.

SPECIFICATIONS

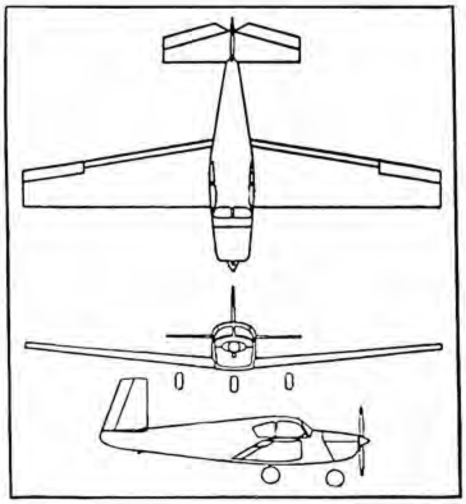
Span 118 ft.; Length 100.6 ft.; Height 31 ft.; Hull Width 10 ft.; Gross Weight over 73,000 lb.; Engines Two Wright R3350-32W; Propeller Hamilton Standard four-blade reversible.

PERFORMANCE

Maximum Speed 250 mph; Landing Speed 110 mph; Range 2600 nautical mi.; Fuel Capacity 3959 gal.; Takeoff Power 3400 bhp.

MOONEY AIRCRAFT, INC.
KERRVILLE, TEXAS

Mooney M-20A



REMARKS

Mooney manufactures the M-20 and M-20A. The 1958 Model M-20 incorporates the following engineered improvements over earlier models: shock-mounted instrument panel, rear seat moved two inches for improved rear seat leg room, heavier generator and battery, radio power supply access door and rack aft of baggage compartment in tail cone, new interior upholstery and exterior paint design. In addition to these improvements, the M-20A has an overhead cabin ventilation system.

SPECIFICATIONS

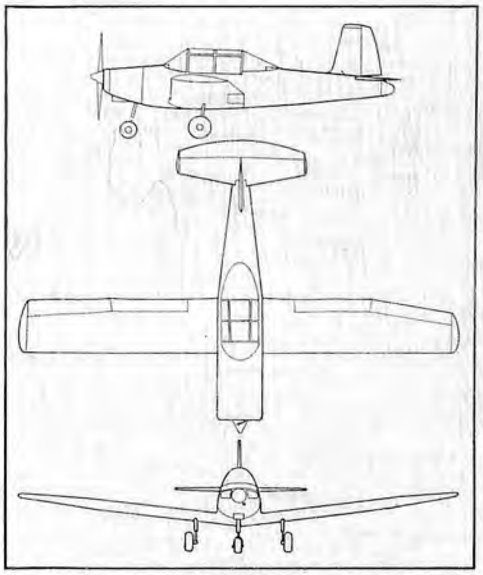
Span 35 ft.; Length 23 ft. 2 in.; Height 8 ft. 4.5 in.; Wing Loading 14.7 lb. per sq. ft.; Power Loading 13.6 lb. per bhp; Engine One Lycoming O-360, 180 hp normal rates, or 180 hp at 2700 rpm takeoff; Fuel Capacity 49 gal.; Propeller McCauley-constant speed; Wing Area 167 sq. ft.; Aileron Area 11.1 sq. ft.; Flap Area 17.2 sq. ft.; Fin Area 5 sq. ft.; Rudder Area 7.9 sq. ft.; Stabilizer Area 21.5 sq. ft.; Elevator Area 12 sq. ft.

PERFORMANCE

Maximum Speed 190 mph at 180 hp at 2700 rpm at Sea Level; Cruise Speed 180 mph at 135 hp at 2400 rpm at 7500 ft.; Landing Speed 57 mph; Rate of Climb 1150 fpm at Sea Level; Service Ceiling 20,000 ft.; Absolute Ceiling 22,000 ft.; Range with Maximum Payload 1075 mi.; Range with Maximum Fuel Load 1075 mi.

MORRISEY AVIATION, INC.
SANTA ANA, CALIFORNIA

Morrisey 2150



REMARKS

The Morrisey 2150 received FAA Type Certificate 4A19 in June, 1958. It is a development from the original Morrisey "Nifty," Model 2000C, 90 hp, which was certificated in December, 1955, and is no longer in production. The Model 2150 is all metal with fixed tricycle gear, Lycoming 150 hp, two-place tandem seating with conventional stick, dual controls. It has steerable nose wheel and individual toe brakes for both pilots. Among its features is the excellent visibility from the cockpit. The high performance and maneuverability have made it attractive not only as a trainer but also in corporate and personal flying. Several ships have been delivered to West Coast users and the company is increasing its manufacturing rate.

SPECIFICATIONS

Span 30 ft.; Length 21 ft. 3 in.; Height 7 ft.; Empty Weight 1125 lb.; Wing Loading 12.6 lb. per sq. ft.; Power Loading 12 lb. per bhp; Engine One Lycoming O-320-A2A, 150 hp normal rates, or 150 hp at 2700 rpm takeoff; Fuel Capacity 35 gal.; Propeller Sensenich M74DM; Wing Area 144 sq. ft.

PERFORMANCE

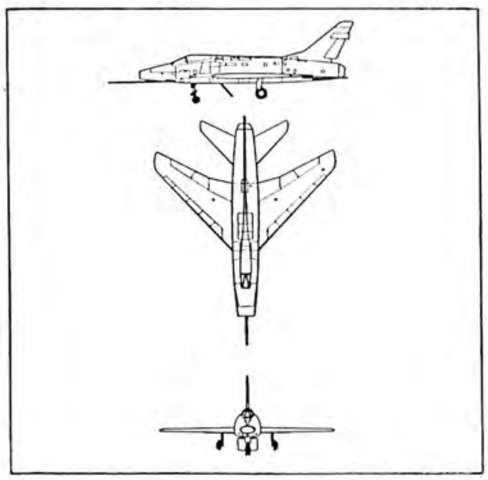
Maximum Speed 148 mph at 150 hp at 2700 rmp at 700 ft.; Cruise Speed 135 mph at 108 hp at 2450 rmp at 700 ft.; Landing Speed 52 mph; Rate of Climb 1450 fpm at Sea Level; Service Ceiling over 22,000 ft.; Range with Maximum Payload 525 mi.; Range with Maximum Fuel Load 525 mi.

NORTH AMERICAN AVIATION, INC.
LOS ANGELES 45, CALIFORNIA

North American F-100D Super Sabre

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.

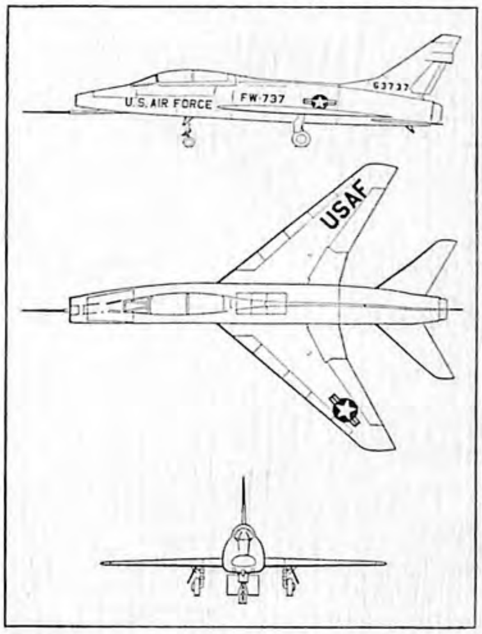


SPECIFICATIONS

Span 38 ft. 7 in.; Length 46 ft. 5 in.; Height 13 ft. 9 in.; 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.



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 of 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.

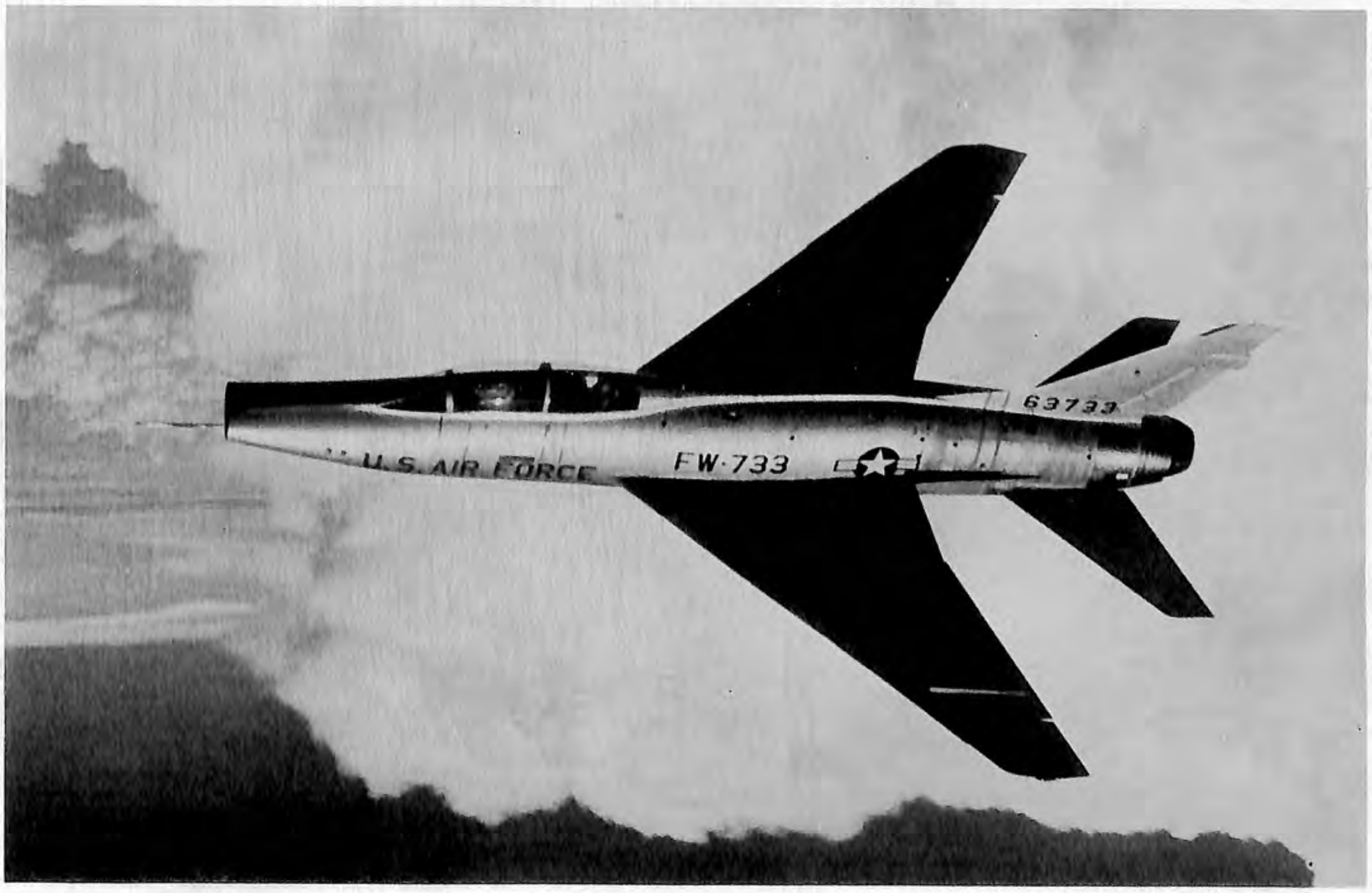
SPECIFICATIONS

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

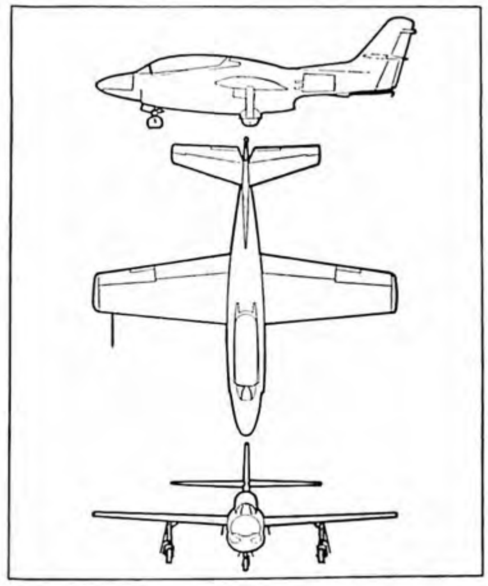
Maximum Speed in excess 1000 mph; Cruise Speed 600 mph at 40,000 ft.; Landing Speed 155 mph; Rate of Climb 22,000 fpm at Sea Level; Service Ceiling 51,000 ft.; Range with Maximum Fuel Load 1800 mi.

North American F-100F Super Sabre



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

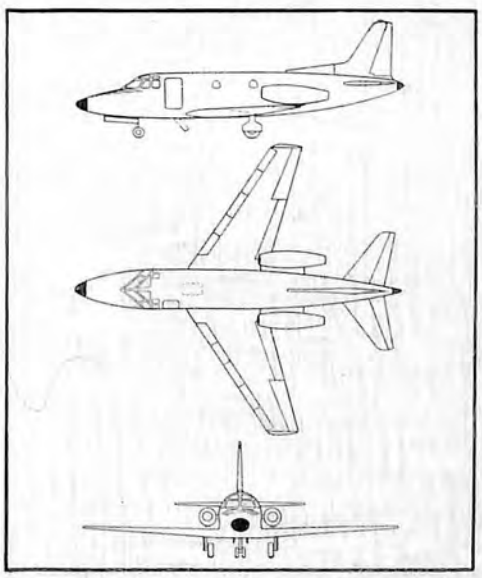
Span 36 ft.; Length 38 ft. 4 in.; Height 14 ft.; Empty Weight 6500 lb. (approximately); Wing Loading 35 lb. per sq. ft.; Engine Westinghouse J34-WE-36, 3400 lb. thrust; Fuel Capacity 381 gal. without tip tanks, 581 gal. with tip tanks; Wing Area 255 sq. ft.; Aileron Area 190 sq. ft.; Flap Area 50 sq. 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 T2J

North American T-39 Sabreliner



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. A prototype Sabreliner (UTX) was built at North American's expense in 1957-58 and was first flown in September, 1958. Basic interior configuration of T-39 provides for four passengers plus pilot and co-pilot.

SPECIFICATIONS

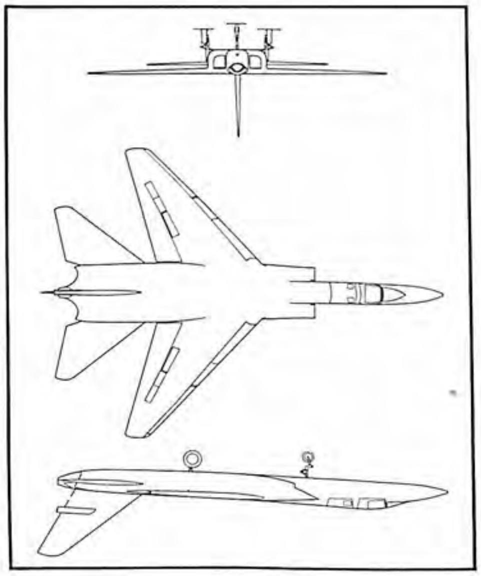
Span 44 ft. 5 in.; Length 43 ft. 9 in.; Height 16 ft.; Empty Weight 9307 lb.; Engines two Pratt and Whitney J60s, 3000 lb. thrust normal rated; Fuel Capacity 1056 gal. (extended range); Wing Area 342.1 sq. ft.; Aileron Area 16.42 sq. ft.; Flap Area 36.6 sq. ft.; Vertical Tail Area 45.6 sq. ft.; Horizontal Tail Area 77 sq. ft.

PERFORMANCE

Maximum Speed 605 mph at 16,000 ft. (optimum alt.); Cruise Speed 500 mph at 43,000 hp; Landing Speed 100 mph; Service Ceiling 45,000 ft. Range with Maximum Fuel Load at Maximum Gross Takeoff Weight 1725 mi.

REMARKS

Mission of the A3J is to provide the fleet with an all-weather, carrier-based attack weapon 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 J79-2 (General Electric) each developing approximately 15,000 lb. thrust.

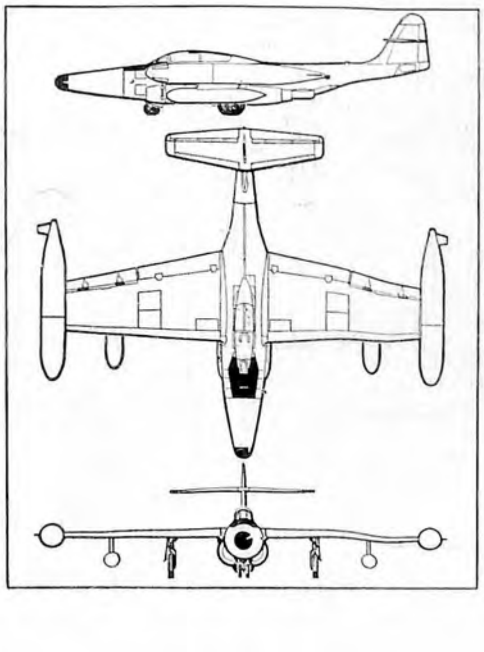
PERFORMANCE

Maximum Speed Supersonic.

North American A3J Vigilante

NORTHROP CORP.
HAWTHORNE, CALIFORNIA

Northrop F-89J Scorpion



REMARKS

The F-89J is a high altitude, mid-wing, twin-engined, jet propelled, all-weather interceptor, manned by a crew of two, pilot and radar operator, seated tandem in pressurized cockpits enclosed by single jettisonable canopy. Ejection seats are provided for both crew members. The plane's characteristic "Scorpion" silhouette is created by its up-swept tail assembly. The horizontal stabilizer is above the engine exhaust and air flow of wing. Operational in Air Defense Command, the F-89J is armed with MB-1 atomic rockets. First firing of an atomic rocket was accomplished by the F-89J during the summer of 1957.

SPECIFICATIONS

Span approximately 56 ft.; Length approximately 53 ft.; Height approximately 17 ft.; Weight over 40,000 lb.; Engines Two Allison J35-A-35 turbojet with thrust-augmenting afterburners; Landing Gear tricycle, with steerable nose wheel.

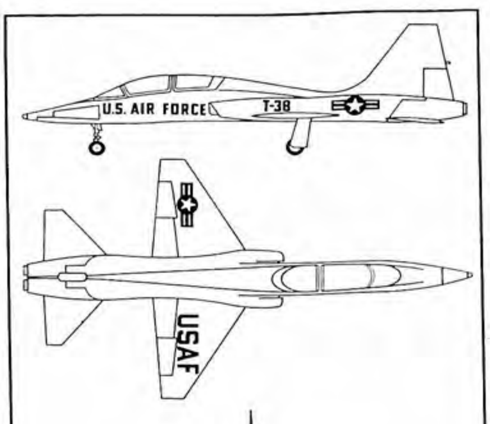
PERFORMANCE

Speed 600 mph class; Altitude over 45,000 ft.; Range over 1000 mi.

Northrop T-38 Talon

REMARKS

The T-38 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-38 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 operation, aerobatics, night flying, instrument instruction and cross-country navigation. The T-38 is now in production at Northrop's Norair Division, Hawthorne, California.



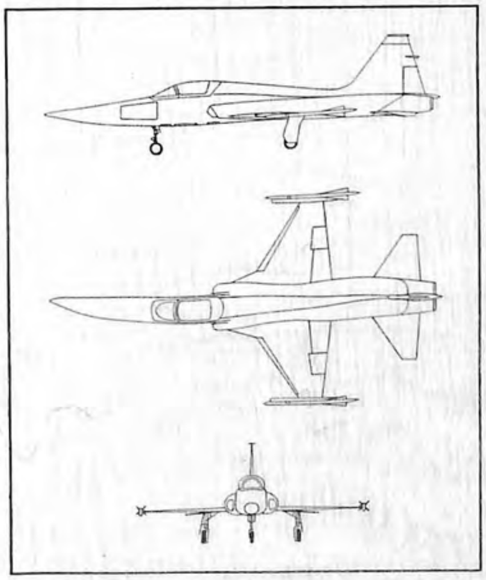
SPECIFICATIONS

Span 25 ft. 3 in.; Length 43 ft.; Height 11 ft. 11 in.; Empty Weight 7000 lb.

PERFORMANCE

Maximum Speed Supersonic.

Northrop N-156F Freedom Fighter



REMARKS

The N-156F is a multipurpose, twin-turbojet fighter, providing high-altitude, supersonic performance in all-weather, capable of zero-length launch and operation from short 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-38 Talon supersonic trainer. The aircraft is versatile in armament and fire control systems. Its mission is "counterair" and includes destruction of enemy airpower both in the air and on the ground. It has a range of more than 2000 nautical miles with provisions for in-flight refueling.

SPECIFICATIONS

Span 26 ft. 5 in.; Length 43 ft. 11 in.; Height 13 ft.; Takeoff Weight approximately 12,000 lb.; Engines Two General Electric J85 jet-turbo.

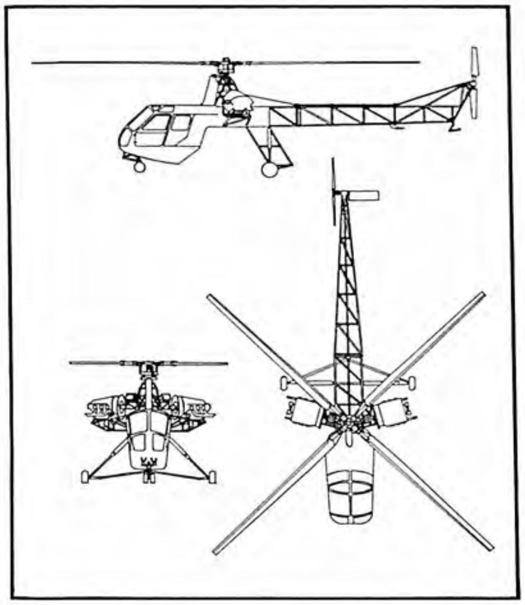
PERFORMANCE

Maximum Speed in excess of Mach 2.

OMEGA AIRCRAFT CORP.
NEW BEDFORD, MASSACHUSETTS

REMARKS

The Omega Twin is a rugged utility type helicopter designed for a wide variety of commercial applications. It embodies a five-place cabin forward, and a large cargo area directly beneath the rotor center-line. Cargo can be carried in this area in a detachable pod, in a net sling, or suspended from the surrounding fuselage structure as a separate unit. The fuselage is a welded tubular steel frame with the aft portion uncovered for ease of inspection and repair, and better stability and vibration characteristics. The high tail rotor position and skid minimize the possibility of tail rotor ground contact. The four-bladed main rotor system consists of two identical two-bladed, fully articulated rotors.



SPECIFICATIONS

Length 48 ft. 2 in.; Height 13 ft.; Empty Weight 3300 lb.; Gross Weight 4750 lb.; Rotor Diameter 39 ft.; Engines Two Lycoming 0-540-F1B5s, 260 hp at 2800 rpm takeoff.

PERFORMANCE

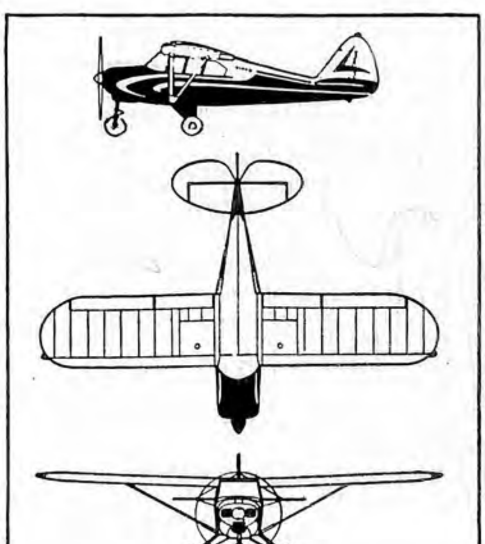
Maximum Speed 95 mph at Sea Level; Cruise Speed 85 mph at 75% power; Rate of Climb 1200 fpm; Service Ceiling 12,000 ft.

Omega BS-12 D

PIPER AIRCRAFT CORP.

LOCK HAVEN, PENNSYLVANIA

Piper PA-22 Caribbean



REMARKS

Piper Caribbean, 150-horsepower version of the Piper Tri-Pacer, is designed especially for airport operators, flying clubs, business and private pilots who want a well-equipped four-passenger airplane with maximum operating economy and low initial cost. For student instruction, Caribbean can be operated at 40 to 50 percent power, with fuel consumption as low as six gallons an hour. Production of the Piper Tri-Pacer also continued heavy during 1959. More than 7000 Tri-Pacers are now being flown in all parts of the world.

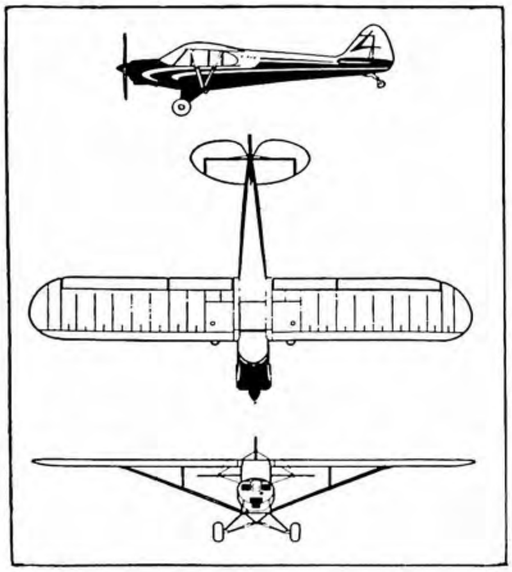
SPECIFICATIONS

Span 29 ft. 4 in.; Length 20 ft. 7 in.; Height 8 ft. 4 in.; Empty Weight 1100 lb.; Wing Loading 13.5 lb. per sq. ft.; Power Loading 13.3 lb. per bhp; Engine One Lycoming 0-320, 150 hp at 2700 rpm takeoff; Fuel Capacity 36 gal., extra 8 gal. optional; Propeller Sensenich metal; Wing Area 147.5 sq. ft.

PERFORMANCE

Maximum Speed 139 mph; Cruise Speed 136 mph at 75% power at 7000 ft. with optional wheel fairings; Landing Speed 49 mph; Rate of Climb 725 fpm; Service Ceiling 15,000 ft.; Absolute Ceiling 17,500 ft.; Range with Maximum Payload 528 mi.; Range with Maximum Fuel Load 645 mi.

Piper PA-18 Super Cub



REMARKS

This series includes the 150 horsepower PA-18 "150," the 90 horsepower PA-18 "95," and also includes the PA-18-A agricultural model, available as sprayer, duster or combination. With gross of 2070 pounds, PA-18-A is equipped with hopper with capacity of 110 gallons of liquid or 18 cubic feet of dust.

SPECIFICATIONS

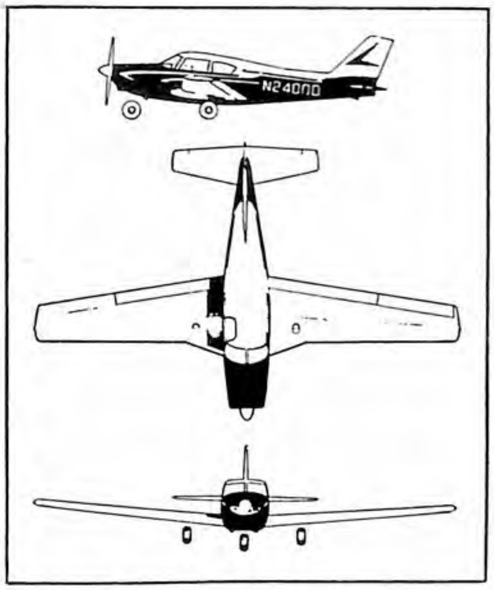
Span 35 ft. 4 in.; Length 22 ft. 6 in.; Height 6 ft. 8 in.; Empty Weight 930 lb.; Gross Weight 1750 lb.; Overload Gross Weight 2070 lb.; Wing Loading 10 lb. per sq. ft.; Power Loading 11.6 lb. per bhp; Engine PA-18 "150" Lycoming O-320 (PA-18 "95" Continental C90), 150 (90) hp at 2700 (2475) rpm takeoff; Fuel Capacity 36 (18) 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.

REMARKS

Piper offers the Comanche, high-performance, all-metal, 4-passenger plane with retractable tricycle landing gear, in two versions: Comanche with 180 hp Lycoming engine, for maximum economy; Comanche 250 with 250 hp, six-cylinder Lycoming for top performance. Advanced design features include swept rudder, stabilator and laminar flow wing section. Roomy cabin, ample luggage space and component systems designed for maintenance ease characterize the Comanches, now in volume production.



SPECIFICATIONS

Span 36 ft.; Length 24 ft. 8 in. (24 ft. 10 in. for "250"); Height 7 ft. 4 in.; Gross Weight 2550 lb. (2800 for "250"); Empty Weight 1475 lb. (1600 lb. for "250"); Wing Loading 14.3 lb. per sq. ft. (15.7 lb. for "250"); Power Loading 14.2 lb. per bhp (11.2 for "250"); Engine Lycoming O-360-A1A (Lycoming O-540-A1A for "250"); 180 hp normal rates (250 for "250"), at 2700 rpm (2575 for "250") takeoff; Fuel Capacity 50 or 60 gal. (60 for "250"); Propeller Constant speed, controllable; Wing Area 178 sq. ft.

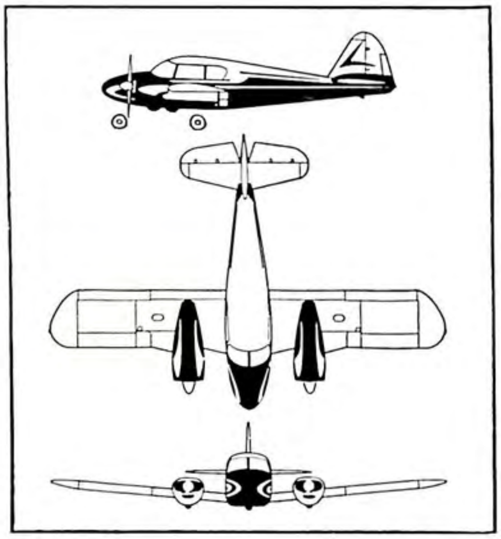
PERFORMANCE

Maximum Speed 167 mph (190 for "250"); Cruise Speed 160 mph (181 for "250") at 75 percent power at 8000 ft.; Landing Speed 58 mph (64 for "250'); Rate of Climb 910 fpm (1400 for "250"); Service Ceiling 18,500 ft. (20,000 for "250"); Absolute Ceiling 21,000 ft. (22,000 for "250"); Range with Maximum Payload 920 mi. (780 for "250"); Range with Maximum Fuel Load 1100 mi. (1100 for "250").

Piper Comanche PA-24

REMARKS

The Piper Twin Apache is all-metal design with short takeoff characteristics and slow landing speed for short field operations. It is capable of maintaining altitude at full gross weight on one engine. The rear seat can be removed in less than two minutes to provide 80 cubic feet of unobstructed stowage space. The model can be converted into an ambulance plane with room for one 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. Optional Apache configurations include a five-passenger version or installation of two reclining airline-type seats in the rear.



SPECIFICATIONS

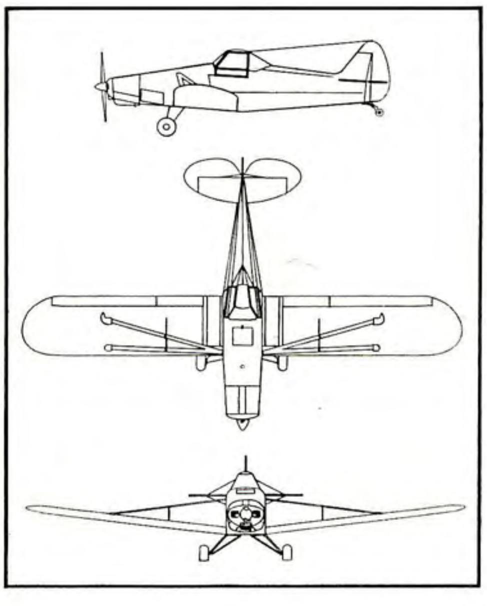
Span 37 ft.; Length 27.1 ft.; Height 9.5 ft.; Engines Two Lycoming O-320 B. 160 hp at 2700 rpm; Gross Weight 3800 lb.; Empty Weight 2230 lb.; Useful Load 1570 lb.; Wing Loading 18.6 lb. per sq. ft.; Power Loading 11.9 lb. per hp; Wing Area 204 sq. ft.; Baggage 200 lb.; Fuel Capacity 108 gal. with auxiliary tanks.

PERFORMANCE

Cruise Speed 171 mph at 7000 ft.; Range up to 1260 mi.

Piper PA-23 Twin Apache

Piper PA-25 Pawnee



REMARKS

Deliveries of new Piper Pawnee began in summer, 1959. Pawnee is a low-wing airplane designed specifically for aerial application of agricultural chemicals. Single-place Pawnee, first airplane to come out of Piper's new Development Center at Vero Beach, Florida, incorporates many features for pilot safety and efficient application of spray and dust. Pawnee has useful load of 1100 pounds, hopper capacity of 150 gallons or 20 cubic feet. Pilot's cockpit is aft for maximum safety, high as possible for unobstructed vision.

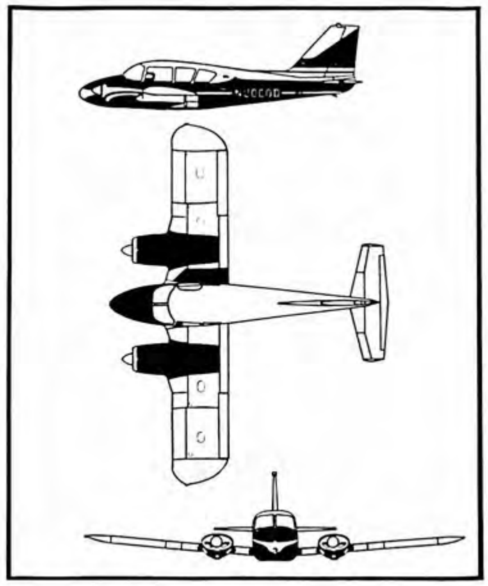
SPECIFICATIONS

Span 36 ft. 2 in.; Length 24 ft.; Height 8 ft. 9 in.; Empty Weight 1200 lb.; Wing Loading 12.5 lb. per sq. ft.; Power Loading 15.3 lb. per bhp; Engine Lycoming 0-320, 150 hp at 2700 rpm takeoff; Fuel Capacity 40 gal.; Propeller McCauley-metal; Wing Area 183 sq. ft.

PERFORMANCE

Maximum Speed 100 mph; Cruise Speed 90 mph; Landing Speed 57 mph; Rate of Climb 65 fpm; Service Ceiling 10,000 ft.; Absolute Ceiling 12,000 ft.; Range with Maximum Payload 400 mi.

REMARKS
Aztec, Piper's new twin-engine executive transport, was placed on the market late in 1959. The five-passenger Aztec has a very high single-engine ceiling. Single engine service ceiling at full 4800 pounds, gross weight is 7400 feet. Design features include swept rudder and single-piece stabilator. Aztec is available in three models, including AutoFlite, equipped with Piper Auto Control, transistorized automatic flight system.



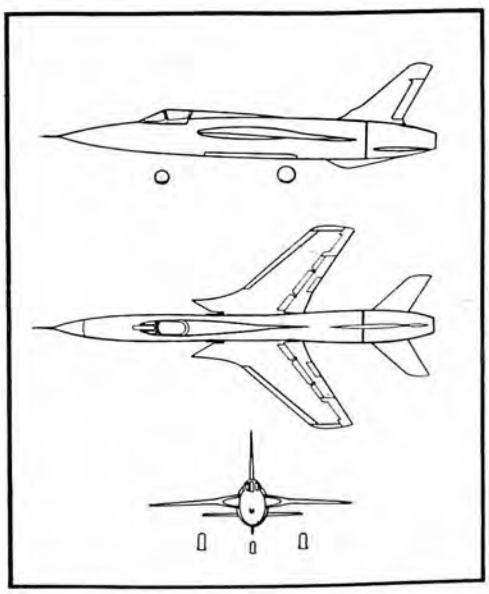
SPECIFICATIONS
Span 37 ft.; Length 27 ft. 7 in.; Height 10 ft. 4 in.; Empty Weight 2775 lb.; Wing Loading 23.5 lb. per sq. ft.; Power Loading 9.6 lb. per bhp; Engines Two Lycoming 0-540, 250 hp at 2575 rpm takeoff; Fuel Capacity 144 gal.; Propeller Hartzell constant speed full feathering.

PERFORMANCE
Maximum Speed 215 mph; Cruise Speed 205 mph at 75% power at 7000 ft.; Landing Speed 62 mph; Rate of Climb 1650 fpm; Service Ceiling 22,500 ft.; Absolute Ceiling 23,750 ft.; Range with Maximum Payload 1400 mi.

Piper PA-23-250 Aztec

REPUBLIC AVIATION CORP.
FARMINGDALE, LONG ISLAND, NEW YORK

Republic F-105D Thunderchief



REMARKS

The F-105D is the latest operational model of the Thunderchief series. Presently in production, it will be included in the Tactical Air Command's inventory of fighter-bomber aircraft. Similar to its predecessor, the F-105B, in its external configuration, the singleseat '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 elcetronic-system and can carry nuclear or thermonuclear weapons and guided or unguided missiles. Like the 'B', it is equipped with an automatic 20 millimeter cannon with a rate of fire of 6000 rounds per minute.

SPECIFICATIONS

Span 34 ft. 11 in.; Length 64 ft. 3 in.; Height 19 ft. 8 in.; Engine J75, over 24,000 lb. thrust with afterburner; more with water injection.

PERFORMANCE

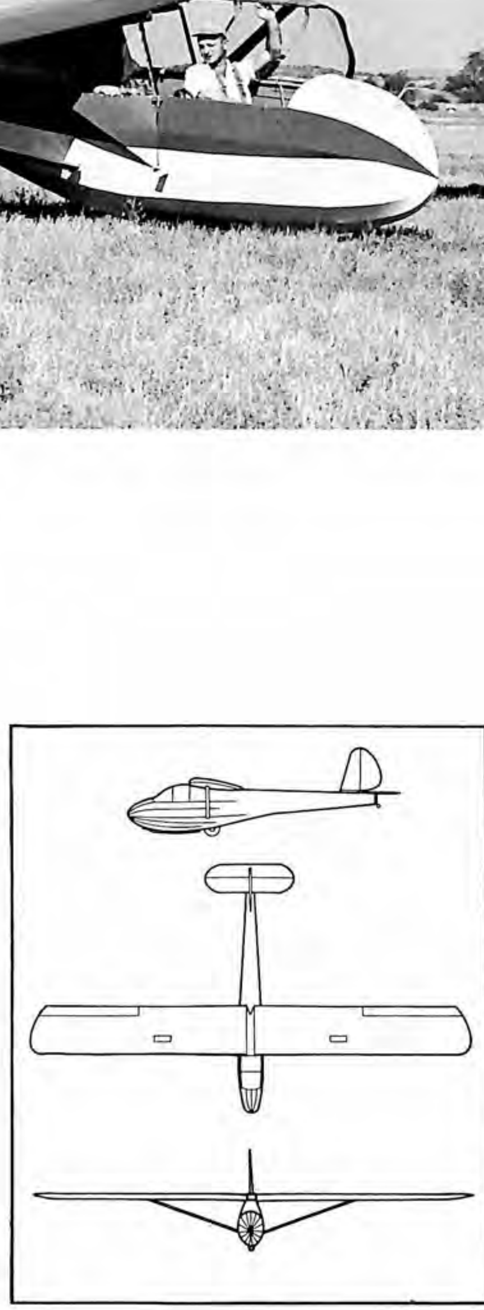
Speed Mach 2; Altitude Ceiling 50,000 plus.

SCHWEIZER AIRCRAFT CORP.
ELMIRA, NEW YORK

Schweizer 2-22C Sailplane

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 and is the type now being used by the Air Force Academy. 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 100 miles have been made and 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 1-23G sailplanes.



SPECIFICATIONS

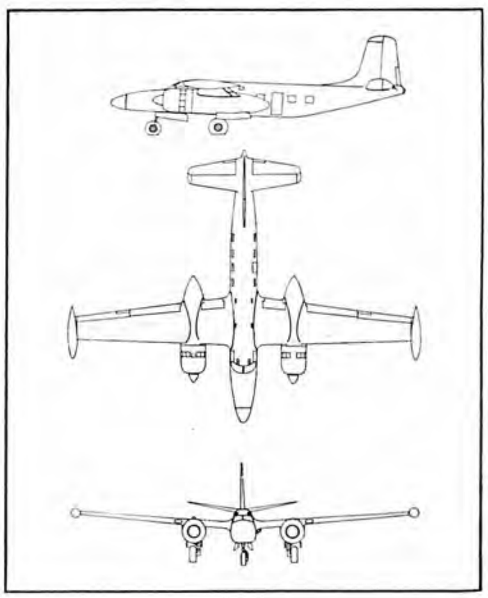
Span 43 ft.; Length 25 ft. 8.5 in.; Height 9 ft.; Empty Weight 450 lb.; Gross Weight 900 lb.; Wing Loading 4.28 lb. per. sq. ft.

PERFORMANCE

Minimum Sinking Speed (solo) 2.8 ft./sec.; (dual) 3 ft./sec.; Cruise Speed 89 mph; Placard Speed 90 mph.

L. B. SMITH AIRCRAFT CORP.
MIAMI 48, FLORIDA

Tempo II



REMARKS

Tempo II is a newly designed and pressurized seven to ten passenger executive version of the Douglas B-26. Retaining only the wings, control surfaces and nacelles of the original plane, the new pressurized fuselage is nine feet seven and one half inches longer than that of the original B-26 and the height is one foot, three inches greater, permitting a constant interior cabin height of six feet two inches throughout its entire passenger cabin length of twenty eight feet. Redesigned wing attachments, incorporating fuselage spar frames of one and one quarter inch thick rolled aluminum alloy plate, frees the cabin of wing spar structure and results in an additional ten inches of length to each wing. The first production model of Tempo II was completed and began flight tests on October 17th.

SPECIFICATIONS

Span 71 ft. 4 in.; Length 60 ft. 1½ in.; Height 20 ft.; Empty Weight 25,000 lb.; Wing Loading 62.7 lb. per sq. ft.; Power Loading 8.33 lb. per bhp; Engines Two Pratt & Whitney R2800 Cs, 1800 hp normal rated, or 2100 hp at 2800 rpm takeoff; Fuel Capacity 1370 gal.; Propeller Hamilton Standard 43E60/6895-20 (reversible); Wing Area 570 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. aft of hinge line; Stabilizer Area 83.4 sq. ft.; Elevator Area 32.7 sq. ft.

PERFORMANCE

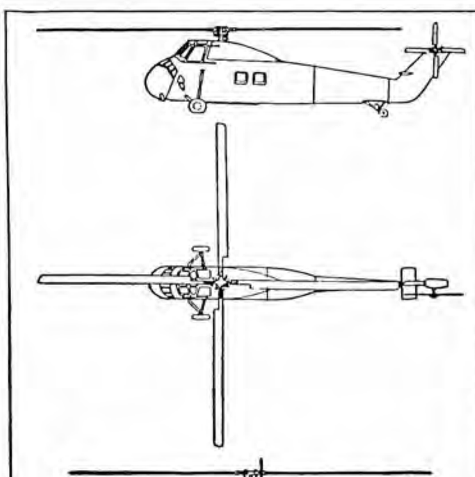
Cruise Speed 350 (TAS) mph at 67% hp at 2400 rpm at 20,000 ft.; Landing Speed 124 mph; Rate of Climb 1650 fpm at S. L.

SIKORSKY AIRCRAFT DIVISION
UNITED AIRCRAFT CORP.
STRATFORD, CONNECTICUT

Sikorsky S-58; HSS (Navy); H-34 (Army); HUS (Marines and Coast Guard)

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 Eisenhower is making frequent use of the Marine and Army versions of the S-58, embarking and disembarking from the White House lawn. More than 1,175 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. Holds three world records for speed in a closed circuit without payload; 100 kilometers (62.137 mi.), 141.9 mph; 500 kilometers (310.685 mi.,) 136 mph; 1000 kilometers (621.369 mi., 132.6 mph.



SPECIFICATIONS

Length 46 ft. 9 in. (Tail Pylon Not Folded); Height 15 ft. 10 in.; Empty Weight 7675 lb. (With Standard Equipment); Gross Weight 13,000 lb.; Useful Load 5325 lb.; Engine Wright Cyclone C989HE2 1275 hp normal rated at 2500 rpm or 1525 hp at 2800 rpm takeoff; Fuel Capacity 290 gal.; Main Rotor Diameter 56 ft.; Tail Wheel 6.00 x 6.

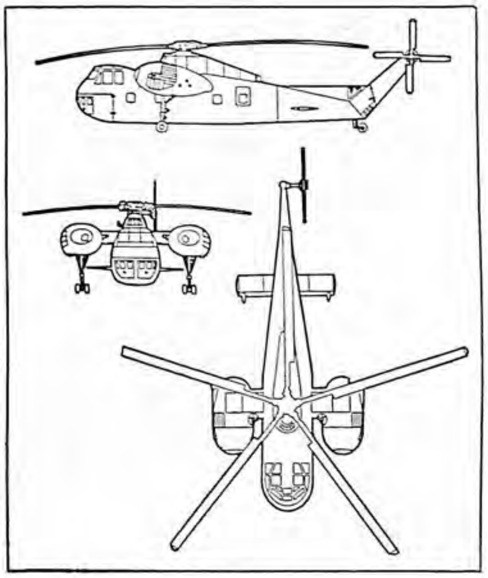
PERFORMANCE

Maximum Speed 123 mph at 1275 hp at 2500 rpm at Sea Level; Cruise Speed 98 mph at 2500 rpm; Maximum Rate of Climb 1100 fpm at Sea Level.

Sikorsky S-56; H-37 (Army); HR2S (Marines)

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 semi-automatic blade folding equipment are featured as is retractable landing gear. Five-bladed main and four-bladed tail rotors are all metal. More than 140 S-56s have been made. Holds two world records: Maximum speed without payload (over 3 Kil. course), 162.7 mph; altitude with 5000 Kg. load (11,023.110 lb.), 12,100 ft.

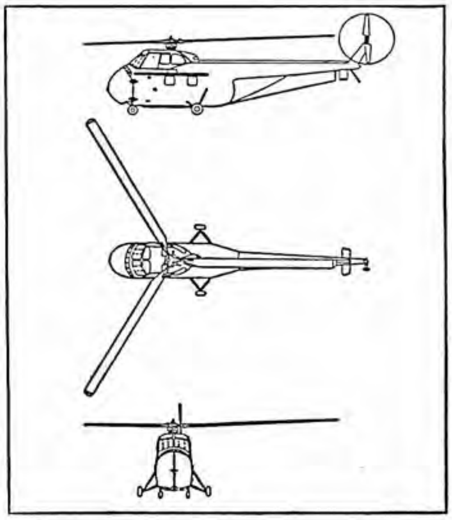


SPECIFICATIONS

Rotor Diameter 72 ft.; Length 82 ft. 10 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.



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

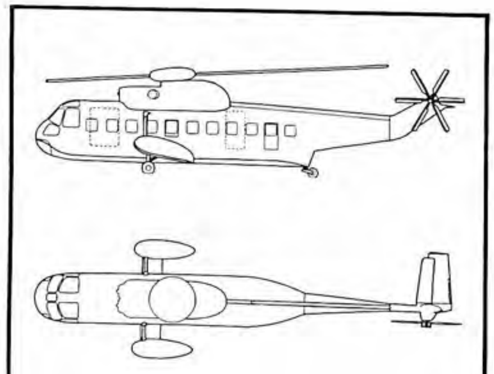
Main Rotor Diameter 53 ft.; Tail Rotor Diameter 8 ft. 9 in.; Length 42 ft. 3 in.; Height 13 ft. 4 in.; Empty Weight 4950 lb.; Gross Weight 7200 lb.; Engine Pratt & Whitney S3H2 rated at 600 bhp; Fuel Capacity 185 gal. Alternate 7500 lb. G.W. configuration uses Wright R1300 engine derated to 700 hp.

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-55; H-19 (Air Force, Army); HRS (Marines); H04S (Navy, Coast Guard)

Sikorsky S-61; HSS-2 (Navy)



REMARKS

The HSS-2, the world's largest amphibious helicopter, has a flying boat hull and twin gas turbine engines. It is being developed for the Navy as an anti-submarine warfare system and will be the Navy's first all-weather helicopter. The HSS-2 was flown publicly for the first time March 24, 1959, and the aircraft is now in production. Along with the develoment of the HSS-2 is the commercial S-61, a 25-28 passenger helicopter which has been ordered by Los Angeles Airways and Chicago Helicopter Airways. First flight of the S-61 is expected in mid-1960, with deliveries scheduled for late 1960 and 1961.

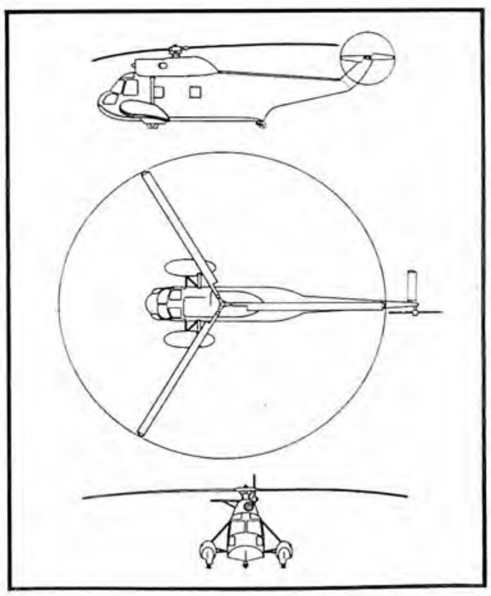
SPECIFICATIONS

Rotor Diameter 62 ft.; Overall Length 72 ft. 8.5 in.; Fuselage Length 58 ft. 11 in.; Empty Weight 10,259 lb.; Gross Weight 18,700 lb.; Useful Load 8,441 lb.; Engines Two General Electric T58-8s, 1250 shp maximum power, 1050 shp normal rated power; Fuel Capacity 2535 gal.

PERFORMANCE

Average Cruising Speed 135 mph at Sea Level; Maximum Speed 150 mph at Sea Level; Maximum Rate of Climb 1640 fpm at Sea Level; Range with Maximum Fuel Load 285 st. mi.

Sikorsky S-62



REMARKS

The S-62, a turbine-powered aircraft carrying from 10 to 12 passengers, is an amphibious helicopter with a flying boat-type hull. 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 began in 1959. 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 ten years.

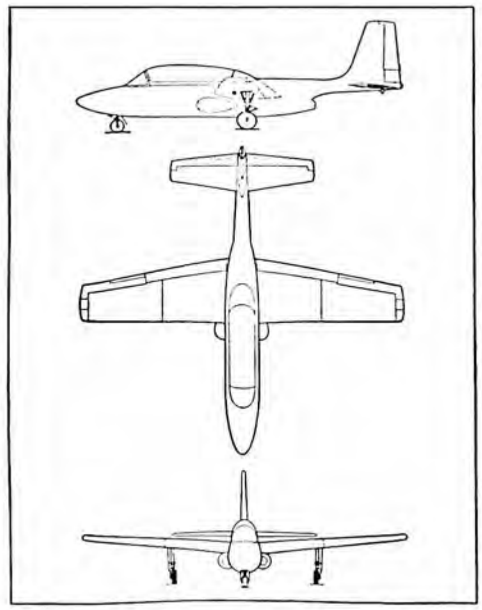
SPECIFICATIONS

Length 44 ft. 6.5 in.; Height 15 ft. 2 in.; Empty Weight 4600 lb.; Gross Weight 7500 lb.; Useful Load 2900 lb.; Engine General Electric T58-6, 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 115 mph at Sea Level; Maximum Speed 124 mph at Sea Level; Maximum Rate of Climb 1380 fpm at Sea Level; Range with Maximum Fuel Load 385 mi.

TEMCO AIRCRAFT CORP.
DALLAS, TEXAS



REMARKS

The TT-1 Pinto primary jet trainer continues in pioneering role for the Navy at Saufley Field, Pensacola, Florida. Training of cadets in the Navy's first all-jet syllabus began in January, with initial solo flights in March. Other classes followed the pioneers, and in August, night solo flights were performed in TT-1s. Evaluation of the all-jet program continues and further production is deferred pending completion. The TT-1 has performance and features planned for easy transition into jets to be flown later in the program. The Pinto is suitable for all conventional aerobatics and has such equipment as ejection seats, liquid oxygen system, integrated torso harness, UHF radio and speed brakes. It was designed specifically for efficient introduction of jet "feel" to primary cadets, but to accomplish more than has been previously taught in that stage of training. The TT-1 combines a subsonic dive speed of 450 knots with a stall speed low enough for first solo flights. Ruggedly built and economical to operate, the TT-1 is stressed for more powerful engines if desired.

SPECIFICATIONS

Span 29 ft. 10 in.; Length 30 ft.; Height 10 ft. 10 in.; Empty Weight 3139 lb.; Gross Weight 4400 lb.; Overload Gross Weight 4440 lb.; Wing Loading 29.4 lb. per sq. ft.; Power Loading 4.78 lb. per bhp; Engine Continental J69-T-2, 920 lb. thrust; Fuel Capacity 124 gal.; Wing Area 150 sq. ft.; Aileron Area 10.4 sq. ft.; Flap Area 15.65 sq. ft.; Fin Area 23.5 sq. ft.; Rudder Area 5.32 sq. ft.; Stablizer Area 39 sq. ft.; Elevator Area 11.6 sq. ft.

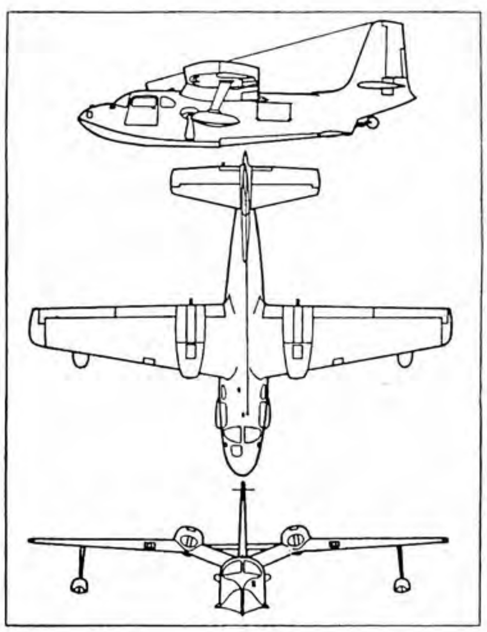
PERFORMANCE

Maximum Speed 286 knots at 100 percent rpm at 15,000 ft.; Average Cruise Speed 234 knots at 100 percent rpm at 22,350 ft.; Landing Speed 70 to 75 knots; Rate of Climb 1900 fpm at Sea Level; Service Ceiling 30,000 ft.; Absolute Ceiling 32,800 ft.; Range with Maximum Fuel Load 239 nautical mi.

Temco TT-1 Pinto Trainer

TRECKER AIRCRAFT CORP.
MILWAUKEE, WISCONSIN

Trecker Gull P-136-L2 Amphibian



REMARKS

Although the present Trecker Corp. has been in full operation little more than a year, it has in production the supercharged Trecker Gull, twin-engine amphibian successor to the Royal Gull.

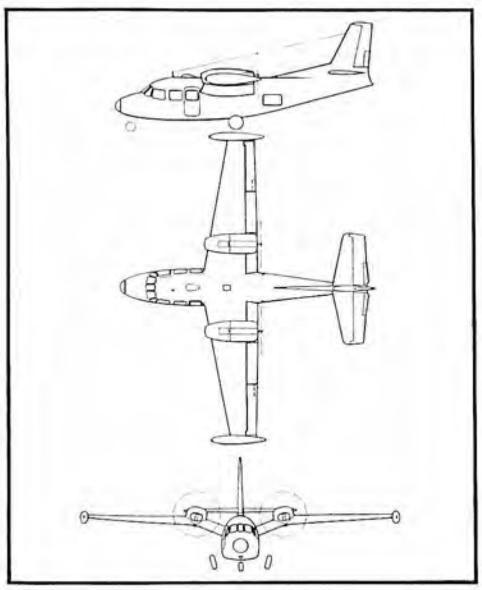
SPECIFICATIONS

Span 44 ft. 5 in.; Length 35 ft. 7 in.; Height 12 ft. 7 in.; Empty Weight 4630 lb.; Wing Loading 24.5 lb. per sq. ft.; Power Loading 10.3 lb. per bhp; Engines Two Lycoming GSO-480-A1A6, 320 hp normal rates, or 340 hp at 3400 rpm takeoff; Fuel Capacity 190 gal.; Propeller Two Hartzell full-feathering, 3-blade; Wing Area 270.2 sq. ft.; Aileron Area 21.3 sq. ft.; Flap Area 28.6 sq. ft.; Fin Area 17.85 sq. ft.; Rudder Area 12.16 sq. ft.; Stablizer Area 29.1 sq. ft.; Elevator Area 27 sq. ft.

PERFORMANCE

Maximum Speed 208 mph at 320 hp at 3200 rpm at 11,000 ft.; Cruise Speed 184 mph at 240 hp at 2750 rpm at 12,500 ft.; Landing Speed 82 mph; Rate of Climb 1279 fpm at Sea Level; Service Ceiling 25,400 ft.; Absolute Ceiling 26,600 ft.; Range with Maximum Payload 55 percent power 800 mi.; Range with Maximum Fuel Load 994 mi.

Trecker 166



REMARKS

The Trecker 166 is a light twin-engine land plane. Because of the high, gull wing's position behind and above the cabin, passenger visibility is excellent. Entire fuel supply is carried outboard of the engines in wing-panel and wing-tip tanks. Complete dual, airline type, yoke controls are standard.

SPECIFICATIONS

Span 46 ft. 9 in.; Length 38 ft. ¾ in.; Height 16 ft. 4¾ in.; Empty Weight 5104 lb.; Wing Loading 28.4 lb. per sq ft.; Engine Lycoming GSO-480-B1C6, 320 hp normal rated, or 340 hp at 3400 rpm takeoff; Fuel Capacity 232.5 gal.; Propeller Hartzell 3 blade, Wing Area 285.9 sq. ft.; Aileron Area 21.3 sq. ft.; Flap Area 29.6 sq. ft.; Fin Area 17.5 sq ft.; Rudder Area 13.2 sq. ft.; Stabilizer Area 37.1 sq. ft.; Elevator Area 27.7 sq. ft.

PERFORMANCE

Maximum Speed 226 mph at 320 hp at 3200 rpm at 11,000 ft.; Cruise Speed 208 mph at 240 hp at 2750 rpm at 12,800 ft.; Landing Speed 68 mph; Rate of Climb 1305 fpm at Sea Level; Service Ceiling 27,500 ft.; Range with Maximum Payload 1155 mi.

UMBAUGH AIRCRAFT CORP.
HAGERSTOWN, MARYLAND

REMARKS

The Umbaugh U-18 expresses the simplest form of rotary wing flight. The rotor system provides all the control for the U-18, once it is in flight, except that a small rudder at the rear of the fuselage aids in turning the craft about its vertical axis. However, satisfactory turns in either direction may be made without the use of the rudder. Longitudinal and lateral control are effected by mechanically tilting the rotor plane (in respect to the ground) the direction that control is desired. Climbing and descending are accomplished by a combination of rotor plane tilting and power application. The rotor is tilted by moving the control stick in the cockpit in the same way and in the same direction as is done in the fixed wing aircraft. Power is provided by a conventional airplane engine, the Lycoming "180" mounted as a pusher driving a fixed pitch propeller. Seating arrangement is tandem, with a completely closed and heated cockpit. Controls are provided for each of the two occupants.

SPECIFICATIONS

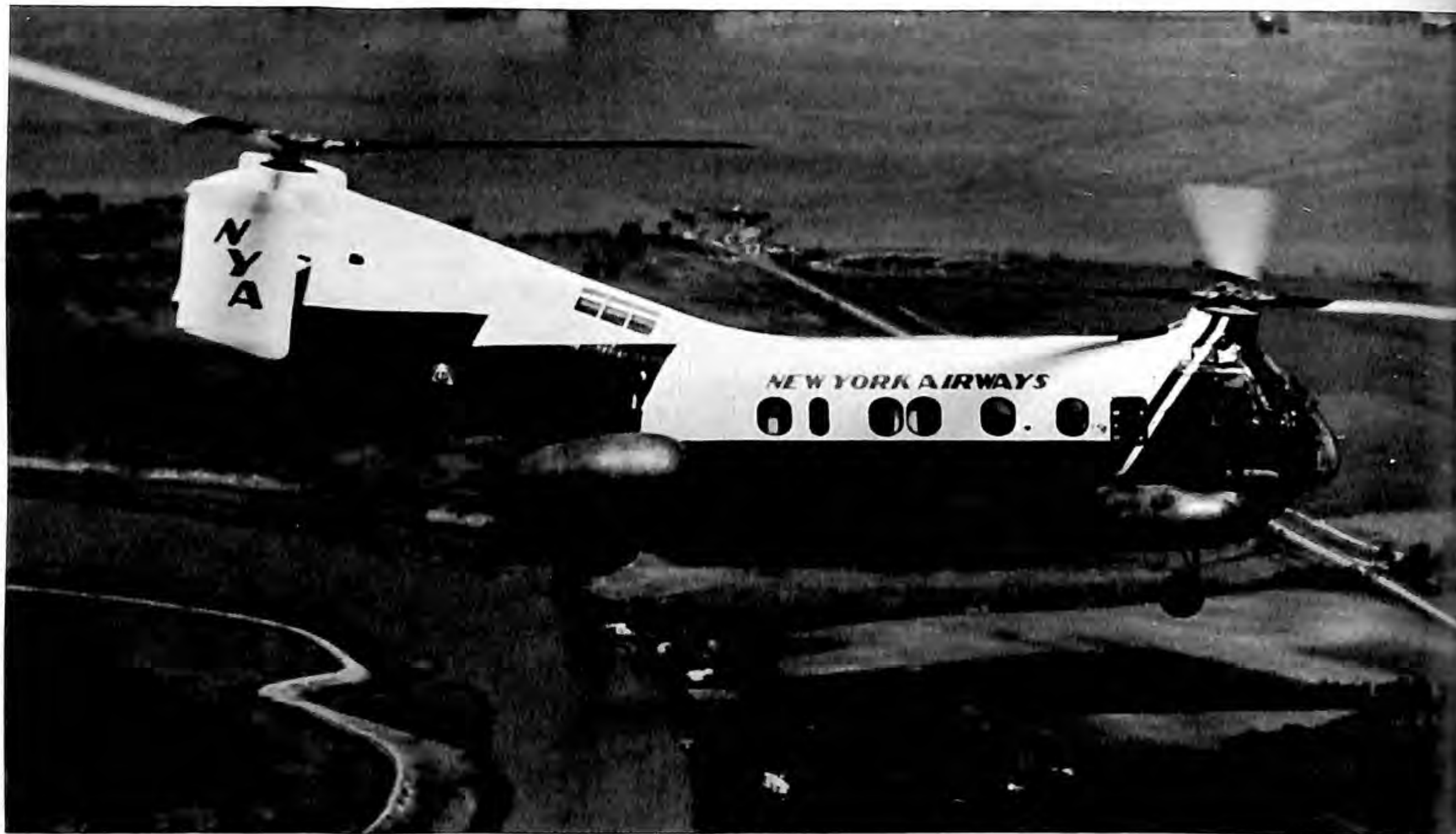
Height 10 ft.; Empty Weight 1200 lb.; Rotor Diameter 35 ft.; Power Loading 10 lb. per bhp; Engine 0-360-A, 180 hp normal rated, or 180 hp at 2700 rpm takeoff; Fuel Capacity 30 gal.; Propeller fixed pitch; Fin Area 10.71 sq. ft.; Rudder Area 7.70 sq. ft.; Stabilizer Area 10.68 sq. ft.

PERFORMANCE

Maximum Speed 115 mph; Cruise Speed 100 mph at 75% power; Landing Speed 0-10 mph; Rate of Climb 1000 fpm at Sea Level; Service Ceiling 15,000 ft.; Absolute Ceiling 17,000 ft.; Range with Maximum Payload 300 mi.; Range with Maximum Fuel Load 300 mi.

Umbaugh U-18 Gyroplane

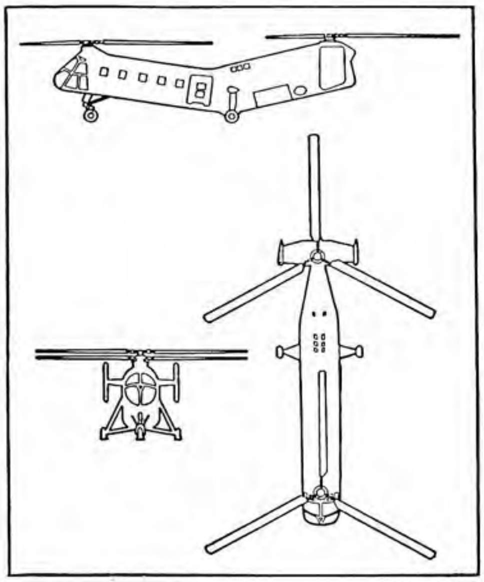
VERTOL AIRCRAFT CORP.
MORTON, PENNSYLVANIA



Vertol Model 44

REMARKS

A prototype for the Vertol 44 was jointly certified by the Civil Aeronautics Administration and the Canadian Department of Transport in April, 1957. The Vertol Model 44 transport helicopter is being offered to industry in three different versions: the Model 44A, cargo utility version which permits transport of 19 passengers; the Model 44B, a luxurious airliner capable of carrying 15 passengers; and the Model 44C, for deluxe executive transport in business and industry. It has a useful load of 5420 pounds, a cruising speed of 101 miles per hour. The tandem configuration eliminates balance problems in the placement of cargo and allows passengers to sit anywhere in the cabin. Five airline versions of this Vertol 44 now are operated by New York Airways. Utility versions are in service with Spartan Air Services, under contract with the Royal Canadian Air Force.

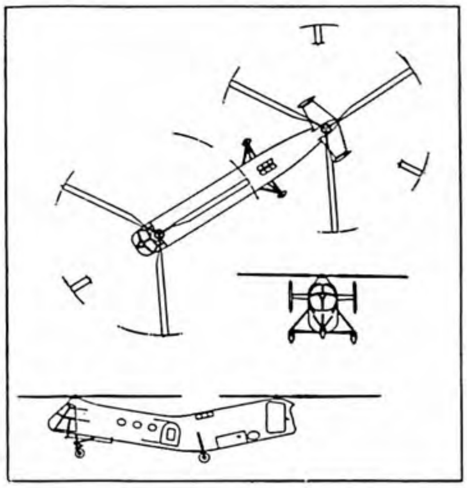


SPECIFICATIONS

Main Rotor Diameter 44 ft.; Length 52 ft. 6 in.; Height 15 ft. 5 in.; Empty Weight 8980 lb.; Useful Load 5420 lb.; Engine Wright 1820-103, 1275 hp normal rates, or 1425 hp at 2700 rpm takeoff; Fuel Capacity 300 gal.

PERFORMANCE

Maximum Speed 127 mph; Cruise Speed 101 mph; Service Ceiling 10,600 ft.; Range with Maximum Fuel Load 360 statute mi.



REMARKS

The H-21B is the Air Force and RCAF model in this series, and is similar to the Army H-21C. The fuselage is of all metal stressed skin, semi-monocoque construction. The cockpit has side-by-side seating with the pilot on the right and complete hydraulic controls. The main entrance door is located on the left side at the rear of the cabin. Twin-turbine powered versions of this aircraft have been extensively flight tested.

SPECIFICATIONS

Rotor Diameter 44 ft.; Length 52 ft. 6 in.; Height 16 ft.; Empty Weight 8500 lb.; Gross Weight 13,300 lb.; Overload Gross Weight 15,200 lb.; Engine Wright R1820-103, 1425 hp, military; Fuel Capacity 300 gal.; Gear fixed tricycle.

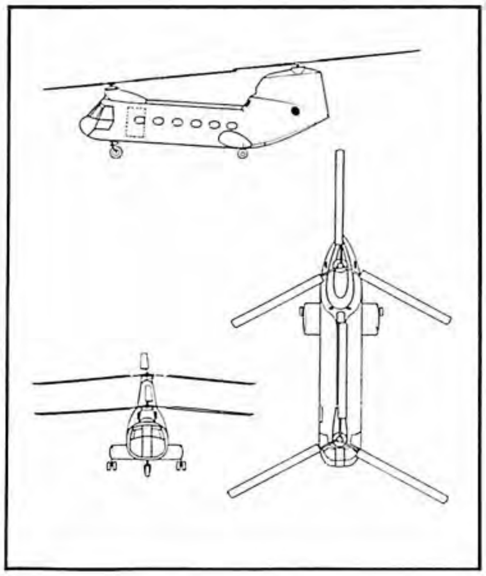
PERFORMANCE

Maximum Speed 135 mph at Sea Level; Cruise Speed 98 mph at Sea Level; Rate of Climb 1100 fpm; Service Ceiling 10,000 ft.; Range over 450 mi.

Vertol H-21 Workhorse Transport

REMARKS

The company-developed Vertol 107 twin-turbine helicopter is the first in a new family of multi-turbine powered helicopters capable of all-weather flying. It is a prototype for the Army's YHC-1, a service test quantity of which have been ordered. This new tandem-rotored transport helicopter has been designed to meet the operational requirements of both military and commercial operators and embodies such features as rear-loading, multi-engine reliability, all-weather capability and ease of maintenance. Maximum cabin area is available for transporting people and/or cargo. With the engines mounted at the base of the aft pylon, the rear ramp can be left open during flight, enabling the helicopter to carry elongated cargo, such as missiles. Although the Vertol 107 is 8 feet shorter than the famous Vertol H-21 Work Horse, the cubic capacity of the cabin is actually one-third greater. Access panels provide easy servicing of all components for maintenance of the aircraft. Designed to grow, the Vertol 107 could take higher-powered turbine engines, as they become available, and the aircraft structure could be enlarged for greater payload capacity without changing the basic aircraft design.



SPECIFICATIONS

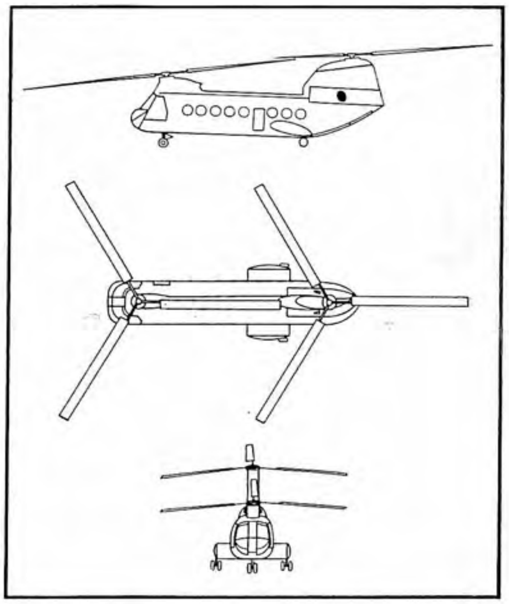
Main Rotor Diameter 48 ft. 4 in.; Length 44 ft. 3.6 in.; Height 17 ft.; Gross Weight 15,500 lb.; Engines Two Lycoming T53 or Two General Electric T58.

PERFORMANCE

Classified.

Vertol 107 (Army YHC-1)

Vertol Model YHC-1A



REMARKS

The Army's YHC-1A is the first growth version of the Vertol-developed Model 107. A service test quantity of this multi-turbine powered YHC-1A was ordered by the Army in July, 1958. It is a prototype for the larger YHC-1B "Chinook." Commercial versions of the YHC-1A, designated the Vertol 107 Model II, are being offered to industry and the export market. New York Airways has signed an option for the right to purchase the first five airliner versions produced by the company. Following the functional design concepts of the 107 prototype, the YHC-1A is multi-turbine powered, features a rear loading ramp, access panels for ease of maintenance.

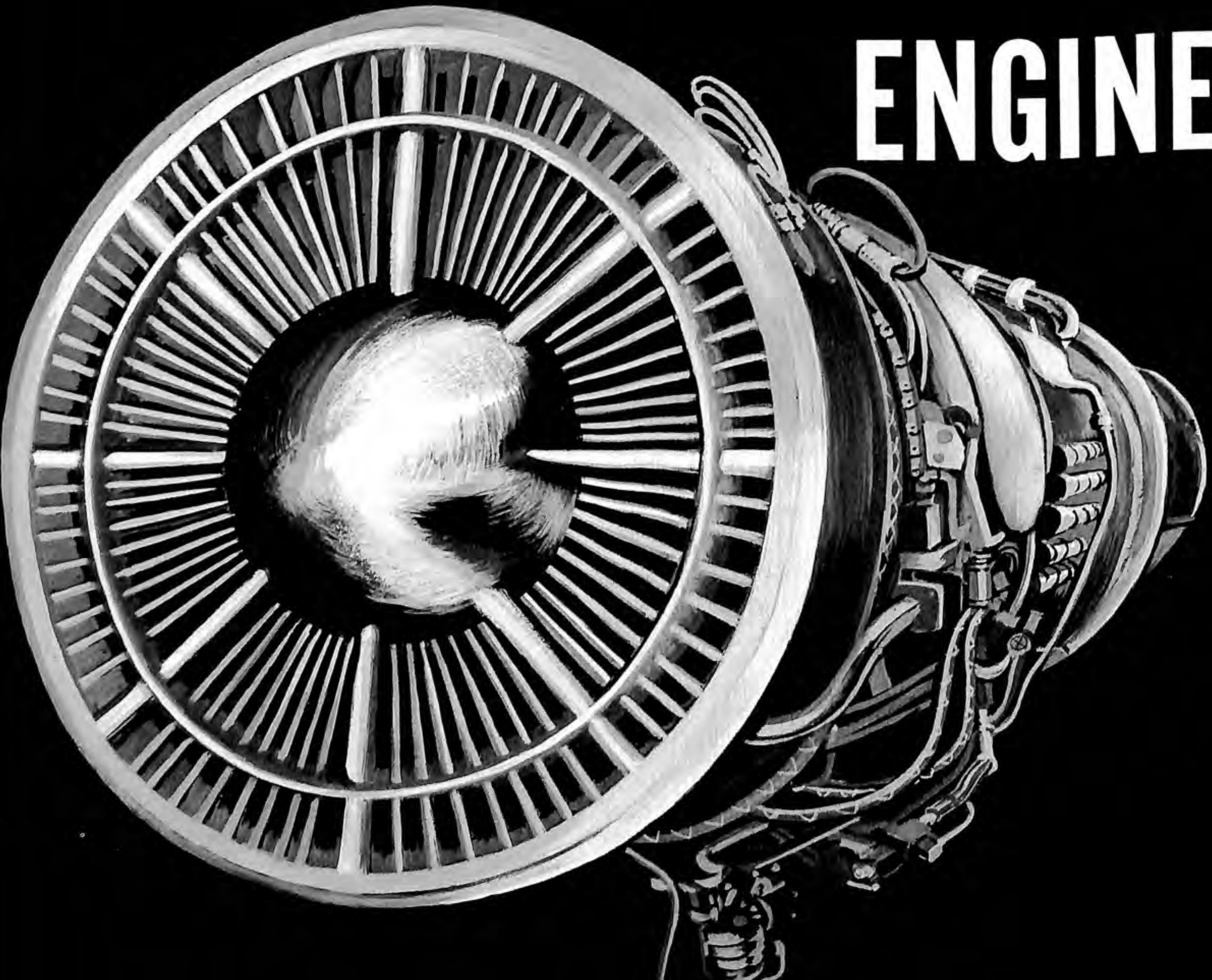
SPECIFICATIONS

Height 16 ft. 10 in.; Rotor Diameter 50 ft.; Engines Two General Electric YT58 shaft turbines.

PERFORMANCE

All data are classified.

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 transmitted to the attachment fittings by two mounting 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

The 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.

AIRCOOLED MOTORS, INC.

SYRACUSE, NEW YORK

• MODEL: FRANKLIN 6A4-165-B3

Data

Type: 6 cylinder, air-cooled, horizontally opposed. FAA Type Certificate: 238.

Specs

Length: 27 13/32 in. Fuel Grade: 80 octane. Bore: 4.5 in. Stroke: 3.5 in. Displacement: 335 cu. in. Compression Ratio: 7:1. Dry Weight: 324 lb. with hub and accessories. Weight per hp: 1.97 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 or Bendix PS5-C. Ignition: Dual Scintilla S6N21. Starter: Delco-Remy. Generator: Delco-Remy. Fuel Pump: AC.

• MODEL: FRANKLIN 6V4-200-C32, C33

Data

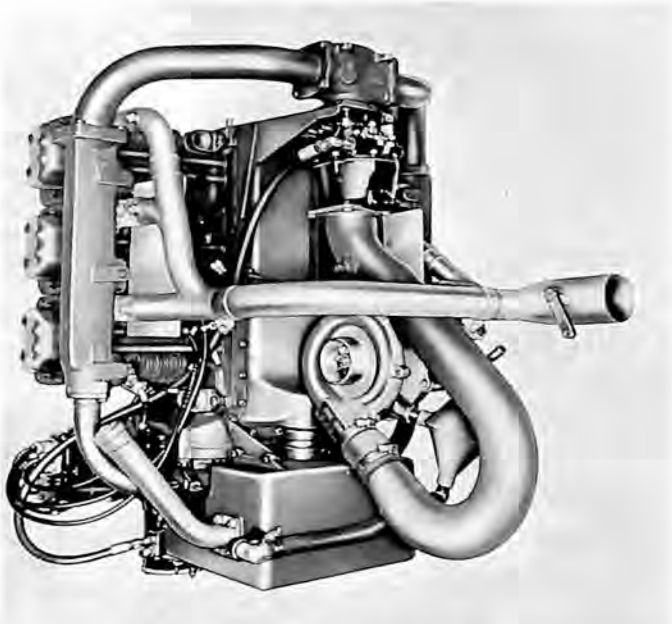
Type: 6 cylinder, air-cooled, horizontally opposed. FAA Type Certificate: 244.

Specs

Length: 29 1/32 in. Fuel Grade: 91 octane. Bore: 4.5 in. Stroke: 3.5 in. Displacement: 335 cu. in. Compression Ratio: 8.5:1. Dry Weight: 333 lb. with accessories. Weight per hp: 1.66 lb.

Performance

Takeoff Power: 200 hp. Fuel Consumption: .52 lb. per hp hr. Oil Consumption: .002 lb. per hp hr.



Aircooled Model 6VS-335.

Equipment
Carburetor: Marvel-Schebler MA4-5 or Bendix PS5-C. Ignition: Dual Scintilla S6RN21. 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: 308 lb. Weight per hp: 1.46 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 S6RN21. Starter: Delco-Remy. Generator: Delco-Remy. Fuel Pump: Weldon. Designed for helicopter installation.

• **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: 321 lb. with hub and accessories. Weight per hp: 2.14 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: 38⁹⁄₆₄ in. Depth: 39¾ in. Width: 31⁹⁄₁₆ 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
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. Other performance data: 225 hp sea level rating, maintains full rating up to 15,000 ft.

Equipment
Carburetor: Marvel MA4-5. 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: 31¹⁹⁄₃₂ in. Displacement: 335 cu. in. Bore: 4½ in. Stroke 3½ in. Compression Ratio: 8.5:1. Fuel Grade: 91 octane. Dry Weight: 308 lb.

Equipment
Carburetor: Marvel-Schebler MA4-5. Magnetos: Scintilla S6RN21. Starter: Delco-Remy 24 volt. Generator: Pierson 24 volt, 20 amp.

AiRESEARCH MANUFACTURING DIVISION
THE GARRETT CORPORATION
PHOENIX, ARIZONA

• **MODEL: GTC 85-135**

Data
Type: Gas Turbine Air Compressor.

Specs
Length: 39.78 in. Width: 26.95 in. Weight: 240 lb. with all flying accessories. Compressor Stages: 2. Turbine Stages: 1.

Performance
S.L. 60° day; Air delivery, 140 lb. per min.; Air pressure, 105 in. of mercury.

Equipment
Starter: Electric, 28 volt; Automatic controls.

Remarks
Altitude starting 15,000 ft. Fuel: Mil-F-3056, Mil-F-5572, Mil-F-5624, grades JP-3 or JP-4. Ambient operating temperature −65°F to +130°F. Current production application: Prime movers for McDonnell model 120 pressure jet utility cargo helicopter (3 per craft).

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 is 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: B2

Data

Type: Free turbine propjet.

Specs

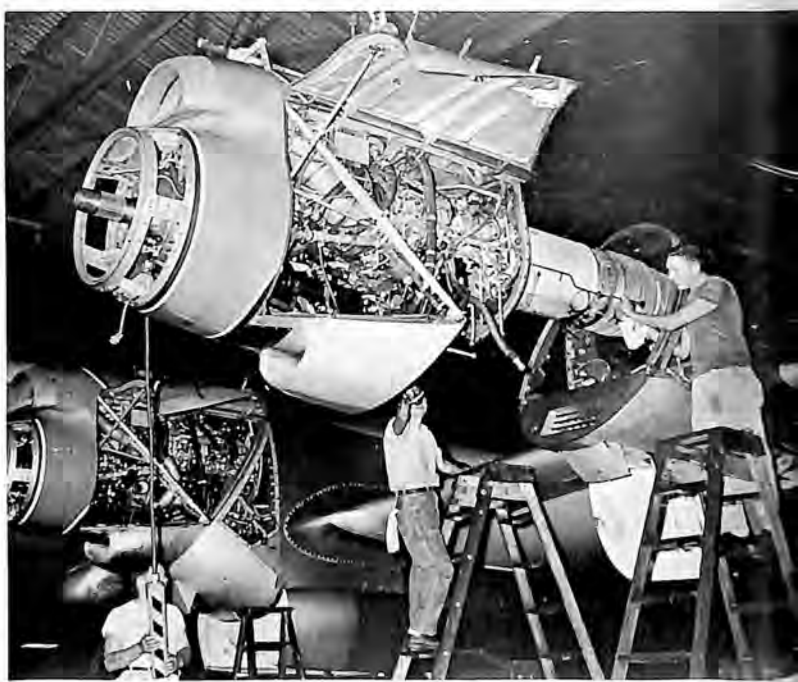
Length: 38.5. Width: 15.8. Fuel Grade: JP-4 (Alternate 115/145). Dry Weight: 106 lb. Compressor Stages: 7 axial; 1 centrifugal. Turbine Stages: Single-stage gas producer; Two-stage power turbine.

Performance

Fuel Consumption: 0.70.

Remarks

Rated at 250 SHP.



Allison 501-D13 propjet.

• MODEL: C2

Data

Type: Free turbine turbo-shaft.

Specs

Length: 34.6. Width: 15.8. Fuel Grade: JP-4 (Alternate 115/145). Dry Weight: 90 lb. Compressor Stages: 7 axial; 1 centrifugal. Turbine Stages: Single-stage gas producer; Two-stage power turbine.

Performance

Fuel Consumption: 0.70.

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.

- **MODEL: T61**

Data

Type: Propjet.

Specs

Length: 142 in. Width: 33 in. Height: 45 in. Dry Weight 2240 lb. Compressor Stages: 9-stage high pressure, 6-stage low pressure. Turbine Stages: 2-stage high pressure, 3-stage low pressure.

Equipment

Starter: Govt. furn. equip.

Remarks

ESHP 6500 at 10,400 rpm at sea level conditions.

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: 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.

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: 33.58 in. Displacement: 471 in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 7.0:1. Fuel Grade: 80/87 octane. Dry Weight: 415 lb., complete with accessories.

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: 471 in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 8.0:1. Fuel Grade: 91/96. Dry Weight: 450 lb., complete with accessories.

Performance

Rating: 240 hp at 2600 rpm at sea level.

Equipment

Carburetor: Bendix. Magneto: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy, 24 volt, 15 amp.

- **MODEL: O-300-A & B**

Data

Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 253.

Specs

Length: 36.38 in. Width: 31.50 in. Displacement: 301.37 in. Bore: 4.0625 in. Stroke: 3.875 in. Compression Ratio: 7.0:1. Fuel Grade: 80/87. Dry Weight: 310.88 lb., complete with accessories.

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-K & L**

Data

Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 273.

Specs

Length: 36.03 in. Width: 33.58 in. Displacement: 471 in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 7.0:1. Fuel Grade: 80/87. Dry Weight: 438 lb., complete with accessories.

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: 30.41 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: 176 lb.

Performance

Rating: 65 hp at 2300 rpm at sea level.

Equipment

Carburetor: Marvel. Ignition: Scintilla.

- **MODEL: C85-12F**

Data

Type: 4 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 233.

Specs

Length: 32 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: 186 lb., complete with accessories.

Performance

Rating: 85 hp at 2575 rpm at sea level.

Equipment

Carburetor: Stromberg. Ignition: Scintilla. Starter: Delco-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: 31.25 in. Fuel Grade: 80/87 octane. Bore: 4.062 in. Stroke: 3.875 in. Displacement: 200.91 cu. in. Compression Ratio: 7:1. Dry Weight: 186 lb., complete with accessories.

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: 46.66 in. Fuel Grade: 80/87 octane. Bore: 5 in. Stroke: 4 in. Displacement: 471 cu. in. Compression Ratio: 7:1. Dry Weight: 350 lb., complete with accessories.

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. Fuel Grade: 80/87 octane. Bore: 5 in. Stroke: 4 in. Displacement: 471 cu. in. Compression Ratio: 7:1. Dry Weight: 393 lb., complete with accessories.

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: 471 in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 7.0:1. Fuel Grade: 100/130. Dry Weight: 474 lb.

Performance

Rating: 265 bhp at 2600 rpm at sea level.

Equipment

Carburetor: Bendix. Magneto: Scintilla. Starter: Eclipse. Generator: Eclipse, 30 volt, 50 amp.

- **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: 471 in. Bore 5.00 in. Stroke: 4.00 in. Compression Ratio: 7.0:1. Fuel Grade: 80/87. 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: GO-526**

Data

Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: Pending.

Specs

Length: 49.12 in. Width: 34.68 in. Displacement: 526 in. Bore: 5.125 in. Stroke: 4.25 in. Compression Ratio: 7.0:1. Fuel Grade: 80/87. Dry Weight: 408 lb., complete with accessories.

Performance

Rating: 290 bhp at 3200 rpm at sea level.

Equipment

Carburetor: Bendix. Magneto: Scintilla.

- **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 in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 8.0:1. Fuel Grade: 91/96. Dry Weight: 432 lb., complete with accessories.

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-D**

Data

Type: 6 cylinder, air-cooled horizontally opposed, FAA Type Certificate: 3E2.

Specs

Length: 43.53 in. Width: 33.58 in. Displacement: 471 in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 8.6:1. Fuel Grade: 100/130. Dry Weight: 426.0 lb. Total Weight: 466.5 lb.

Performance

Rating: 260 bhp at 2625 at sea level.

Equipment

Fuel Injector: Continental Motors. Magneto: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy, 25 amp. 24 volt.

• **MODEL: IO-470-J**

Data

Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate 3E1.

Specs

Length: 37.93 in. Width: 33.58 in. Displacement: 470 in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 7.0:1. Fuel Grade: 80/87. 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**

Data

Type: 6 cylinder, fan-cooled, horizontally opposed, FAA Type Certificate: 292.

Specs

Length: 47.69 in. Width: 33.64 in. Displacement: 526 in. Bore: 5.125 in. Stroke: 4.25 in. Compression Ratio: 7.0:1. Fuel Grade 91/96. Dry Weight: 568 lb.

Performance

Rating: 270 bhp at 3200 rpm at sea level.

Equipment

Carburetor: Bendix. Magneto: Scintilla.

Remarks

This is a supercharged helicopter engine.

• **MODEL: GSO-526-A**

Data

Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 303.

Specs

Length: 52.28 in. Width: 34.68 in. Displacement: 526 in. Bore: 5.125 in. Stroke: 4.25 in. Compression Ratio: 6.0:1. Fuel Grade: 100/130. Dry Weight: 549, complete with accessories.

Performance

Rating: 340 hp at 3100 rpm at sea level.

Equipment

Carburetor: Bendix. Magneto: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy, 24 volt, 50 amp.

• **MODEL: GO-300-A**

Data

Type: 6 cylinder, air-cooled, horizontally opposed, FAA Type Certificate: 298.

Specs

Length: 39.12 in. Width: 31.50 in. Displacement: 301 in. Bore: 4.0625 in. Stroke: 4.25 in. Compression Ratio: 7.3:1. Fuel Grade: 80/87. Dry Weight: 312 lb., complete with accessories.

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.

• **MODEL: O-470-H**

Data

Type: 6 cylinder, air-cooled, horizontally opposed, wet sump, FAA Type Certificate: 273.

Specs

Length: 67.65 in. Width: 33.58 in. Displacement: 471 in. Bore: 5.00 in. Stroke: 4.00 in. Compression Ratio: 8.0:1. Fuel Grade: 91/96. Dry Weight: 471.75 lb. Total Weight: 510.00 lb.

Performance

Rating: 240 bhp at 2600 rpm at sea level.

Equipment

Carburetor: Bendix. Magneto: Scintilla. Starter: Delco-Remy. Generator: Delco-Remy, 12 volt, 25 amp.

Remarks

Engine has a direct drive spline type extended propeller shaft. This is a pusher type engine.

• **MODEL: O-200-A**

Data

Type: 4 cylinder, air-cooled, horizontally opposed, wet sump, FAA Type Certificate: 252.

Specs

Length: 28.53 in. Width: 31.56 in. Displacement: 201 in. Bore: 4.062 in. Stroke: 3.875 in. Compression Ratio: 7.0:1. Fuel Grade: 80/87. Dry Weight: 189.69 lb. Total Weight: 220.00 lb., with accessories.

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.

GENERAL ELECTRIC COMPANY
AIRCRAFT GAS TURBINE DIVISION
CINCINNATI, OHIO

• **MODEL: CJ-805-3, -3B**

Data

Type: Commercial turbojet engine, single rotor, variable stator.

Specs

Length: 109.56 in. (188.94 in. with reverser/suppressor). Frame Size: 32 in. Compression Ratio: 13:1. Total Weight: 2800 lb. Compressor Stages: 17 (6 variable). Turbine Stages: 3.

Performance

Maximum Thrust: 11,200 lb. at .086 sfc. Normal Rated Thrust: 9500 lb. at .738 sfc. Maximum Cruise Thrust: 8850 lb. at .728 sfc.

Remarks

Current production installation: Convair 880.

• **MODEL: CJ-805-23**

Data

Type: Commercial turbofan engine. Single rotor, variable stator, aft fan.

Specs

Length: 144 in. Width: Basic Engine, 32 in., Aft fan, 53 in. Compression Ratio: Basic Engine, 13:1, Aft fan, 1.6:1. Total Weight: 3825 lb. Compressor Stages: 17. Turbine Stages: 3.

Performance

Maximum Thrust: 16,100 lb. at .541 sfc. Normal Rated Thrust: 13,700 lb. at .505 sfc. Maximum Cruise Thrust: 13,300 lb. at .504 sfc.

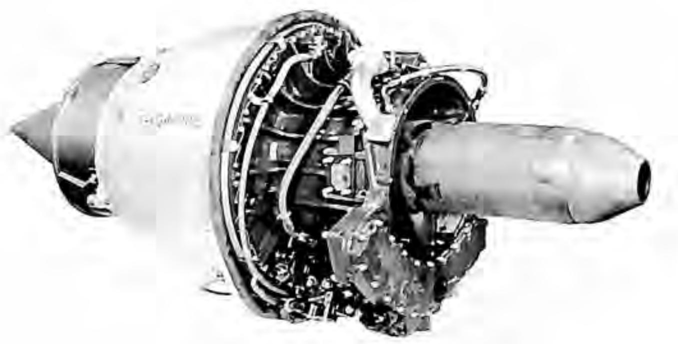
Remarks

Current production installation: Convair 600 luxury jetliner.

• **MODEL: J79-GE-2, -3A, -5A, -7**

Data

Type: Military turbojet.



Continental Aviation's J69-T-25.

Specs
Length: 204 in. Frame Size: 32 in. Compression Ratio: 12:1. Total Weight: 3200 lb. Compressor Stages: 17, axial flow, single rotor. Turbine Stages: 3.

Performance
Maximum Thrust: 15,000 lb.

Remarks
Current production installation: Lockheed F-104, Convair B-58 Hustler, North American A3J Vigilante, McDonnell F4H.

- **MODEL: J93-3**

Data
Type: Turbojet.

Specs
Classified.

Performance
Mach 3.0.

Equipment
Classified.

Remarks
Current production installation: North American B-70 advanced bomber.

SMALL AIRCRAFT ENGINE DEPARTMENT
LYNN, MASSACHUSETTS

- **MODEL: T58-6**

Data
Type: Turboshaft.

Specs
Diameter: 16 in. Length: 55 in. Compression Ratio: 8.3:1. Fuel Grade: JP-4/JP-5. Dry Weight: 271 lb. Compressor Stages: 10. Turbine Stages: 2 plus 1.

Performance
Maximum shp: 1050. Normal Rated shp: 900. Fuel Consumption: .64 military.

Remarks
Current production installation: military: Sikorsky HSS-2; Vertol YHC-1A; Kaman HU2K; Sikorsky HSS-1 (experimental); Vertol H-21D (experimental); Kaman K-16 (experimental VTOL); Fairchild M-224-1 (experimental VTOL). Civilian version, designated CT-58-100, certified by FAA for use in commercial helicopters. Announced commercial applications: Sikorsky S-61; Sikorsky S-62; Vertol 107 Model II. T58-8, 1250 shp growth engine, successfully completed 50-hr. PFRT August 1959. 150-hr. qualification test scheduled for July 1960.

- **MODEL: CF700**

Data
Type: Turbofan.

Specs
Diameter: 33 in. Length: 69 in. Fuel Grade: JP-4. Total Weight: 585 lb., 665 lb. with reverser. Compressor Stages: 8. Turbine Stages: 2.

Performance
Maximum Thrust: 4000 lb. takeoff. Normal Rated Thrust: 1020 lb., normal, Continuous 36,000 ft., Mach 0.8. Fuel Consumption: 0.69 takeoff. Fuel consumption: 0.97 lb./lb./hr. normal, Continuous 36,000 ft., Mach 0.8.

Remarks
Engine development program, proceeding on company funds, calls for producing flight-worthy engines by mid-1961 and FAA certified engines in early 1962.

- **MODEL: T64-2**

Data
Type: Turboshaft.

Specs
Height: 30.4 in. Length: 91 in. Width: 24.75 in. Fuel Grade: JP-4/JP-5. Dry Weight: 854 lb. Compressor Stages: 14. Turbine Stages: 2 plus 2.

Performance
Maximum SHP: 2650 (military). Normal rated SHP 2235. Fuel Consumption: 0.506 (military). Normal Rated Fuel Consumption: 0.527.

- **MODEL: T64-4, -8**

Data
Type: Turboprop.

Specs
Height: 36 in. Length: 113 in. Width 29 in. Fuel Grade: JP-4/JP-5. Dry Weight: 1079 lb. Compressor Stages: 14. Turbine Stages: 2 plus 2.

Performance
Maximum ESHP: 2570 (military). Normal Rated ESHP: 2230. Fuel Consumption ESFC: 0.522 (military). Normal Rated Fuel Consumption: 0.529.

Remarks
T64-4 prop gear is below engine centerline; T64-8 prop gear is above engine centerline.

- **MODEL: T64-6**

Data
Type: Direct drive.

Specs
Height: 30.4 in. Length: 62 in. Width: 23.8 in. Fuel Grade: JP-4/JP-5. Dry Weight: 710 lb. Compressor Stages: 14. Turbine Stages: 2 plus 2.

Performance
Maximum SHP: 2690 (military). Normal Rated SHP: 2270. Fuel Consumption: 0.498 (military). Normal Rated Fuel Consumption: 0.520.

Equipment
Turboshaft configuration for helicopters formed by using helicopter reduction gear; turboprop configuration for propeller driven aircraft formed by adding propeller reduction gear and propeller brake; direct drive version consists of basic power section without shafting or gearing.

- **MODEL: J85-5**

Data
Type: Turbojet–piloted configuration.

Specs
Diameter: 20.3 in. Length: 104 in. Fuel Grade: JP-4. Total Weight: 525 lb. Compressor Stages: 8. Turbine Stages: 2.

Performance
Maximum Reheat Thrust, SLS, Standard Day: 3850 lb. Military Thrust, SLS, Standard Day: 2500 lb. Power to Weight Ratio: 7-3:1. Specific Weight: .136.

Equipment
Afterburner. Starter: Air Impingement.

Remarks
Scheduled production installation: Northrop N-156F; Northrop T-38; Radioplane Q4-B. J85-5 has successfully run its official 50 hr. PFRT.

- **MODEL: J85-7**

Data
Type: Turbojet—missile configuration.

Specs
Diameter: 17.7 in. Length: 42 in. Fuel Grade: JP-4. Total Weight: 325 lb. Compressor Stages: 8. Turbine Stages: 2.

Performance
Military Thrust: 2450 lb., SLS, Standard Day. Power to Weight Ratio: 7.5:1. Specific Weight: .132.

Equipment
Starter: Air Impingement.

Remarks
Scheduled production installation: McDonnell GAM-72. J85-7 has successfully run its official QT.

LYCOMING DIVISION
AVCO CORPORATION
STRATFORD, CONNECTICUT

- **MODEL: T53-L-1A (LTC1B-2)**

Data
Type: Shaft turbine engine.

Specs
Diameter: 23.0 in. Length: 47.6 in. Width: 23.0 in. Pressure Ratio: 6:1. Fuel Grade: Mil-F-5624 Grade JP-4. Dry Weight: 484 lb. Compressor Stages: 50 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 105; Vertol Model 107.

- **MODEL: T53-L-3 (LTC1F-1)**

Data
Type: Turboprop.

Specs
Diameter: 23.0 in. Length: 58.4 in. Width: 23.0 in. Pressure Ratio: 6:1. Fuel Grade: JP-4. Dry Weight: 530 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. Scheduled for production for use in Grumman AO-1 Mohawk high-performance observation plane for Army.

- **MODEL: T53-L-5 (LTC1K-1)**

Data
Type: Shaft turbine engine.

Specs
Diameter: 23.0 in. Length: 47.6 in. Width: 23.0 in. Pressure Ratio: 6:1. Fuel Grade: JP4. Dry Weight: 485 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: 0.664 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-3 (LTC4B-2)**

Data
Type: Shaft turbine engine.

Specs
Diameter: 24.25 in. Length: 44.04 in. Width: 24.25 in. Pressure Ratio: 6:1. Fuel Grade JP-4. Dry Weight: 600 lb. Compressor Stages: 7 axial plus 1 cent. Turbine Stages: 1 compressor plus 2 free power.

Performance
Maximum SHP: 1900 military. Normal Rated SHP: 1700 Fuel Consumption: .641 ESFC at military power. Oil Consumption: .25 gal. per hr.

Remarks
Engine has two stage free-type power turbine combination axial-centrifugal compressor driven by a single stage turbine, and external vaporizing annular combustor.

- **MODEL: T55-L-1 (LTC4A-1)**

Data
Type: Turboprop.

Specs
Diameter: 24.25 in. Length: 58.85 in. Width: 24.25 in. Pressure Ratio: 6:1. Fuel Grade: JP-4. Dry Weight: 695 lb. Compressor Stages: 7 axial plus 1 cent. Turbine Stages: 1 compressor plus 2 free power.

Performance
Maximum SHP: 1600. Normal Rated SHP: 1325. Fuel Consumption: .648 ESFC at takeoff. Oil Consumption: .25 gal. per hr.

Remarks
Engine has 2-stage free-type power turbine combination axial-centrifugal compressor driven by a single stage turbine, and external vaporizing annular combustor.

- **MODEL: T55-L-5 (LTC4B-7)**

Data
Type: Shaft turbine engine.

Specs

Diameter: 24.25 in. Length: 44.0 in. Width: 24.25 in. Pressure Ratio: 6:1. Fuel Grade: JP4. Dry Weight: 560 lb. Compressor Stages: 7 axial plus 1 centrifugal. Turbine Stages: 1 compressor plus 2 free power.

Performance

Maximum SHP: 1940 military. Normal Rated SHP: 1740. Fuel Consumption: 0.629 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. Scheduled for production for use in Vertol YHC-1B "Chinook" cargo helicopter for Army. Embodies Lycoming's "Universal Engine" concept.

LYCOMING DIVISION
AVCO CORPORATION
WILLIAMSPORT, PENNSYLVANIA

• MODEL: O-235-C1

Data

Type: 4 cylinder, air-cooled, horizontally opposed, 115 hp. FAA Type Certificate: 223.

Specs

Length: 29.56 in. Fuel Grade: 80 octane. Bore: 4.375 in. Stroke: 3.875 in. Displacement: 233.3 cu. in. Compression Ratio: 6.75:1. Dry Weight: 236 lb. with hub and accessories. Weight per hp: 2.05 lb.

Performance

Takeoff Power: 115 hp 2800 rpm. Cruise: 86 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-21. Starter: Delco-Remy. Generator: Delco-Remy.

• MODEL: O-290-D2B

Data

Type: 4 cylinder, air-cooled, horizontally opposed, direct drive, 140 hp. FAA Type Certificate: 229.

Specs

Length: 29.56. Width: 32.24. Height: 22.81. Bore: 4.875. Stroke: 3.875. Compression Ratio: 7.0:1. Displacement: 289.0 cu. in. Weight: 264 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-3FPA. Magnetos: Scintilla S4LN-20 and S4LN-21. Generator: Delco-Remy, 12 volt. Starter: Delco-Remy.

• MODEL: O-320-A2B

Data

Type: 4 cylinder, air-cooled, horizontally opposed, direct drive, 150 hp. FAA Type Certificate: 274.

Specs

Length: 29.56. Height: 23.12. Width: 32.24. Bore: 5.125. Stroke: 3.875. Displacement: 319 cu. in. Compression Ratio: 7.00:1. Weight: 272 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-20 and S4LN-21. Generator: Delco-Remy, 12 and 24 volt. Starter: Delco-Remy.

• MODEL: O-320-B2B

Data

Type: 4 cylinder, air-cooled, horizontally opposed, direct drive, 160 hp. FAA Type Certificate: 274.

Specs

Length: 29.56. Width: 32.24. Height: 23.12. Bore: 5.125. Stroke: 3.875. Displacement: [illegible] cu. in. Compression Ratio: 8.5:1. 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-20 and S4LN-21. Generator: Delco-Remy, 12 or 24 volt. Starter: Delco-Remy, 12 or 24 volt.

• MODEL: O-340-A1A

Data

Type: 4 cylinder, air-cooled, horizontally opposed, direct drive, 170 hp. FAA Type Certificate: 277.

Specs

Length: 29.56. Width: 32.55. Height: 24.55. Bore: 5.125. Stroke: 4.125. Compression Ratio: 8.5:1. Displacement: 340.4 cu. in. Weight: (with starter and generator) 278 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-20 and S4LN-21. Generator: Delco-Remy, 12 volt. Starter: Delco-Remy.

• MODEL: O-360-A1A

Data

Type: 4 cylinder, air-cooled, horizontally opposed, 180 hp. FAA Type Certificate: 286.

Specs

Length: 29.56 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: 285 lb.

Equipment

Carburetor: Marvel-Schebler MA4-5. Magnetos: Scintilla S4LN-20, S4LN-21. Starter: Delco-Remy. Generator: Delco-Remy.

• MODEL: O-360-B1A

Data

Type: 4 cylinder, air-cooled, horizontally opposed, 180 hp. FAA Type Certificate: 286.

Specs

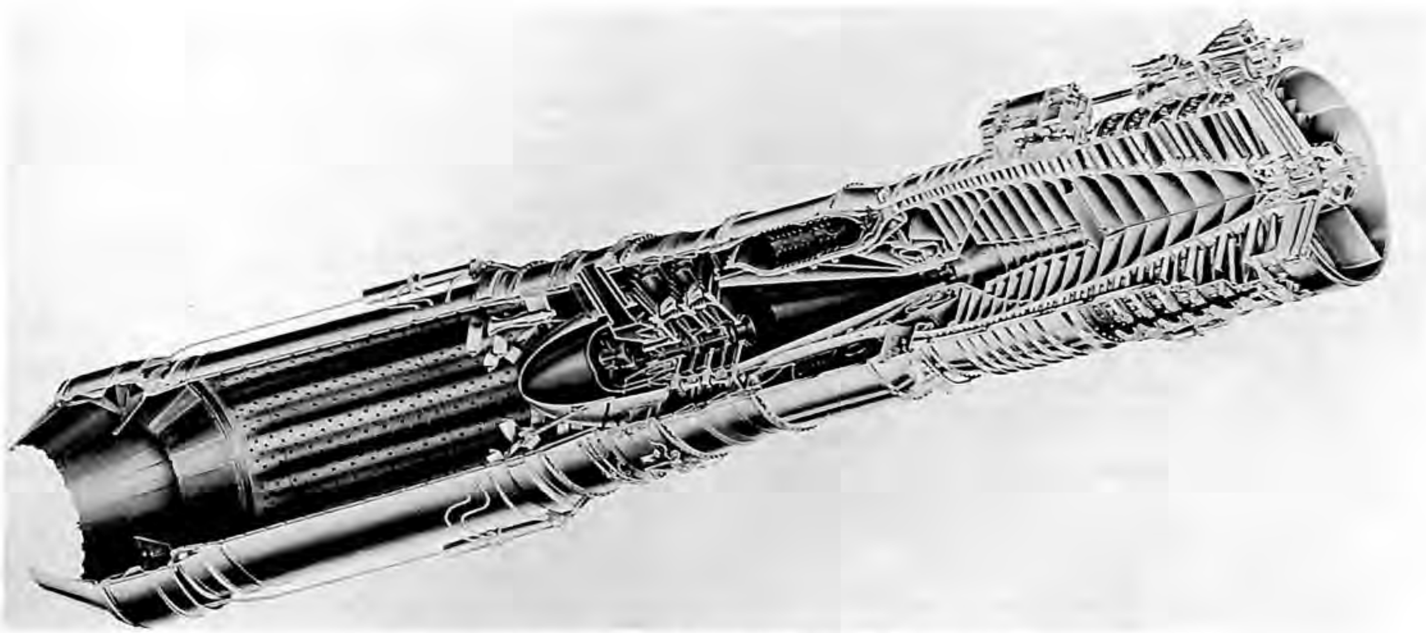
Length: 29.56 in. Width: 33.37 in. Height: 24.59 in. Displacement: 361 cu. in. Bore: 5.125 in. Stroke: 4.375. Compression Ratio: 7.20:1. Fuel Grade: 80/87.

Performance

Takeoff and Rated Power: 168 hp at 2700 rpm.

Equipment

Carburetor: Marvel-Schebler MA4-5. Magnetos: Scintilla S4LN-20, S4LN-21. Starter: Delco-Remy. Generator: Delco-Remy.



Cutaway view of General Electric's J79 turbojet engine.

• **MODEL: O-360-C2B**

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: 360 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 Rated Power: 180 hp at 2900 rpm.

• **MODEL: 0-540-F1B5**

Data

Type: 6 cylinder, horizontally opposed 260 hp. FAA Type Certificate 295.

Specs

Height: 24.56 in. Length: 38.42 in. Width: 33.37 in. Displacement: 540 in. (3) Bore: 5.125 in. Stroke: 4.375 in. Compression ratio: 8.5:1. Fuel Grade: 91/96. Dry Weight: 398 lb.

Performance

Maximum Thrust: 260 hp at 2800 rpm to 800 ft. alt. Normal Rated Thrust: 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: VO-360-A1A**

Data

Type: 4 cylinder, horizontally opposed, vertical, air-cooled helicopter, 180 hp. FAA Type Certificate: 1-E1.

Specs

Height: 21.92 in. Length: 29.79 in. Width: 33.37 in. Displacement: 360 cu. in. Bore: 5.125 in. Stroke: 4.375 in. Compression Ratio: 8.50:1. Fuel Grade: 91/96. Dry Weight 298 lb.

Performance

Takeoff and Rated Power: 180 hp at 2900. Fuel Consumption: 545 lb. hp per hr. at 80 percent rated power.

Equipment

Carburetor: Marvel-Schebler MA4-5. Magneto: Two Scintilla S4LN-21s.

Remarks

Current production installation: Brantly B-2 helicopter (Army HO-3).

• **MODEL: VO-435-AIE**

Data

Type: 6 cylinder, air-cooled, horizontally opposed, for vertical helicopter installation 260 hp. FAA Type Certificate: 279.

Specs

Height: 34.73. Width: 33.58. Depth. 24.13. Fuel Grade: 80/87. Bore: 4.875. Stroke: 3.875. Displacement 434 cu. in. Compression Ratio: 7.3:1. Weight: 392 lb.

Performance

Takeoff: 270 hp at 3400 rpm. Rated Power: 250 hp at 3200 rpm. Fuel Consumption: 20.0 gal. per hr. at 80 percent rated power.

Equipment

Carburetor: Marvel-Schebler MA4-5 AA. Magnetos: Scintilla S6LN-200 and S6RN-204. Hand cranking provisions optional. New design crankcase and oil pump.

• **MODEL: VO-540-B1B,-B1C**

Data

Type: 6 cylinder, horizontally opposed, vertical, air-cooled helicopter 305 hp. FAA Type Certificate: 304.

Specs

Height: 24.57 in. Length: 34.73 in. Width: 34.14 in. Displacement: 540 cu. in. Bore: 5.125 in. Stroke: 4.375 in. Compression Ratio: 7.30:1. Fuel Grade: 80/87. Dry Weigth: 430 lb.

Performance

Takeoff Power: 310 hp at 3300 rpm. Rated Power: 305 hp at 3200 rpm. Fuel Consumption: 17.0 gal. per hr. at 60 percent rated power.

Equipment
Carburetor: Marvel-Schebler MA-6AA. Magneto: Scintilla S6RN-200, S6LN-204.

- **MODEL: GO-435-C2B2-6**

Data
Type: 6 cylinder, horizontally opposed, geared, air-cooled, 240 hp. FAA Type Certificate: 228.

Specs
Height: 28.02. Length: 38.64. Width: 33.12 in. Displacement: 430.0 in. Bore: 4.875 in. Stroke: 3.875. Compression Ratio: 7.3:1. Fuel Grade: 80/87. Dry Weight: 430 lb.

Equipment
Carburetor: Marvel-Schebler MA4-5. Magnetos: Scintilla S6LN-20, and S6LN-21.

- **MODEL: GO-480-B1A6, -B1D**

Data
Type: 6 cylinder, horizontally opposed, air-cooled, gear drive, 270 hp. FAA Type Certificate: 275.

Specs
Length: 38.64 in. Width: 33.12 in. Height: 28.02 in. Bore: 5.125 in. Stroke: 3.875 in. Displacement: 479.7. Compression Ratio: 7.3:1. Weight: 432 lb. Fuel Grade: 80/87.

Performance
Takeoff Power: 270 hp at 3400 rpm (2180 prop rpm). Rated Power: 260 at 3000 rpm. Fuel Consumption: 14.1 gal. per hr. at 2600 rpm, economy cruise.

Equipment
Carburetor: Bendix-Stromberg PS-5BD. Magnetos: Scintilla S6LN-20, S6LN-21.

- **MODEL: GO-480-G1A6**

Data
Type: 6 cylinder, horizontally opposed, geared, air-cooled, 295 hp. FAA Type Certificate: 275.

Specs
Height: 28.02 in. Length: 38.64 in. Width: 33.12 in. Displacement: 480 cu. in. Bore: 5.125 in. Stroke: 3.875 in. Compression Ratio: 8.70:1. Fuel Grade: 100/130. Dry Weight: 439 lb.

Performance
Takeoff Power: 295 hp at 3400 rpm. Rated Power: 280 hp at 3000 rpm.

- **MODEL: GO-480-G1B6**

Data
Type: 6 cylinder, reduction gear drive, horizontally opposed, air cooled, 295 hp. FAA Type Certificate: 275.

Specs
Length: 40.04. Width: 33.12. Height: 27.46 in. Bore: 5.125 in. Stroke: 3.875 in. Compression Ratio: 8.70:1. Displacement: 479.7 cu. in. Weight: 464 lb. Fuel Grade: 100/130.

Performance
Takeoff Power: 295 hp at 3400 rpm. Rated Power: 280 hp at 3000 rpm. Fuel Consumption: 13.0 gal. per hr. at rated speed and 60 percent rated power.

Equipment
Carburetor: Bendix Stromberg PS-5BD. Magnetos: Scintilla S6LN-20 and S6RN-21.

- **MODEL: GO-480-G2D6**

Data
Type: 6 cylinder, gear drive, horizontally opposed, air-cooled, 295 hp. FAA Type Certificate: 275.

Specs
Height: 28.02. Length: 40.59. Width: 33.12. 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 rated speed and 60 percent rated power.

Equipment
Carburetor: Bendix-Stromberg PS-5BD. Magnetos: Scintilla S6LN-20, S6LN-21.

- **MODEL: GSO-480-B1A6**

Data
Type: 6 cylinder, horizontally opposed, geared, supercharged, 340 hp. FAA Type Certificate: 284.

Specs
Length: 49.36. Height: 33.08. Width: 33.12. Bore: 5.125. Stroke: 3.875. Displacement: 479.7. Compression Ratio: 7.3:1. Weight: 498 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: 16.0 gal. per hr. at 60 percent rated power at 2600 rpm.

Equipment
Carburetor: Bendix PS-7BD. Magnetos: Scintilla S6LN-20 and S6RN-21.

- **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. Height: 33.26. Width: 33.12. Bore: 5.125. Stroke 3.875. Displacement: 479.7 cu. in. Compression Ratio: 7.3:1. 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: 16.0 gal. per hr. at 60 percent rated hp and 2600 rpm.

Equipment
Carburetor: Bendix PSH-7BD. Magnetos: Scintilla S6LN-20, S6RN-21.

- **MODEL: GS0-480-B1C6**

Data
Type: 6 cylinder, horizontally opposed, geared, supercharged. 340 hp. FAA Type Certificate 284.

Specs
Height: 22.56 in. Length: 52.18 in. Width: 33.12 in. Displacement: 480 in. Bore: 5.125 in. Stroke: 3.875 in. Compression Ratio: 7.3:1. Fuel Grade: 100/130. Dry Weight: 497 lb.

Performance
Maximum Thrust: Takeoff 340 at 3400 rpm. Normal Rated Power 320 at 3200 rpm. Fuel Consumption: 16 gal. per hr. 60% rated power 2600 rpm. Takeoff and rated power to 8000 ft. altitude.

Equipment
Carburetor: Bendix PSH-7BD. Magneto: Scintilla S6LN-20, S6RN-21.

Remarks
Current production installation: Trecker P136-L-2 Super Gull.

- **MODEL: GS0-480-B2D6**

Data
Type: 6 cylinder, horizontally opposed, geared, supercharged, 340 hp. FAA Type Certificate 284.

Specs
Height: 22.56 in. Length: 47.06 in. Width: 33.12 in. Displacement: 480 in. (3). Bore: 5.125 in. Stroke: 3.875 in. Compression Ratio: 7.3:1. Fuel Grade: 100/130. Dry Weight: 498.

Performance
Takeoff 340 at 3400 rpm 60% rated power. Normal Rated Power: 320 at 3200 rpm. Fuel Consumption: 16 gal. per hr. 2600 rpm.

Equipment
Carburetor: Bendix PSD-7BD. Magneto: Scintilla S6LN-20, S6RN-21.

Remarks
Current production installation: McKinnon Enterprises 4-engine model G-21A Goose Conversion.

- **MODEL: O-540-A1B5,-A1C5**

Data
Type: 6 cylinder, air-cooled, horizontally opposed, direct drive, 265 hp. FAA Type Certificate: 295.

Specs
Length: 37.22. Height: 25.81. Width: 33.37. Bore: 5.125. Stroke: 4.375. Displacement: 541.5 cu. in. Compression Ratio: 8.5:1. Weight: 397. Fuel Grade: 91/96.

Performance
Takeoff Power: 265 hp at 2800 rpm. Rated Power: 260 hp at 2700 rpm. Fuel Consumption: 12 gal. per hr. at economy cruise.

Equipment
Carburetor: Marvel-Schebler MA4-5. Magnetos: Two Scintilla, S6LN-21. Generator: Delco-Remy 12 or 24 volt. Starter: Delco-Remy.

- **MODEL: SO-580-A1B (O-580-3)**

Data
Type: 8 cylinder, air-cooled, opposed, supercharged, for horizontal or vertical helicopter installation, 400 hp. FAA Type Certificate: 285.

Specs
Length: 46.67. Width: 33.12. Height: 24.58. Bore: 4.875. Stroke: 3.875. Compression Ratio: 7.3:1. Displacement: 578 cu. in. Weight: 578 lb. Fuel Grade: 100/130.

Performance
Takeoff Power: 400 hp at 3300 rpm. Rated Power: 350 hp at 3000 rpm. Fuel Consumption: 16.5 gal. per hr. at rated speed and 80 percent rated power.

Equipment
Carburetor: Bendix PS-9BDE. Magnetos: Scintilla (2) S4LN-20 and (2) S4RN-21.

- **MODEL: IGSO-480-A1A6**

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: 480 cu. in. Bore: 5.125 in. Stroke: 3.875 in. Compression Ratio: 7.30:1. Fuel Grade: 100/130. Dry Weight: 496 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. Magneto: Scintilla S6LN-20, -21, -64, -61.

Remarks
Current production installations: Beechcraft Twin-Bonanza, Beechcraft Queen Air, Aero Design Alti-Cruiser.

- **MODEL: IMO-360-A1A**

Data
Type: 4 cylinder, horizontally opposed, air-cooled, fuel injection, drone, 180 hp.

Specs
Height: 17.47 in. Length: 34.36 in. Width: 33.37 in. Displacement: 360 cu. in. Bore: 5.125 in. Stroke: 4.375 in. Compression Ratio: 8.50:1. Fuel Grade: 91/96. Dry Weight: 251 lb.

Performance
Takeoff and Rated Power: 180 hp at 2700 rpm. Fuel Consumption: 10.5 gal. per hr. at 75 percent rated power.

Equipment
Fuel Injector: Simmonds. Magneto: Scintilla S4LN-21.

Remarks
Current production installation: Aerojet-General AN/USD-2 Surveillance Drone for Army.

- **MODEL: IMO-360-B1B**

Data
Type: 4 cylinder, horizontally opposed, air-cooled, fuel injection, drone, 230 hp. at 3400 rpm.

Specs
Height: 17.49 in. Length: 32.68 in. Width: 34.25 in. Displacement: 360 in. (3). Bore: 5.125 in. Stroke: 4.375 in. Compression Ratio: 8.7:1. Fuel Grade: 100/130. Dry Weight: 274 lb.

Performance
Takeoff and Rated Power: 230 hp. at 3400 rpm. Full throttle fuel consumption: 22 gal. per hr.

Equipment
Fuel Injector: Simmonds Type 580. Magnetos: Scintilla S4LN-21.

Remarks
Current production installation: Aerojet-General Surveillance Drone.

PRATT & WHITNEY AIRCRAFT DIVISION
UNITED AIRCRAFT CORPORATION
EAST HARTFORD, CONNECTICUT

- **MODEL: TWIN WASP D SERIES (R-2000)**

Data
Type: 14 cylinder, air-cooled, radial. FAA Type Certificate: 230.

Specs
Diameter: 49.1 in. Length: 59.66 in. Fuel Grade: 100/130. Bore: 5.75 in. Stroke: 5.5 in. Displacement: 2004 cu. in. Compression Ratio: 6.5:1. Dry Weight: Single speed, 1585 lb.; two speed, 1605 lb.

Performance
Takeoff: 1450 at 2700 rpm and 1000 ft. Normal Rated Power: 1200 hp at 2550 rpm and 5000 ft.

Equipment
Carburetor: Stromberg PD-12F13. Ignition: two Scintilla SF14LN-8.

Remarks
Powers Douglas C-54 military transport and the commercial version, the DC-4.

• **MODEL: DOUBLE WASP CB SERIES (R-2800)**

Data

Type: 18 cylinder, air-cooled, radial. FAA Type Certificate: 264.

Specs

Diameter: 52.8 in. Length: 81.40 in. Fuel Grade: 100/130 or 108/135. Bore: 5.75 in. Stroke: 6 in. Displacement: 2804 cu. in. Compression Ratio: 6.75:1. Dry Weight: Two speed, 2390 lb.; single speed, 2357 lb.

Performance (CB 3)

Takeoff Power: 2400 hp at 2800 rpm at 4000 ft. with water injection; 2050 hp at 2700 rpm at 6000 ft. dry. Normal Rated Power: 1800 hp at 2600 rpm at 8500 ft. CB16, same in low, but has maximum continuous rating in high of 1700 hp.

Equipment

Carburetor: Stromberg PR-58E5. Ignition: Scintilla DLN-10 low tension.

Remarks

Military versions of the Double Wasp power the following production aircraft: Bell XHSL-1 helicopter, Fairchild C-123 transport, Convair T-29 trainer, Douglas C-118A cargo, Grumman AF-28 and -2W hunter-killer teams, North American AJ-1 carrier bomber. Commercial versions power the Convair 240, 340 and 440 transports, Douglas DC-6, -6A, and -6B transports and Martin 2-0-2A and 4-0-4 transports.

• **MODEL: PT2G-6 (T34-P-9W)**

Data

Type: Axial-flow turboprop.

Specs

Diameter: 34.06 in. Length: 155.12 in. Fuel Grade: JP-4. Dry Weight: 2870 lb. Compressor Stages: 13. Turbine Stages: 3.

Performance

Maximum Power: 7500 ESHP wet, 6500 ESHP dry. Normal Rated Power: 5650 ESHP. Fuel Consumption: 0.55 TSFC at takeoff wet, 0.67 TSFC cruise at 80 percent normal rated power. Oil Consumption: 5.0 lb. per hr. maximum. Military rated power 6300 ESHP.

Remarks

Current production installation: military.

• **MODEL: PT2G-7**

Data

Type: Axial-flow turboprop.

Specs

Diameter: 34.06 in. Fuel Grade: JP4. Dry Weight: 2870 lb. Compressor Stages: 13. Turbine Stages: 3.

Performance

Maximum Power: 7500 eshp-wet, 6500 eshp-dry. Normal Rated Power: 5650 eshp. Maximum Continuous Power: 5650 eshp. Maximum Cruise Power: 4840 eshp.

Remarks

Current production installation: commercial.

• **MODEL: JT3C-2 (J57-P-43W)**

Data

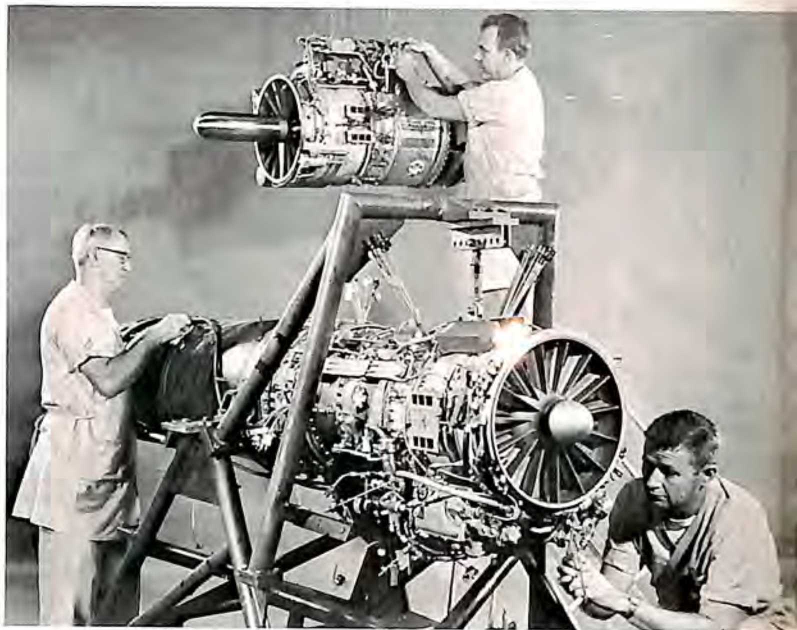
Type: Twin-spool, axial-flow turbojet. FAA Type Certificate: 290.

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.



General Electric's lightweight J85.

Remarks

Current production installation: Boeing B-52; Boeing KC-135 and military.

• **MODEL: JT3C-6**

Data

Type: Twin-spool, axial-flow turbojet.

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 9500; maximum cruise thrust 8100.

Remarks

Current production installation: Boeing 707; Douglas DC-8 and commercial.

• **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 and commercial.

• **MODEL: JT3C-12**

Data

Type: Axial-flow turbojet.

Specs
Diameter: 38.88 in. Fuel Grade: JP4, JP5. Dry Weight: 3495 lb. Compressor Stages: 16. Turbine Stages: 3.

Performance
Maximum Thrust: 13,000. Normal Rated Thrust: 10,000. Maximum Continuous Thrust: 10,000. Maximum Cruise Thrust: 8500.

Remarks
Current production installation: commercial.

- **MODEL: JT3C-21 (J57-P-16, -55)**

Data
Type: Twin-spool, axial-flow turbojet with afterburner.

Specs
Diameter: 39.6 in. Length: 250.84 in. Fuel Grade: JP-4. Dry Weight: 4750 lb. Compressor Stages: 16. Turbine Stages: 3.

Performance
Maximum Thrust: 16,900 with afterburner; 10,700 without afterburner. Normal Rated Thrust: 9150. Fuel Consumption: 0.82 TSFC cruise at 75 to 90 percent normal rated thrust.

Remarks
Current production installation: McDonnell F-101; Chance Vought F8U-2 and military.

- **MODEL: JT3C-26 (J57-P-20)**

Data
Type: Axial-flow turbojet.

Specs
Diameter: 38.9 in. Fuel Grade: JP4. 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: military.

- **MODEL: JT3D-1**

Data
Type: Axial-flow turbofan.

Specs
Diameter: 53.0 in. Fuel Grade: JP-4/JP-5. Dry Weight: 4025 lb. Compressor Stages: 13. Turbine Stages: 3. 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: 0.4 gal. per hr. maximum. Maximum continuous thrust 14,500; maximum cruise thrust 12,500.

Remarks
Current production installation: commercial.

- **MODEL: JT3D-2 (TF33-P-3)**

Data
Type: Axial-flow turbofan.

Specs
Diameter: 53.0 in. Fuel Grade: JP4. Dry Weight: 3900 lb. Compressor Stages; 13. Turbine Stages: 3. Fan Stages: 2.

Performance
Maximum Thrust: 17,000 to 90° F. Normal Rated Thrust: 12,500. Military Rated Thrust: 15,000.

Remarks
Current production installation: military.

- **MODEL: JT3D-3**

Data
Type: Axial-flow turbofan.

Specs
Diameter: 53.0 in. Fuel Grade: JP4, JP5. Dry Weight: 4130 lb. Compressor Stages: 13. Turbine Stages: 3. Fan Stages: 2.

Performance
Maximum Thrust: 18,000 to 90° F. Normal Rated Thrust: 15,000. Maximum Continuous Thrust: 15,000. Maximum Cruise Thrust: 12,750.

Remarks
Current production installation: commercial.

- **MODEL: JT3D-4 (TF33-P-)**

Data
Type: Axial-flow turbofan.

Specs
Diameter: 53.0 in. Fuel Grade: JP4. Dry Weight: 3950 lb. Compressor Stages: 13. Turbine Stages: 3. Fan Stages: 2.

Performance
Maximum Thrust: 18,000 to 100° F. Normal Rated Thrust: 15,000. Military Rated Thrust: 17,000.

Remarks
Current production installation: military.

- **MODEL: JT4A-3 (steel) JT4A-5 (titanium)**

Data
Type: Axial-flow turbojet.

Specs
Diameter 43.0 in. Fuel Grade: JP4, JP5. Dry Weight: 5020 lb. (-3); 4815 lb. (-5). Compressor Stages: 15. Turbine Stages: 3.

Performance
Maximum Thrust: 15,800. Normal Rated Thrust: 12,500. Maximum Continuous Thrust: 12,500. Maximum Cruise Thrust: 11,450.

Remarks
Current production installation: Douglas DC-8, Boeing 707-320 and commercial.

- **MODEL: JT4A-9 (steel) JT4A-10 (titanium)**

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: 13,000. Maximum Continuous Thrust: 13,500. Maximum Cruise Thrust: 11,850.

Remarks
Current production installation: commercial.

- **MODEL: JT4A-11 (steel) JT4A-12 (titanium)**

Data
Type: Axial-flow turbojet.

Specs
Diameter: 43.0 in. Dry Weight 5100 lb. (-11), 4895 lb. (-12). Compressor Stages: 15. Turbine Stages: 3.

Performance
Maximum Thrust: 17,500 to 90° F. Normal Rated Trust: 14,900. Maximum Continuous Thrust: 14,900. Maximum Cruise Thrust: 13,800.

Remarks
Current production installation: commercial.

- **MODEL: JT4A-28 (J75-P-17)**

Data
Type: Axial-flow turbojet.

Specs
Diameter: 43.0 in. Fuel Grade: JP4. Dry Weight: 5875 lb. Compressor Stages: 15. Turbine Stages: 3.

Performance
Maximum Thrust: 24,500 (afterburning). Normal Rated Thrust: 14,300. Military Rated Thrust: 16,100.

Remarks
Current production installation: Convair F-106, military.

- **MODEL: JT4A-29 (J75-P-19W)**

Data
Type: 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: 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: 2400. Military Rated Thrust: 3000.

Remarks
Current production installation: military.

- **MODEL: JT12A-6**

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: 2300. Maximum Continuous Thrust: 2400. Maximum Cruise Thrust: 2140.

Remarks
Current production installation: commercial, Lockheed JetStar.

- **MODEL: JT12A-7 (J60-P-)**

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: 645 lb. Compressor Stages: 9. Turbine Stages: 2.

Performance
Maximum Thrust: 4025 (afterburning). Normal Rated Thrust: 2350. Military Rated Thrust: 2920.

Remarks
Current production installation: militai

ROCKETDYNE DIVISION
NORTH AMERICAN AVIATION, INC.
CANOGA PARK, CALIFORNIA

- **MODEL: MA-3 ATLAS**

Data
Type: Liquid propellant rocket engine utilizing LOX and RP-1 fuel.

Performance
Rating: 360,000 lb. thrust at sea level.

Equipment
The Atlas MA-3 rocket engine consists 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 power plant for the Atlas ICBM. It furnishes the first-stage propulsion for the Atlas/Able research vehicle.

- **MODEL: MB-3 THOR**

Data
Type: Liquid propellant rocket engine utilizing LOX and RP-1 fuel.

Performance
Rating: 150,000 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 engine is used as the power plant for the Thor IRBM. It furnishes the booster propulsion for the Discoverer satellites and the Air Force space probes.

- **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 power plant 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: 75,000 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 power plant for the U. S. Army Redstone intermediate range ballistic missile. It furnishes the first-stage propulsion for the Explorer satellites.

• MODEL: 10-NS-100,000 BOOSTER ROCKET

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 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.

WESTINGHOUSE ELECTRIC CORPORATION
AVIATION GAS TURBINE DIVISION
KANSAS CITY, MISSOURI

• MODEL: J34-WE-48

Data
Type: Axial-flow turbojet.

Specs
Diameter: 27 in. Length: 111.4 in. Height: 34.5 in. Weight: 1210 lb. Compression Ratio: 4.10.

Performance
Takeoff Thrust: 3400 lb. at 12,500 rpm. Operating Altitude: 45,000 ft.

Remarks
Powers the North American Aviation T2J Navy basic trainer. An earlier version, the J34-WE-36, is used in pods as auxiliary power for Lockheed P2V-7 Neptune.

• MODEL: YJ81-WE-3

Data
Type: Axial-flow turbojet.

Specs
Length: 58.9 in. Diameter: 15.8 in.

Performance
Thrust: 1740 lb. (S.L.S.). SFC: 1.26. Annular Combustion Chamber-Burning JP-4.

Remarks
Engine initially designed for use in missiles and drones.

WRIGHT AERONAUTICAL DIVISION
CURTISS WRIGHT CORPORATION
WOOD-RIDGE, NEW JERSEY

• MODEL: R1300-2A & 2B

Data
Type: 7 cylinder, air-cooled, radial.

Specs
Length: 48.10 in. Width: 50.70 in. Weight: 1067 lb. Displacement: 1300 cu. in. Bore: 6.125 in. Stroke: 6.312 in. Compression Ratio: 6.2:1. Fuel Grade: 91/96.

Performance
Takeoff hp: 800 at 2600 rpm Normal S.L. Normal Rated hp: 700 at 2400 rpm up to 5000 ft. Military Rating: 800 at 2600 rpm at 3500 ft. Fuel Consumption: .72 lb. per bhp per hr. Oil Consumption: .025 lb. per bhp per hr. at normal rated power.

Equipment
Carburetor: Stromberg PD9F1. Magneto: Bosch SF-7LU-3.

Remarks
This engine designed for blimp and helicopter installations: also the R1300-3.

• MODEL: R1300-3

Data
Type: 7 cylinder, air-cooled, radial.

Specs
Length: 49.68 in. Width: 50.45 in. Weight: 1080 lb. Displacement: 1300 cu. in. Bore: 6.125 in. Stroke: 6.312 in. Compression Ratio: 6.2:1. Fuel Grade: 91/96.

Performance
Takeoff hp: 800 at 2600 rpm Normal S.L. Normal Rated hp: 700 at 2400 rpm. Military Rating: 800 at 2600 rpm at 3500 ft. Fuel Consumption: .700 lb. per bhp per hr., at normal rated power. Oil Consumption: .020 lb. per bhp per hr. at normal rated power.

Equipment
Carburetor: Bendix PD9G1. Magneto: Amer. Bosch S7LU-3.

Remarks
Current production installation is Sikorsky H-19 helicopter. Designed for operation at 39° angle nose-up. Direct drive. Commercial version 99OC7BA1 installed in Sikorsky S-55.

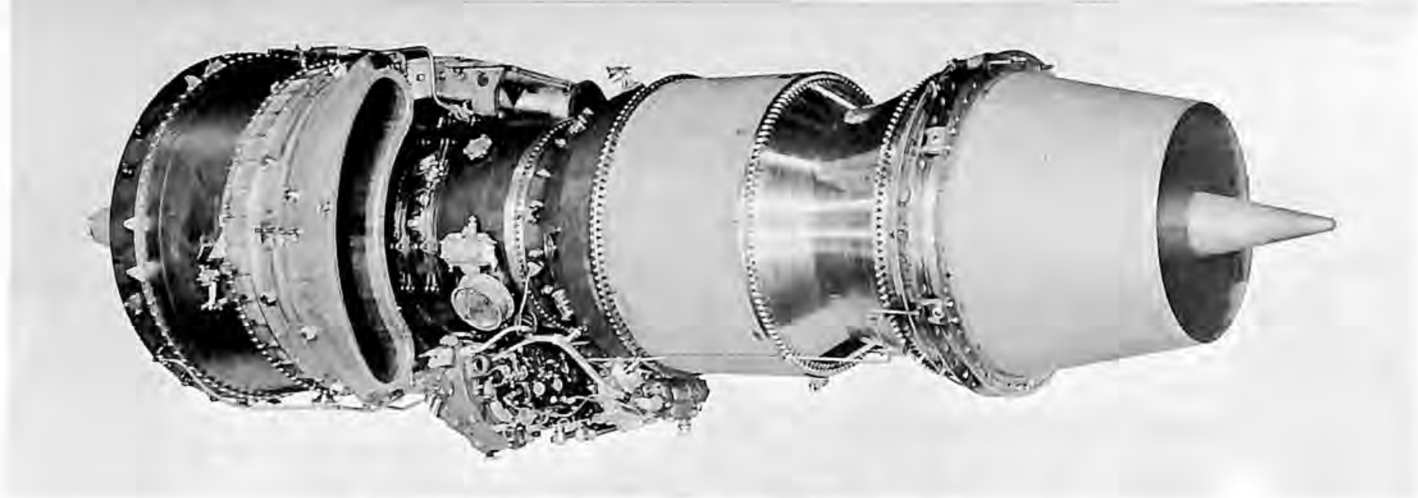
• MODEL: R1300-4

Data
Type: 7 cylinder, air-cooled, radial.

Specs
Length: 48.10 in. Width: 50.70 in. Displacement: 1300 cu. in. Bore: 6.125 in. Stroke: 6.312. Compression Ratio: 6.20:1. Fuel Grade: 91/96. Total Weight: 1092 lb.

Performance
Takeoff hp: 800 at 2600 rpm Normal S.L. Military Rating: 800 at 2600 rpm at 3500 ft. Normal Rating: 700 at 2400 rpm up to 5000 ft. Specific Fuel Consumption: .720 lb. per bhp per hr. at normal rated power. Oil Consumption: .025 lb. per bhp per hr. at normal rated power.

Equipment
Carburetor: Bendix PD9F1. Magnetos: Bosch S7LU-3.



Pratt & Whitney's JT3D turbofan 17,000-pound thrust engine.

Remarks
Installation—Goodyear Blimp ZS2G-1. Increased strength gears in rear section.

• MODEL: R1820-86

Data
Type: 9 cylinder, air-cooled, radial.

Specs
Length: 48.34 in. Width: 55.27 in. Displacement: 1820 cu. in. Bore: 6.125 in. Stroke: 6.875. Compression Ratio: 6.80:1. Fuel Grade: 100/130. Total Weight: 1385 lb.

Performance
Takeoff hp: 1425 at 2700 rpm Normal S. L. Military Rating: 1425 at 2700 rpm at 2000 ft. Normal Rating: 1275 at 2500 rpm up to 3100 ft. Specific Fuel Consumption: .693 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: Bosch S9LU-2.

Remarks
Installation: North American T-28C,B. Commercial version 987C9HD1 installed in Learstar Mark 1.

• MODEL: R1820-82

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.

• MODEL: R1820-84

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: 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.

• MODEL: R1820-88

Data
Type: 9 cylinder, air-cooled, radial.

Specs
Length: 58.89 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: 1560 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-12K18. Magnetos: Bendix Scintilla D9LN-2.

Remarks
Installation: Goodyear ZPG-3W Blimp. This engine has strengthened two-piece nose section with 60A prop shaft spline size.

• MODEL: R1820-103

Data
Type: 9 cylinder, air-cooled, radial.

Specs
Length: 48.35 in. Width: 55.25 in. Displacement: 1820 cu. in. Bore: 6.125 in. Stroke: 6.875. Compression Ratio: 6.80:1. Fuel Grade: 100/130. Total Weight: 1362 lb.

Performance
Takeoff hp: 1425 at 2700 rpm Normal S.L. Military Rating: 1425 at 2700 rpm at 1000 ft. Normal Rating: 1275 at 2500 rpm up to 3000 ft. Specific Fuel Consumption: .700 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-12K19. Magnetos: Bosch S9LU-3.

Remarks
Installation: Vertol Helicopter H-21. Commercial version 977C9HD1 installed in Vertol Helicopter V-44.

- **MODEL: R3350-26WB**

Data
Type: 18 cylinder, air-cooled, radial.

Specs
Length: 80.81 in. Width: 55.62 in. Weight: 2953 lb. Displacement: 3350 cu. in. Bore: 6.125 in. Stroke: 6.312 in. Compression Ratio: 6.7:1. Fuel Grade: 115/145.

Performance
Takeoff hp: 2700 at 2900 rpm Normal S.L. Military Rating: 2700 at 2900 rpm at 3700 ft. Normal Rated hp: 2300 at 2600 rpm up to 6200 ft. Fuel Consumption: 720 lb. per bhp per hr. Oil Consumption: .030 lb. per bhp per hr. at normal rated power.

Equipment
Carburetor: PR58U1. Magneto: Bendix-Scintilla DLN-9.

Remarks
Installation: Douglas AD7.

- **MODEL: R3350-32W (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: 3521 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 up to 4100 ft. Specific Fuel Consumption: .660 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: 981TC18EA1 (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: 3651 lb.

Performance
Takeoff hp: 3700 at 2900 rpm. Max. Cont. (Low Blow). Normal Rated hp: 2850 at 2600 rpm. Cruise Rated hp: 1910 at 2500 rpm 13,500 ft. Fuel Consumption: .645 lb. per bhp per hr. Oil Consumption: .022 lb. per bhp per hr.

Equipment
Carburetor: Bendix PR5882. Magnetos: Bendix-Scintilla DLN-9.

Remarks
Installation CP-107 Bristol Britannia for RCAF.

- **MODEL: 988TC18EA1-2 and 3 (TURBO COMPOUND)**

Data
Type: 18 cylinder, air-cooled, radial.

Specs
Length: 89.53 in. Width: 56.59 in. Weight: 3645 lb. (EA1 and 3); 3745 lb. (EA2). Displacement: 3350 cu. in. Bore: 6.125 in. Stroke: 6.312 in. Compression Ratio: 6.7:1. Fuel Grade: 115/145.

Performance
Takeoff hp: 3400 at 2900 rpm, maximum continuous (Low Blo). Normal Rated hp: 2850 at 2600 rpm. Cruise Rated hp: 1910 at 2400 rpm (Low Blo). Fuel Consumption: .645 lb. per bhp per hr. at 2800 rpm. Oil Consumption: .022 lb. per bhp per hr.

Equipment
Carburetor: Bendix PR5882. Magnetos: Bendix-Scintilla DLN-9.

Remarks
Reduction gear ratio of EA-1 and 3 is 0.4375:1; EA-2 reduction gear ratio is 0.355:1. Installation: EA-1 in Douglas DC-7C, EA-2 Lockheed 1649, EA-3 Lockheed 1049 G and H.

- **MODEL: J65-W-16**

Data
Type: Axial-flow turbojet.

Specs
Length: 121.9 in. Width: 37.5 in. Total Weight: 2742 max. lb. Compressor Stages: 13 of 29.375. Turbine Stages: 2 of 30.5 in.

Performance
Maximum Thrust: 7700 at 8300 rpm. Normal Rated Thrust: 6780 at 8070 rpm. At Normal Rated: .895 lb. per hr. per lb. thrust. 75 percent Normal Thrust: 5080 at 7510 rpm.

Remarks
North American FJ-3 and 4; Douglas A4D.

- **MODEL: J65-W-18**

Data
Type: Axial-flow turbojet.

Specs
Diameter: 37.5 in. Length: 181.4 in. Total Weight: 3425 lb. Compressor Stages: 13 of 29.375 dia. Turbine Stages: 2 of 30.5 in dia.

Performance
Maximum Thrust: 10,500 at 8300 rpm. Normal Rated Thrust: 6370 at 8030 rpm. At Normal Rated: .920 lb. per hr. per lb. thrust. 75 percent Normal Thrust: 4850 at 7475 rpm.

Remarks
Current production installation: Grumman F11F-1. This engine is equipped with afterburner.

- **MODEL: 988TC18EA4, 5 & 6 (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: 3775 lb. (EA-5); 3675 lb. (EA-4, -6).

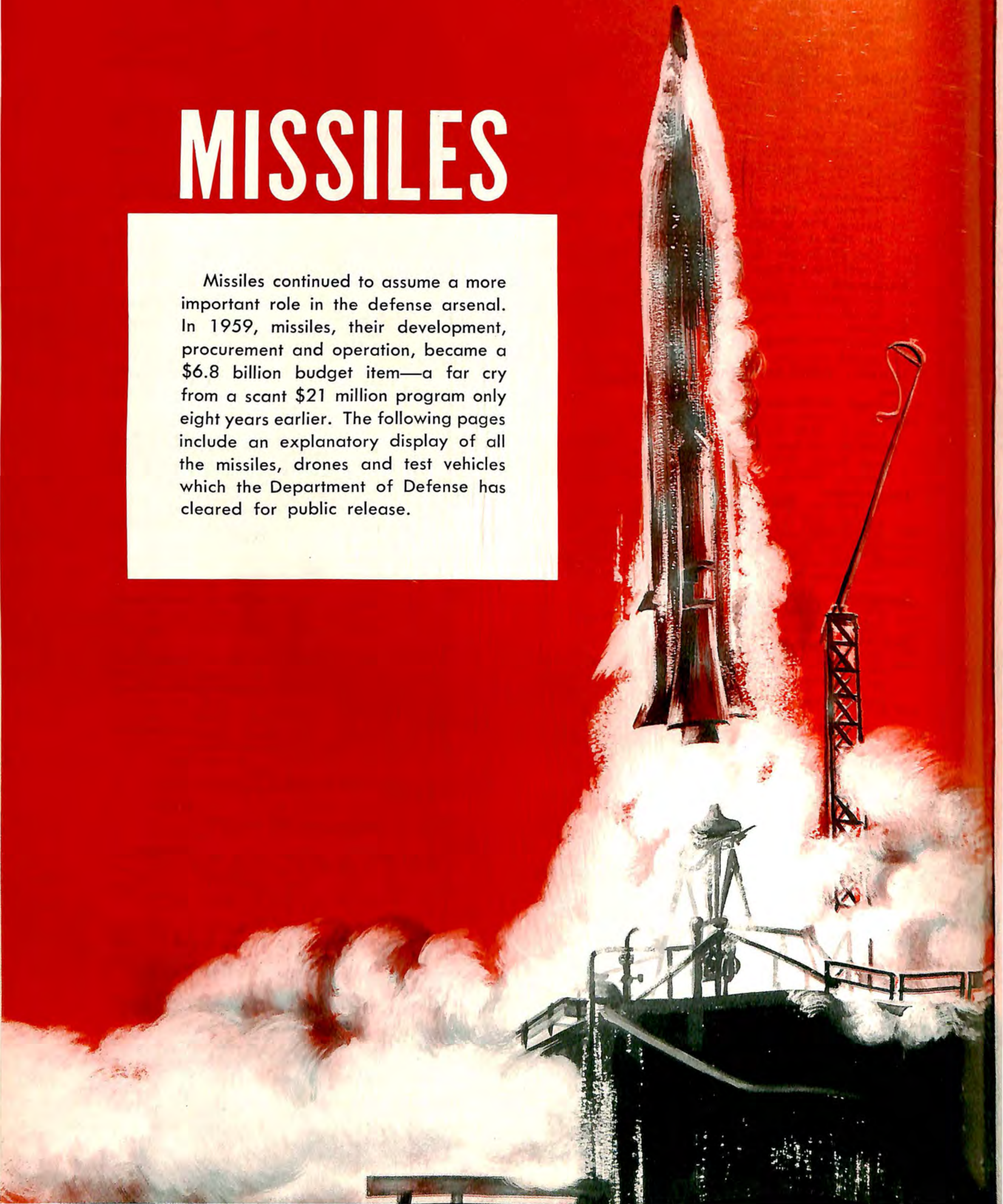
Performance
Takeoff hp: 3400 at 2900 rpm. maximum continuous (Low Blo) .645 lb. per bhp. Normal Rated hp: 2920 at 2650 rpm, S. L. .022 lb. per bhp per hr. Maximum Cruise hp: 1975 at 2500 rpm, 14,100 ft. (Low Blo).

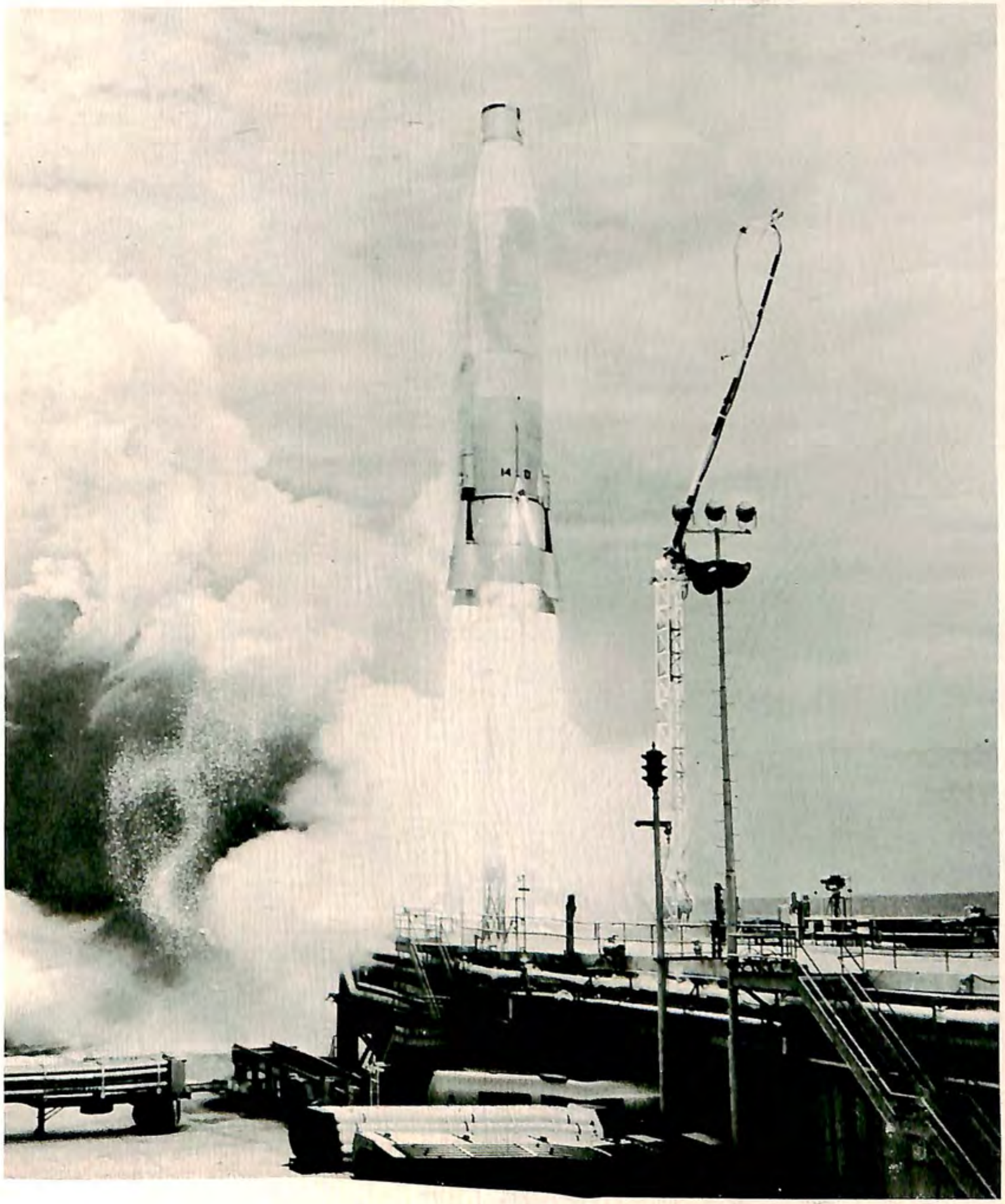
Equipment
Carburetor: Bendix PR58S2. Magnetos: Bendix-Scintilla DLN-9.

Remarks
Reduction gear ratio of EA-5 is 0.355:1; EA-4 and 6 reduction gear ratio is 0.4375:1. Installation: EA-4 in Douglas DC-7C, EA-6 in Lockheed 1049G and H.

MISSILES

Missiles continued to assume a more important role in the defense arsenal. In 1959, missiles, their development, procurement and operation, became a \$6.8 billion budget item—a far cry from a scant \$21 million program only eight years earlier. The following pages include an explanatory display of all the missiles, drones and test vehicles which the Department of Defense has cleared for public release.





ATLAS

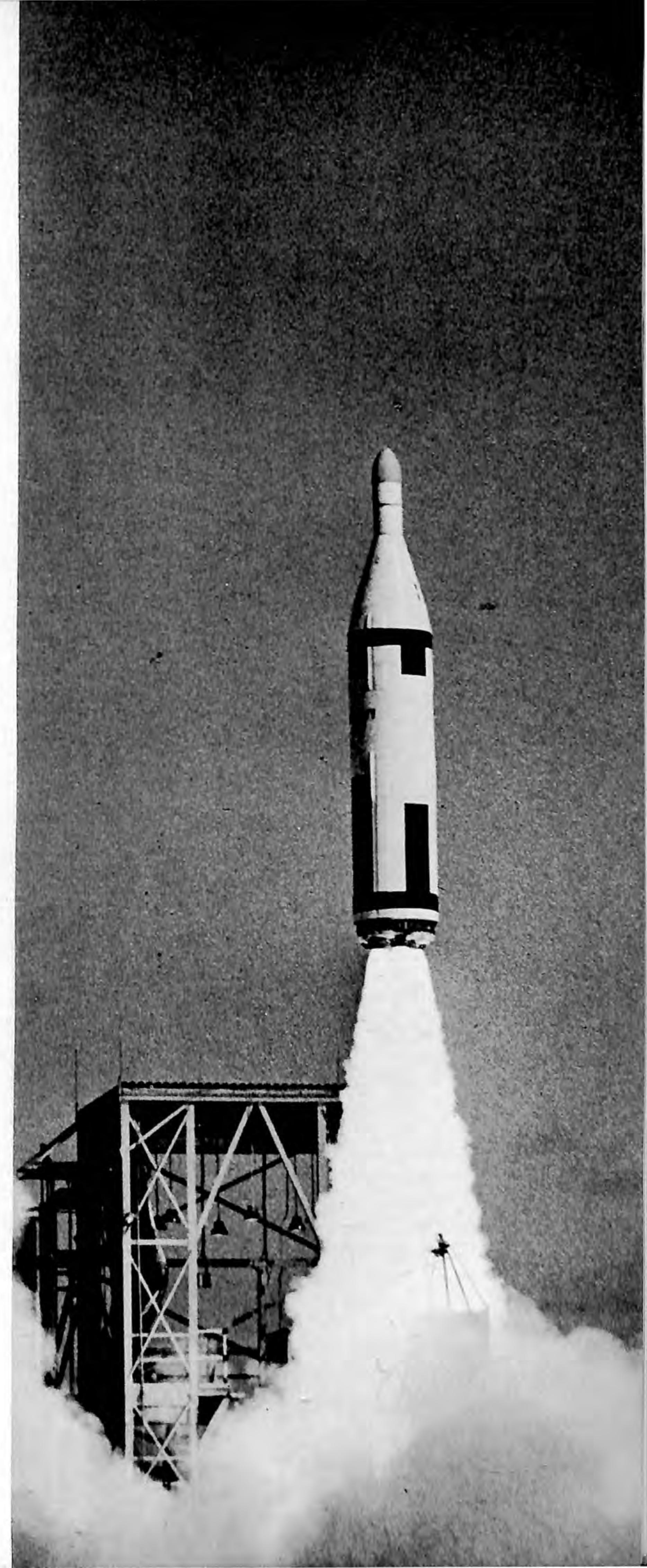
America's first intercontinental ballistic missile, designed to deliver a thermonuclear warhead 5,500 nautical miles, achieved operational status with Strategic Air Command's 1st Missile Division in 1959. Convair-Astronautics is responsible for production, testing and base activation. Rocketdyne Division of North American Aviation builds the power system, which consists of two liquid-propellant booster rockets, a sustainer, and two vernier engines. Total thrust is 360,000 pounds. The 75-foot, 260,000 pound missile reaches altitudes of 600 to 900 miles and speeds of more than 16,000 miles per hour. Guidance manufacturers include General Electric Company, Burroughs Corporation and American Bosch Arma Corporation. Latest model of the ICBM is the Atlas Series D. In addition to its use as a weapon, Atlas will be used as first-stage booster for a family of space vehicles, including the Able space probe, the Mercury manned capsule, Discoverer unmanned global reconnaissance vehicle, and Vega and Centaur, general purpose space vehicles. Status: operational.

TITAN

The second of the Air Force's intercontinental ballistic missiles, the SM-68 Titan, made its first test flight at the Atlantic Missile Test Range on February 6, 1959, and the test program continued throughout the year. A complement, rather than a duplicate of Atlas, Titan is a two-stage missile launched by a 300,000 pound thrust booster. The second stage is powered by an 80,000 pound thrust engine; both stages are liquid propelled. Titan will be launched from underground silos, or "hard" sites. The 110-ton Titan, which has speed and range performance similar to Atlas, is 91 feet long; first stage diameter is 10 feet and second stage is eight feet. The Martin Company builds the airframe and Aerojet-General Corporation the power system. Bell Telephone Laboratories and Remington Rand Univac are responsible for the radio-inertial guidance system used initially; a later version will have an all-inertial system built by AC Spark Plug. Status: In development.

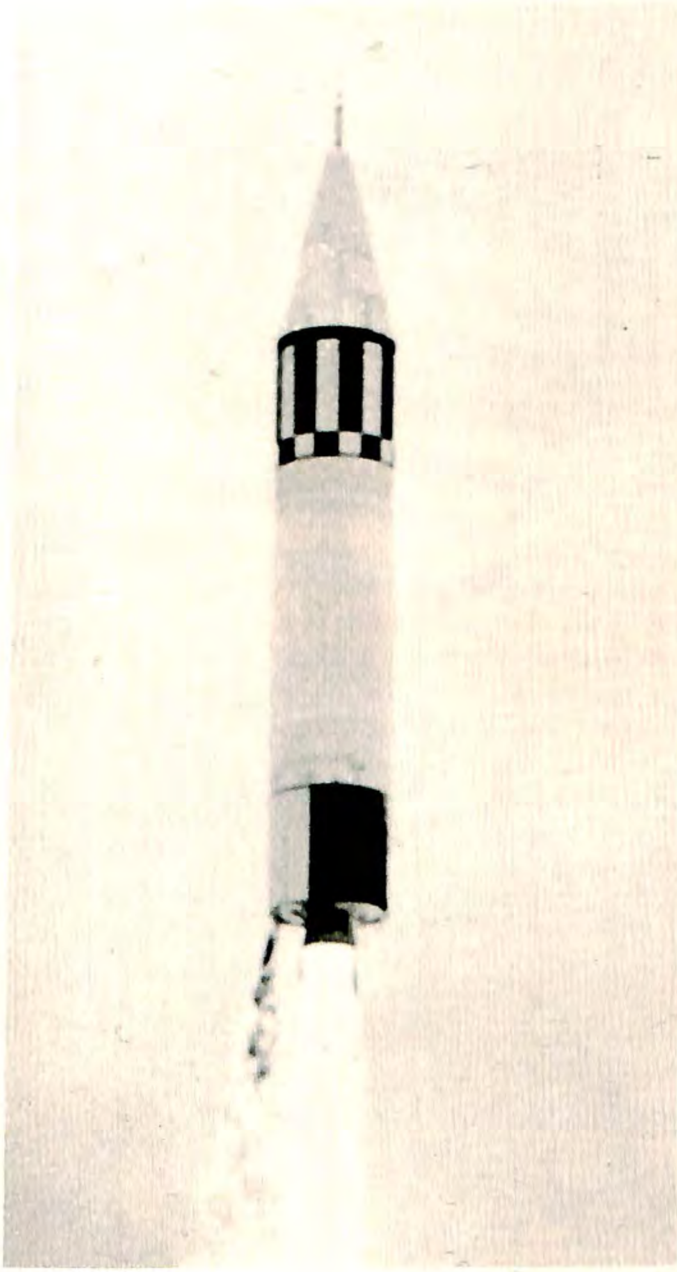
POLARIS

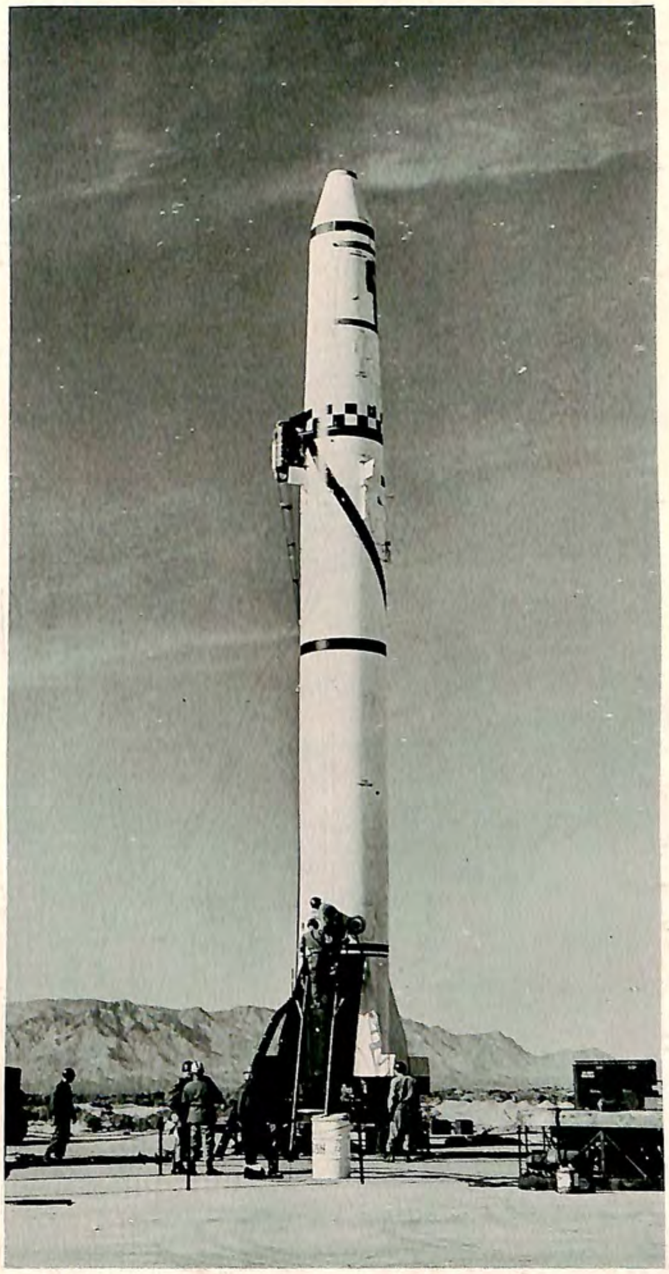
Designed for use with nuclear submarines, the Navy's Polaris is an intermediate range Fleet Ballistic Missile. During 1959, the missile reached advanced flight test status and it was scheduled to become operational late in 1960. Initial range, slated for improvement, is 1,200 nautical miles. Polaris is 28 feet long and solid propelled. Successful test flights were made from a ship's motor simulator and from a surface vessel, and underwater testing of the launching system was ahead of schedule. At year-end, three of nine FBM submarines had been launched. Prime contractor and airframe manufacturer of Polaris is Lockheed's Missiles and Space Division. The weapon's inertial guidance system is manufactured by General Electric Company and Aerojet-General Corporation provides the power plant. Status: In advanced development and limited production.



THOR

Thor, first American intermediate range ballistic missile to achieve operational capability, was deployed to the United Kingdom in September, 1958. The single stage, 65-foot missile has a range of 1,500 nautical miles. Power is supplied by a Rocketdyne 150,000 pound thrust liquid rocket. AC Spark Plug manufactures the inertial guidance system. Douglas Aircraft Company and Space Technology Laboratories share prime contractor responsibility and Douglas build the airframe. Status: Operational.



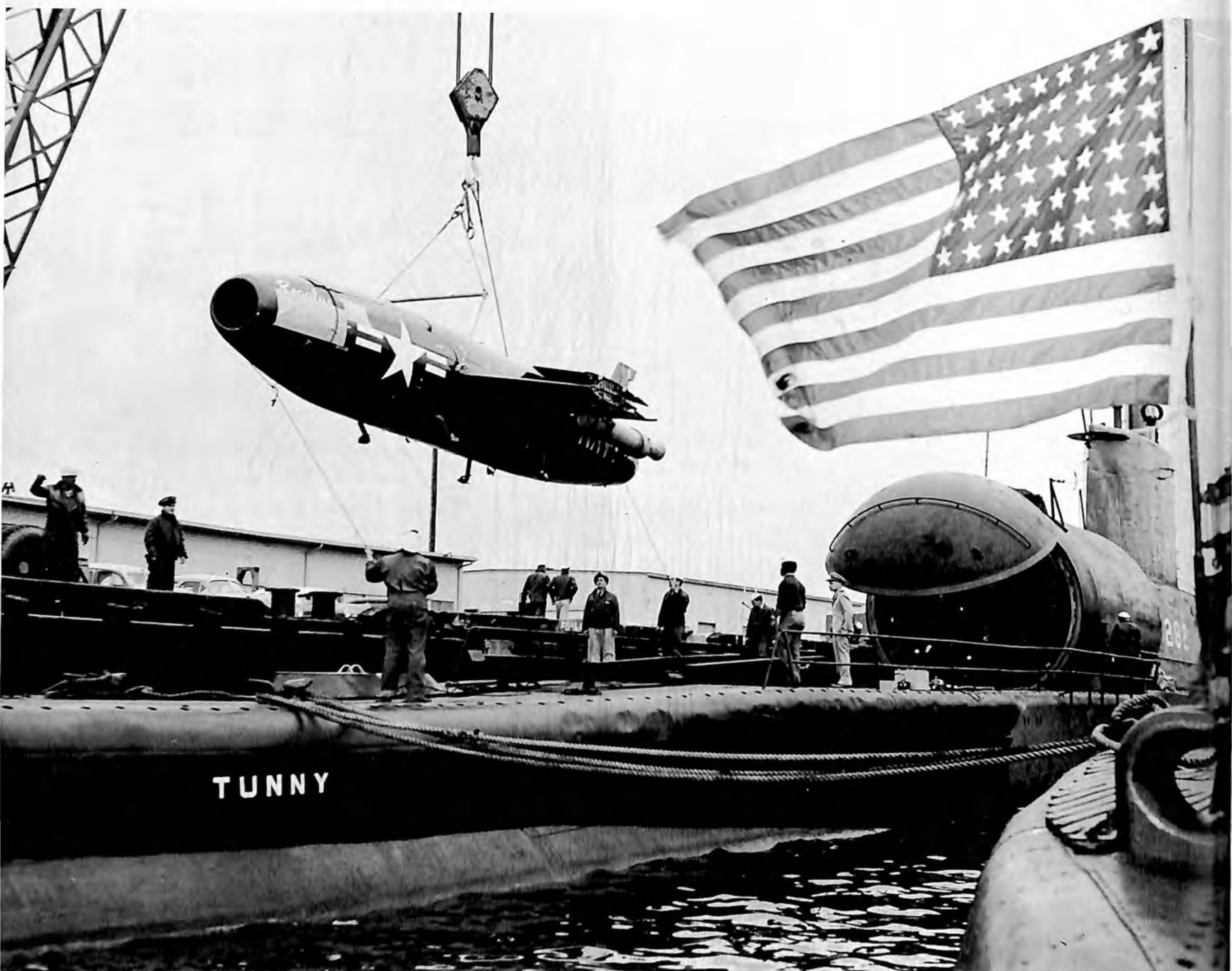


JUPITER

The SM-78 Jupiter was the first American intermediate range ballistic missile to be successfully fired. Originally developed by the Army, the missile was turned over to the USAF for operational use. After development by the Army Ballistic Missile Agency, the 60-foot, 110,000 pound Jupiter was assigned to Chrysler Corporation for production work and the first Chrysler-built, operational-type Jupiter was launched early in 1959. Rocketdyne builds the 150,000 pound thrust engine and Ford Instrument Company manufactures the inertial guidance system. Status: Operational.

REDSTONE

One of the older and most reliable missiles in the American arsenal, the Army's Redstone was first test fired in 1950. First ballistic missile to be deployed overseas, it was designed to extend and supplement the range and firepower of artillery. Redstone, which can deliver a nuclear or conventional warhead up to 200 miles, is 63 feet long and five feet 10 inches in diameter. Power source is a 75,000 pound thrust Rocketdyne engine. Chrysler Corporation builds the missile and Ford Instrument Company its guidance system. Status: Operational.

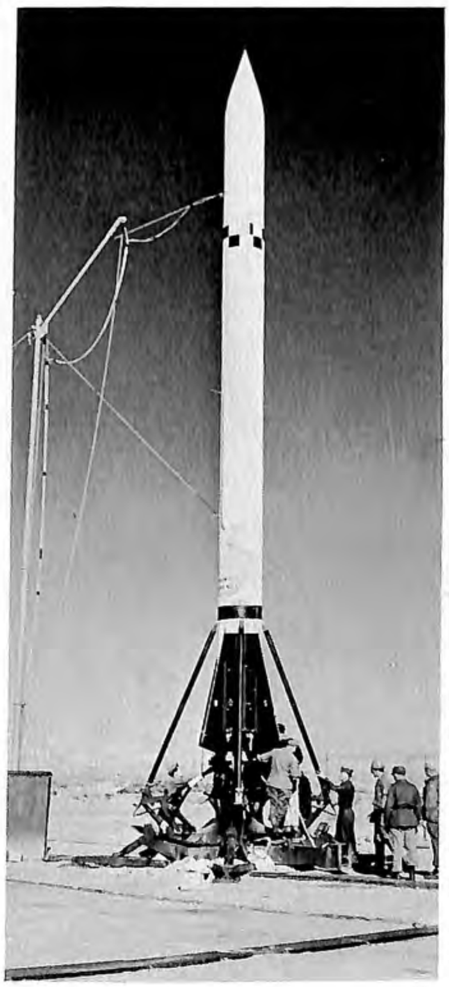


REGULUS I

First operational attack missile to join the Navy fleet, Regulus I was phased out of production in 1958 but remains in fleet service. The transonic air-breather, powered by an Allison J33 turbojet, is 33 feet long, has a 21-foot span and a range of 500 miles. Of nuclear capability, it can be launched from surface ships, submarines or shore bases. An advanced, supersonic Regulus II program was cancelled late in 1958. Regulus I is built by Chance Vought Aircraft. Status: Operational.

SNARK

An intercontinental missile of the air-breathing variety, the SM-62 Snark is an Air Force weapon of near sonic speed and nuclear capability. It is 67.2 feet long and has a wing span of 42 feet. A 15,000 pound thrust Pratt & Whitney J75 turbojet engine provides sustaining power after initial launch by a pair of rocket boosters. Northrop Corporation manufactures the inertial guidance system as well as the airframe. Status: Operational.



CORPORAL

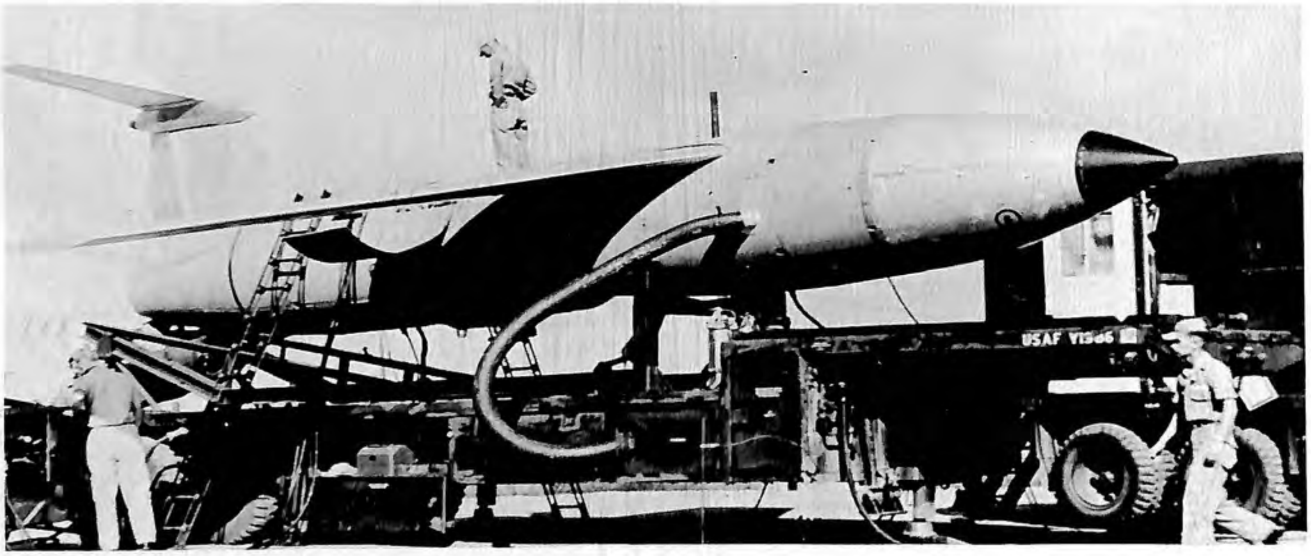
The Army's first ballistic-type weapon, Corporal (left) is still in operational use although scheduled for replacement. A short-range battlefield missile, it is liquid-propelled, 45 feet long and 30 inches in diameter. Radio guided, it weighs 11,000 pounds. The missile and its take-off pedestal are built by Firestone Tire and Rubber Company. Status: Operational.

SERGEANT

A short-range ballistic missile, Sergeant (right) was designed to replace the Army's Corporal. It is smaller than its predecessor, but has greater range, mobility, accuracy, and reliability. Sergeant is 34 feet long and 2.6 feet in diameter. It is powered by a Thiokol solid fuel propulsion system. Prime contractors are Jet Propulsion Laboratory and Sperry Utah Engineering Laboratory; Sperry also has guidance responsibility. Status: In production.

MACE

A replacement for Matador, the TM-76 Mace became operational in 1959 and was deployed to Germany. An air-breather like its predecessor, Mace has a range of more than 650 miles and it carries either a conventional or nuclear warhead. It uses either an inertial guidance system or ATRAN, a map-matching system. The former is manufactured by AC Spark Plug, while Goodyear Aircraft Corporation manufactures the ATRAN. A 100,000 pound thrust Thiokol booster is used for launch, an Allison J33 turbojet for sustained flight. The Martin Company is prime contractor. Status: TM-76A, the ATRAN-guided version, operational; TM-76B, inertially-guided with 1,200 mile range, in production.



MATADOR

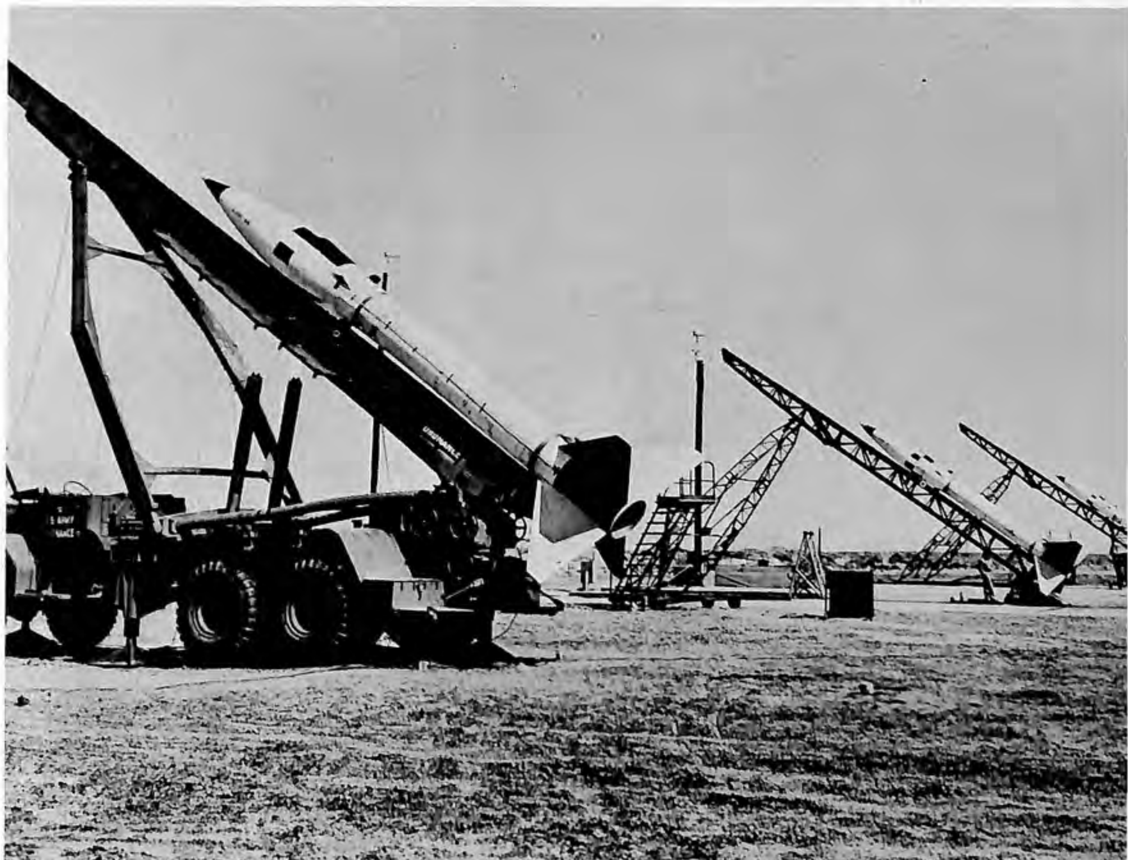
Matador was the first Air Force missile to attain operational status. Forty feet long, it is controlled electronically by ground personnel. A Thiokol solid booster provides initial launch impetus and an Allison J33 turbojet sustains flight at more than 650 miles per hour. The Martin Company is prime contractor. Status: Operational.

LITTLE JOHN

A supplement to Honest John, Little John is a free flight rocket without electronic controls featuring a high degree of accuracy, simplicity of design and ease of operation. Little John is 14.5 feet long and 12.5 inches in diameter. It is supersonic and has a range of 10 miles. Allegheny Ballistics Laboratory supplies the solid fuel rocket and Emerson Electric builds the frame. Status: In training with Army's 101st Airborne Division, near operational use.

HONEST JOHN

Honest John is an artillery rocket designed to provide close fire support for ground operations. Designated M-31A1C, the missile has a range of about 16 miles. Prime contractors are Douglas Aircraft Company and Emerson Electric Company. The 27-foot missile is powered by a solid fuel rocket and is unguided. Status: Operational.



LACROSSE

A highly accurate missile, Lacrosse became operational in 1959. Designed to replace heavy artillery in strikes against strong points delaying advance of ground troops, Lacrosse weighs slightly more than a ton and can carry a wide variety of conventional or nuclear warheads. It is 19.2 feet long and 20.5 inches in diameter; its stub wings span nine feet. Solid-propelled, it is guided by a forward command station. Lacrosse was developed by Cornell Aeronautical Laboratory and put in production by The Martin Company at its Orlando plant. Federal Telephone Laboratories provides the guidance system. The weapon is fired from a launcher mounted on a two and one half ton truck. Status: Operational, four battalions activated in 1959.

MINUTEMAN

Minuteman is a second generation ICBM under development by the Air Force. Designed to fill a need for a long-range weapon with more rapid reaction time than the existing liquid-fueled ICBMs, Minuteman will have a solid-fuel propulsion system and will be lighter, simpler and smaller than Atlas and Titan. It is to be a three-stage weapon in the same range category as its predecessors. A hard-based weapon, it will be stored in and launched from underground silos. Contracts were awarded to Boeing Airplane Company for assembly and test; Aerojet-General, Thiokol and Hercules Powder Company for solid-propellant development; North American Aviation's Autometics Division for guidance and control; and AVCO Corporation for the nose cone. Status: In development.

SHILLELAGH

Designed to provide greatly increased fire-power for close support of ground troops, Shillelagh is a lightweight missile system to be used against armor, troops and fortifications. Prime contractor is Aeronautics Division of Ford Motor Company. Status: In development.

PERSHING

Designed to replace Redstone in the Army's missile inventory, Pershing is a selective range two-stage ballistic missile. Both stages are solid-propelled by Thiokol rockets. With a new type mobile transporter-erector-launcher, Pershing will have the mobility of smaller weapons. Of nuclear capability, it has an inertial guidance system. It will be transportable by aircraft or helicopters. The Martin Company (Orlando) is prime contractor and airframe manufacturer; Bendix Eclipse Pioneer Division has guidance responsibility. Status: In development.

LOBBER

Not a weapon but a cargo ballistic missile, Lobber is a nine-foot solid-propelled missile capable of carrying 50 pounds of priority supplies in its payload section. Inexpensive to manufacture, it can be carried in the field by a three-man Army team under combat conditions. Contractor is Convair (San Diego) Division of General Dynamics Corporation. Status: In development.

SURFACE TO UNDERWATER

WEAPON ALPHA

Weapon Alpha is a 500 pound, 12.75 inch anti-submarine rocket, installed on destroyer escorts and the Navy's new class 931 frigates. It gives destroyers greater range and latitude of attack by removing the necessity of positioning the ship in the immediate area of enemy submarines as is necessary with depth charges. The rocket sinks rapidly and covers a much wider area than depth charges. It carries a conventional explosive charge. Status: Operational.

ASROC

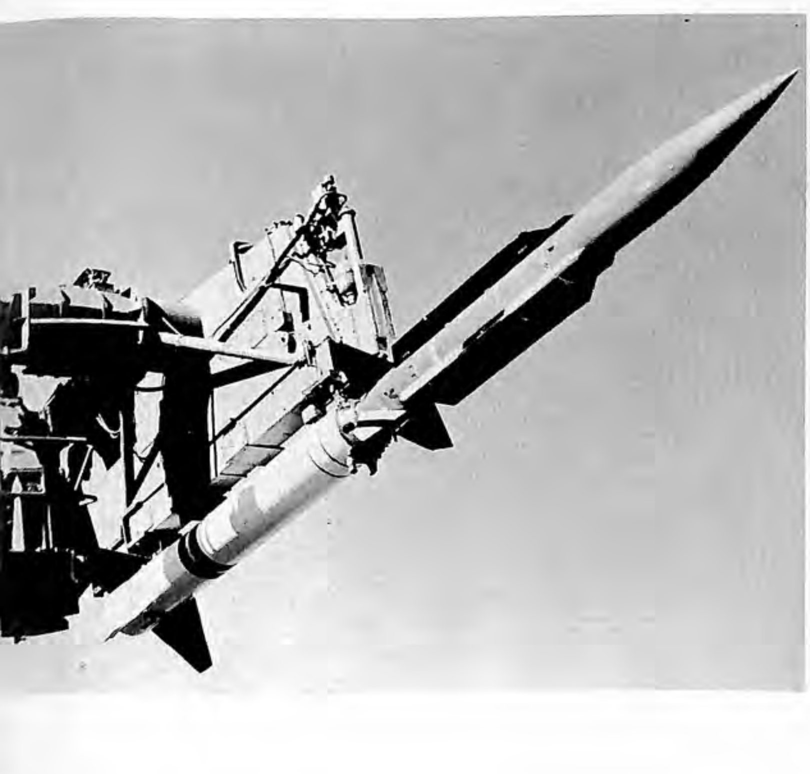
Designed for anti-submarine work, ASROC is a new surface-to-underwater weapon for the Navy on which no details have been released. Prime contractor is the Ordnance Division of Minneapolis-Honeywell Regulator Company.

SUBROC

SUBROC is an advanced tactical missile to be launched from submerged submarines. It will have a far greater range than currently available submarine attack weapons. The SUBROC system can detect an enemy sub at an undisclosed range, compute its course and speed, and fire the missile. The spent rocket drops away and the warhead continues on to the target. Prime contractor is Goodyear Aircraft Corporation, working under the direction of the Naval Ordnance Laboratory. Status: In development.

TALOS

A supersonic Navy missile powered by a 40,000 horsepower ramjet engine, Talos is designed to destroy enemy aircraft penetrating at high altitudes. First sea firing of the Talos was made from the guided missile cruiser, USS Galveston, early in 1959. The weapon weighs about 3,000 pounds and has a range of 65 miles. The missile was developed by the Applied Physics Laboratory of Johns Hopkins University and it is being produced by Bendix Aviation Corporation at the Naval Industrial Reserve Ordnance Plant, Mishawaka, Indiana. Status: Operational.

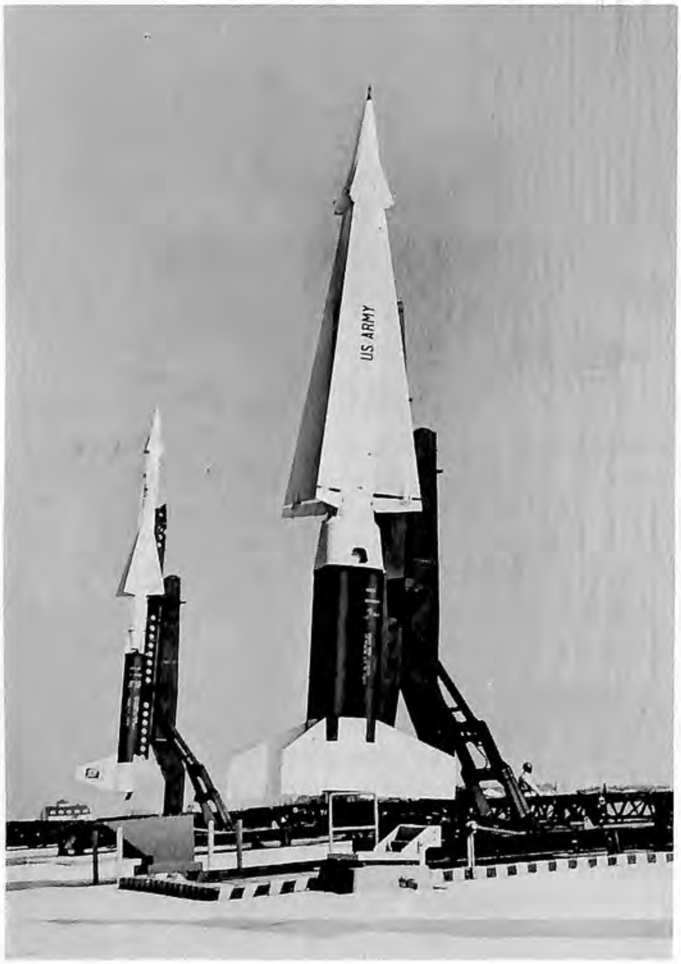


TERRIER

A Navy and Marine Corps anti-aircraft weapon, Terrier is supersonic and has a range of about 10 miles. Powered by a solid rocket provided by Allegheny Ballistics Laboratory, it is supersonic. The Navy's first operational guided missile, it has been in service for several years. Terrier is 15 feet long, 14 inches in diameter, has a wing span of four feet and weighs 1,100 pounds. Its altitude capability is more than 50,000 feet. Guidance is provided by a beam-rider system; guidance equipment is manufactured by Convair and Motorola, Inc. Convair is also prime contractor and airframe manufacturer. Under development is an advanced Terrier with an improved guidance system and substantial performance increases. Status, basic Terrier: Operational.

NIKE-AJAX

The first American surface-to-air missile, the Army's Nike-Ajax is still operational at a number of metropolitan sites, although it is gradually being replaced by the improved Nike-Hercules. In service since 1953, Nike-Ajax is liquid-propelled, supersonic and guided by radio commmand. It is 21 feet in length and has a range of about 25 miles. Western Electric Company is prime contractor; Douglas Aircraft Company builds the airframe and Bell Telephone Laboratories is responsible for the guidance system. Status: Operational.



NIKE-HERCULES

An Army air defense missile with a nuclear warhead, Nike-Hercules is a larger and longer ranging successor to Nike-Ajax. It has a speed of more than Mach 2.5 and its range is 75 miles. Hercules is 27 feet long and has a diameter of 31 inches. The first stage booster is powered by four solid rockets; the second stage has a single solid fuel sustainer. A command guidance system is employed. Western Electric Company is prime contractor, Douglas Aircraft is airframe manufacturer and Bell Telephone Laboratories provides guidance. Status: Operational.

NIKE-ZEUS

One of the most important missile projects is the Army's Nike-Zeus, an automated missile system designed for defense against attack by enemy intercontinental ballistic missiles. The Nike-Zeus system will intercept enemy missiles and destroy them a safe distance from intended targets, with the aid of several radars: a remotely located acquisition radar for long-range detection, a second acquisition-tracking radar for early calculation of hostile missile trajectories, and tracking radars at the battery sites which direct the kill. Integrated with each radar is a computer which coordinates its activities with other computers in the system over a high speed communications network. The missile itself is solid propelled, has a nuclear warhead, and is command guided. It is being developed by the same team which turned out the predecessor Nikes, Ajax and Hercules: Western Electric, Douglas Aircraft and Bell Telephone Laboratories. Status: In development. (See picture on page 66.)

BOMARC

A supersonic pilotless interceptor, the Air Force's IM-99 Bomarc is an intermediate range air defense weapon designed to engage enemy attackers some distance from the intended target. The IM-99A, powered by two Marquardt ramjet engines, has a range of about 200 miles, a ceiling of more than 60,000 feet and a top speed of better than Mach 2.5. The missile weighs about eight tons, is 47 feet long and has a wing span of 18.2 inches. It is boosted by an Aerojet-General liquid rocket which accelerates the weapon to ramjet velocity. The advanced IM-99B has a range of 400 miles. Boeing Airplane Company is prime contractor and airframe manufacturer; Westinghouse provides the command guidance system. Status: IM-99A, operational; IM-99B, in production.

REDEYE

Designed to provide individual troops with defense against low level air attack in forward areas, Redeye will be used by both the Army and Marine Corps. Similar in appearance to a World War II anti-tank bazooka, it is fired from its own shipping container. Redeye is four feet long, three inches in diameter and weighs 20 pounds. It has an infrared guidance system. Convair Division of General Dynamics Corporation is prime contractor and Philco Corporation supplies the guidance system. Status: In development.

TARTAR

Tartar is an improved version of the Terrier missile in operational Navy service. Supersonic, it is 15 feet long and one foot in diameter. It is solid propelled and has a range of about 10 miles. Production versions are scheduled for use on 13 guided missile destroyers and three heavy cruisers (the Chicago, Albany and Fall River), which are to be converted into missile ships. Tartar is built by Convair (Pomona), a Division of General Dynamics Corporation. Status: In Production.

HAWK

One of the Army's latest air defense weapons, the Hawk is a supplementary weapon to the Nike-Ajax and Nike-Hercules. It is designed primarily for use against low flying aircraft. Three Hawk missiles can be fired from a single launching unit; a battery consists of 12 launchers, or 36 missiles. Hawk features simple, rugged, easy-to-maintain equipment. It is 17 feet long and has a four foot wing span. Propelled by a Thiokol solid fuel rocket, it has a ceiling capability ranging from less than 100 feet up to 38,000 feet. Production is handled by Raytheon Manufacturing Company, with Northrop Corporation and Aerojet-General Corporation as major subcontractors. Status: In production, scheduled for operational service in 1960.

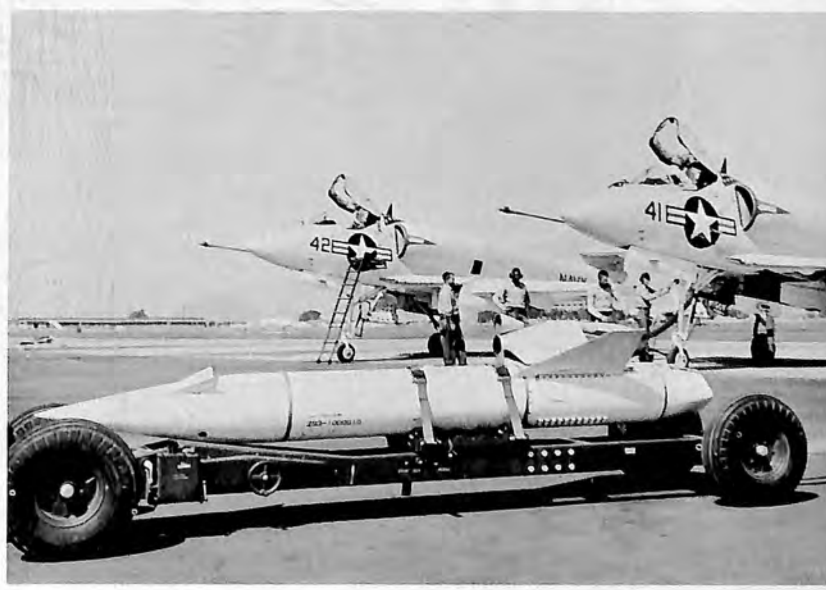
AIR TO SURFACE

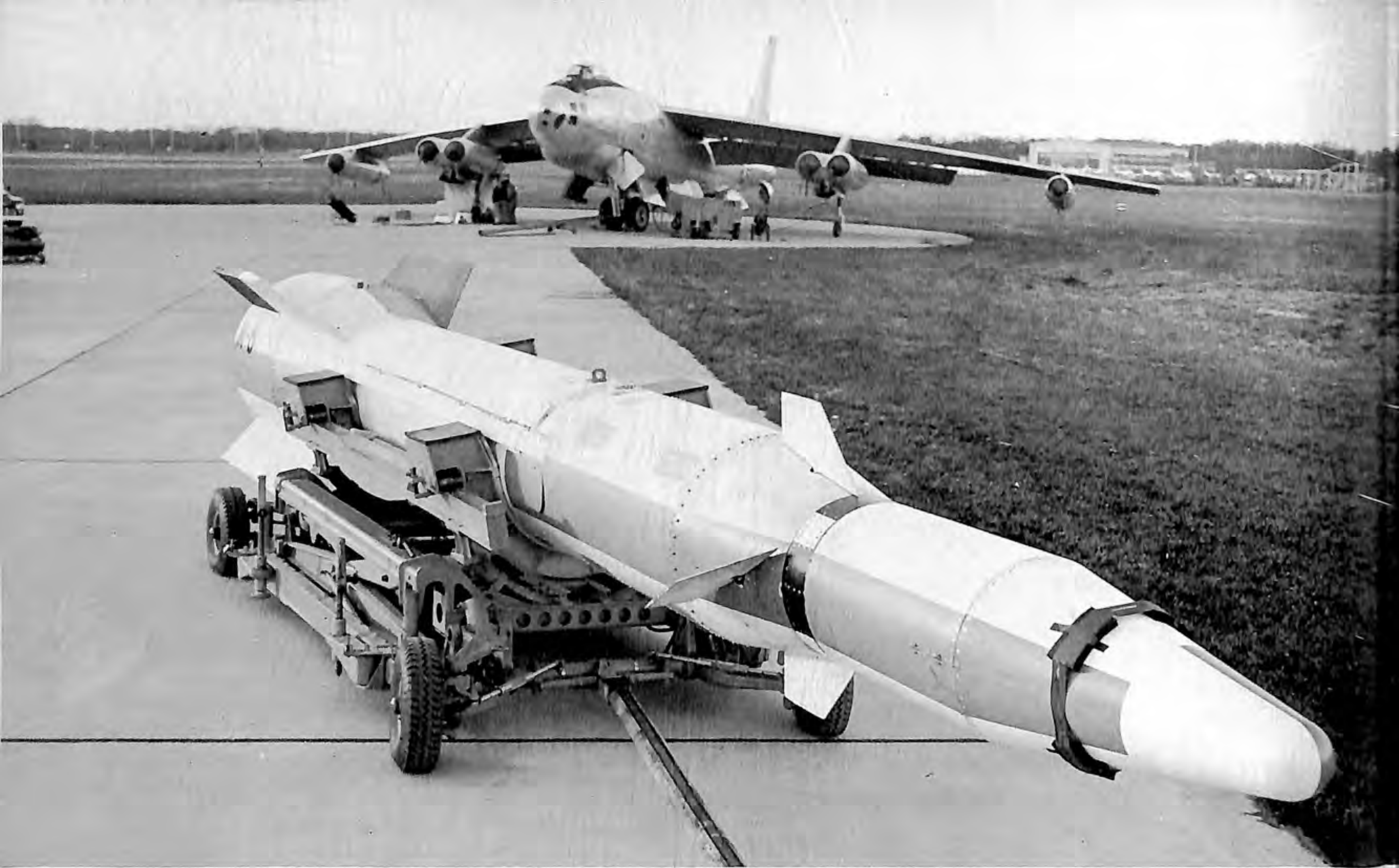
ZUNI

Designed primarily as an air-to-ground rocket for use with Navy fighter and attack aircraft, Zuni has interchangeable warheads which also permit its employment as an air-to-air weapon. Now being produced by Bridgeport Brass Company, it was originally developed by the Naval Ordnance Test Station, China Lake, California. Unguided, it is more than nine feet in length and has a Mach 3 speed capability. Status: In production.

BULLPUP

A tactical missile, Bullpup is simple in design, relatively inexpensive, yet highly accurate. It has a range of two miles plus and a speed of Mach 1.8. The missile is 11 feet long and weighs 540 pounds, including a warhead weight of 250 pounds. Bullpup is guided by radio command and powered by either a solid or liquid rocket, the former provided by the Naval Propellant Plant at Indianhead, Maryland, the latter by Thiokol's Reaction Motors Division. Prime contractor and airframe manufacturer is The Martin Company's Orlando (Florida) Division. Bullpup will be used by both the Air Force and the Navy. Status: Navy version, operational; USAF version GAM-83A, in production; USAF version GAM-83B, in development.



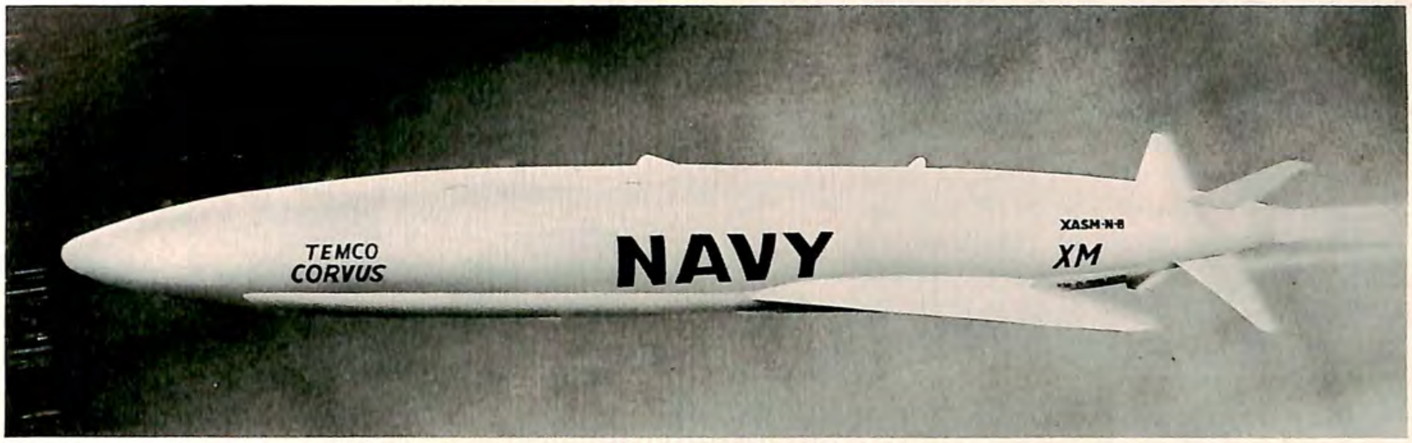


ALBM

"ALBM" is the code designation for a new and important weapon, the air launched ballistic missile, which would provide Strategic Air Command bombers with a mobile aerial launch capability for missiles of 1,000 nautical miles range or more. An initial research version, called the 199B ALBM (shown here), was built and test fired from a Boeing B-47 by The Martin Company. Douglas Aircraft Company received a later contract for advanced development of the concept. The Douglas weapon is named GAM-87A, Sky Bolt. Status: In development.

HOUND DOG

A missile designed to extend the capability of manned strategic bombers of the USAF's Strategic Air Command, Hound Dog can deliver a nuclear warhead over a range of several hundred miles after release from a Boeing B-52. Propelled by a 7,500 pound thrust Pratt & Whitney J52 turbojet engine, the GAM-77 Hound Dog is supersonic with an altitude capability of more than 50,000 feet. It is 42.5 feet long and has a maximum fuselage diameter of 28 inches. Guidance is provided by an inertial system built by Autonetics Division of North American Aviation. The weapon is manufactured by North American's Missile Division. Status: In advanced development, to be delivered to SAC in 1960.



CORVUS

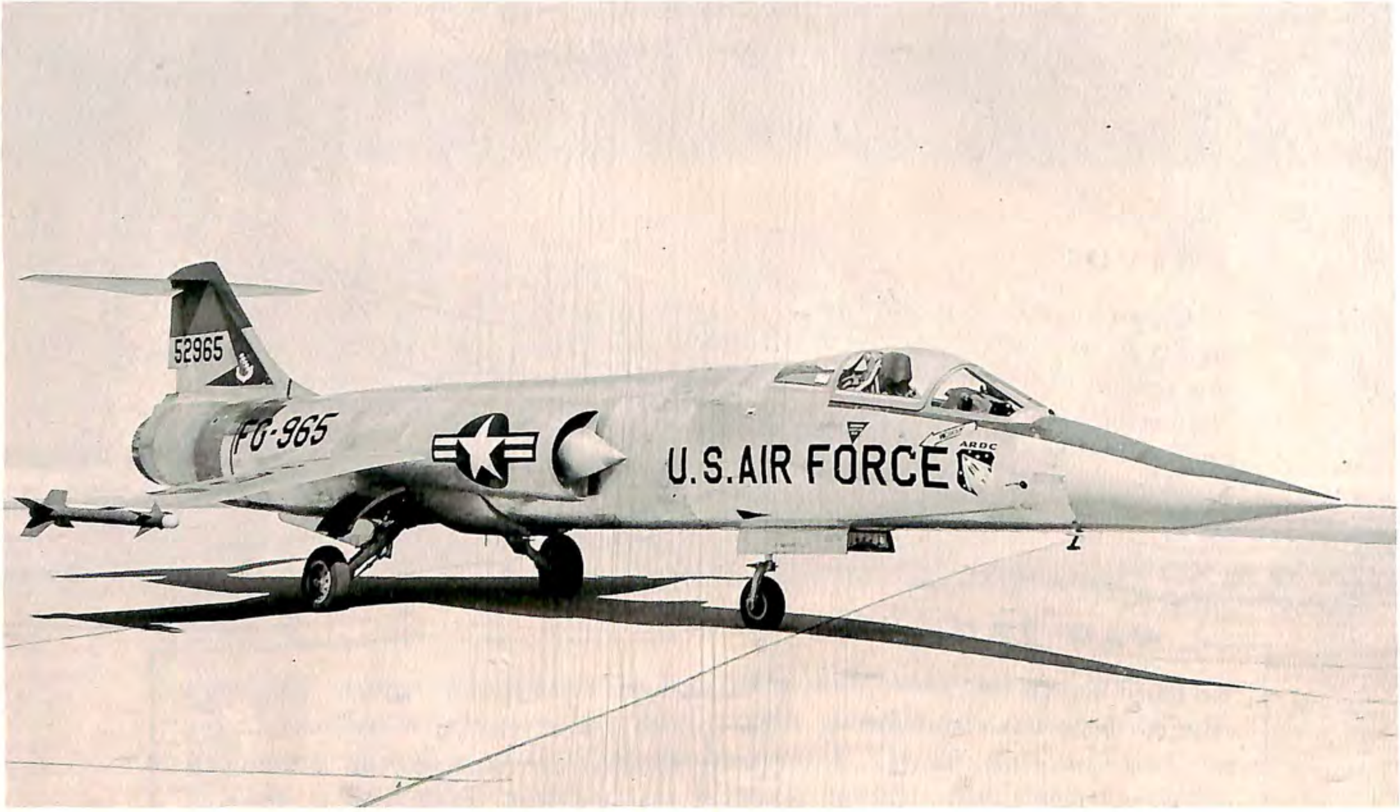
A supersonic missile using a pre-packaged liquid rocket engine, Corvus was designed to enable Navy carrier-based aircraft to attack heavily defended areas. A test version of the weapon was successfully air-launched from a Douglas A4D at the Pacific Missile Range on July 18, 1959. Temco Aircraft Corporation is prime contractor and airframe manufacturer, guidance is provided by Texas Instrument Company and W. L. Maxson Corporation, and Thiokol's Reaction Motors Division is handling production of the rocket engine. Status: In development.

WAG TAIL

Designed for greater penetration effect through low altitude launch, Wag Tail entered flight test status during 1959. An Air Force project, it employs a gyro reference guidance system. Minneapolis-Honeywell's Aeronautical Division is prime contractor, airframe and guidance manufacturer. Wag Tail is powered by a Thiokol rocket engine. Status: In development.

QUAIL

Mission of the GAM-72 Quail, a diversionary missile for use by the Air Force's Strategic Air Command, is to assist in target penetration by diverting attention of enemy defenses from SAC's bombers. Air-launched from Boeing B-52 bombers, the Quail is 12.9 feet long and has a wing span of 5.4 feet. Subsonic, it is powered by a General Electric J85 turbojet engine. McDonnell Aircraft Corporation is prime contractor, and the company also has airframe and guidance responsibility. Quail was first tested in 1958. Status: In development.



SIDEWINDER

A rugged inexpensive missile with fewer than two dozen moving parts, Sidewinder is a defensive weapon for Navy fighter aircraft. A simple aluminum tube powered by a solid rocket, Sidewinder is nine feet long, five inches in diameter, with a speed capability of Mach 2.5. The weapon is manufactured by Philco Corporation. General Electric Company provides an infrared or heat seeking guidance system. Work is in progress on an advanced second generation version of Sidewinder, called Sidewinder 1C. It will have greater speed and range than the original version. Status: Sidewinder, operational; 1C, in development.

EAGLE

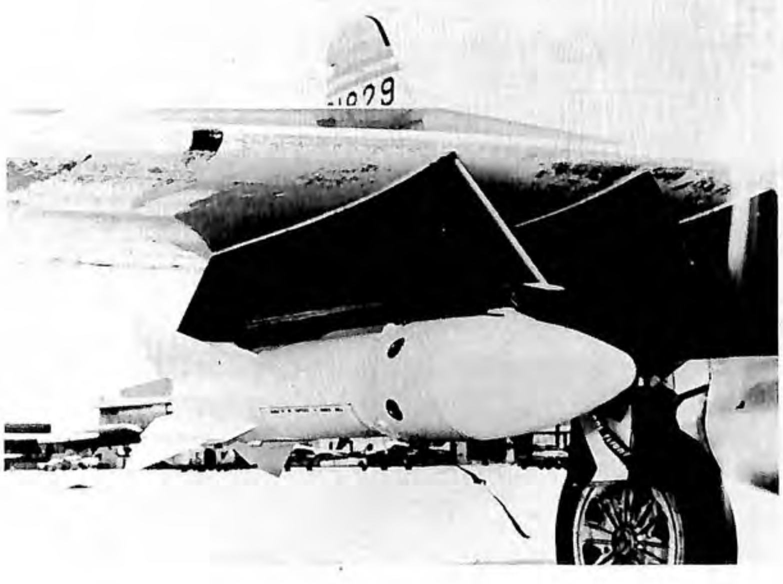
Eagle represents a new trend in guided missiles, in that the launching aircraft may be relatively slow since in this system the high performance is built into the missile instead of the manned aircraft. Bendix Aviation Corporation is prime contractor and is also responsible for Eagle's flight control, electronic guidance and support equipment. Grumman Aircraft Engineering Company produces the airframe and ground handling equipment. Aerojet-General will provide a new high performance propulsion system. Status: Early development.

SPARROW III

For use with Navy interceptors, Sparrow III is 12 feet long, weighs 350 pounds and attains a speed of 1500 miles per hour within seconds after launching. A replacement for Sparrow I in fleet air defense, it has the ability to attack enemy high performance aircraft from all aspects, including "head-on", and in all kinds of weather. Solid propelled, it has a radar homing guidance system. Prime contractor is Raytheon Manufacturing Company, which also has guidance responsibility. Aerojet-General provides the power source. Status: Operational.

FALCON

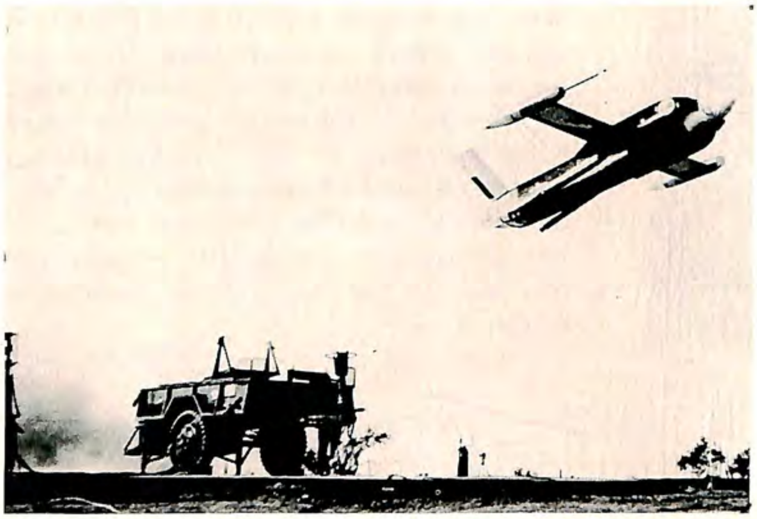
Falçon is the name of a family of air-to-air rockets which are fired and guided automatically with either radar or a heat seeking device. The latest versions are the GAR-3 and GAR-4; the -3 employs radar guidance and the -4 uses the infrared system. The basic missiles are about six feet long and 6.4 inches in diameter; the -3 is a foot longer. They are solid propelled and they use a conventional high-explosive warhead. Manufacturer is Hughes Aircraft Company. Status: Operational.



GENIE

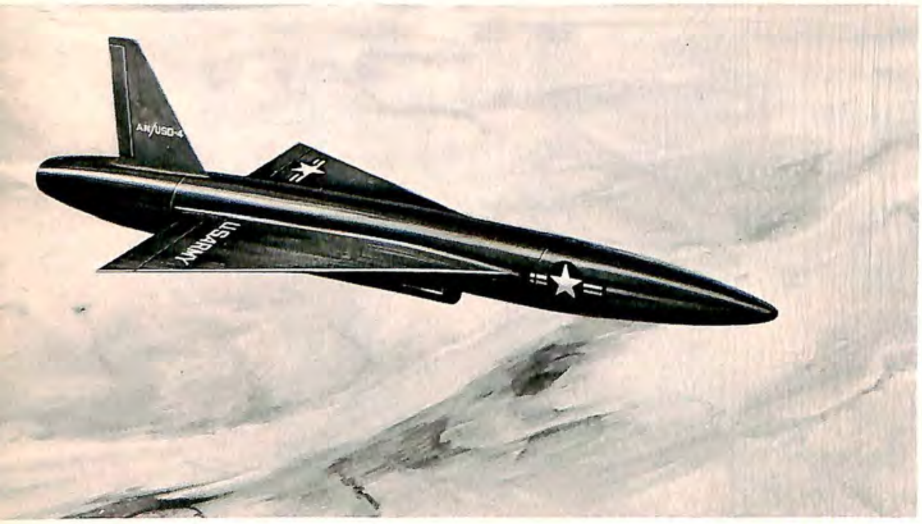
First test fired from an aircraft in 1957, Genie was the first air-to-air weapon to be equipped with a nuclear warhead. The relatively small missile is powered by an Aerojet-General solid rocket. It is unguided. The weapon, carried by F-89s, F-101s and F-106s of the Air Force's Air Defense Command, is manufactured by Douglas Aircraft Company. Status: Operational.

DRONES, TARGETS AND SURVEILLANCE



SD-2

Another Army surveillance drone, the SD-2 is zero launched by means of solid propellant rocket boosters from a standard military vehicle and recovered by parachute. The drone was developed by Rheem Manufacturing Company and taken over by Aerojet-General when the latter company acquired a portion of Rheem. It is now manufactured by Aerojet-General's Aeronautical Division, which is working on an improved version of the SD-2.



SD-4

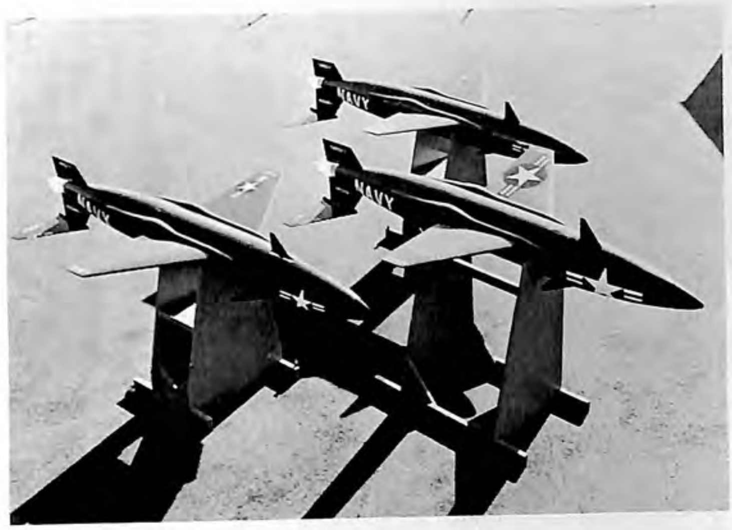
The SD-4 is a combat surveillance drone being built by Republic Aviation Corporation for the Army. Jet-propelled, it is equipped with photographic, radar and infrared devices to keep watch on enemy installations and movements.

SD-5

Another of a new series of intelligence-seeking drones, the SD-5 is an airborne surveillance system equipped with a number of sensory devices for reporting battlefield reconnaissance information. It is under development by Fairchild's Aircraft and Missile Division.

RP-76

Built by Radioplane Division of Northrop Corporation, the RP-76 is a target drone for surface-to-air missiles. Speed is in the high subsonic range. Power is supplied by a solid fuel rocket. Air launched and radio controlled, it is operable up to 40,000 feet.

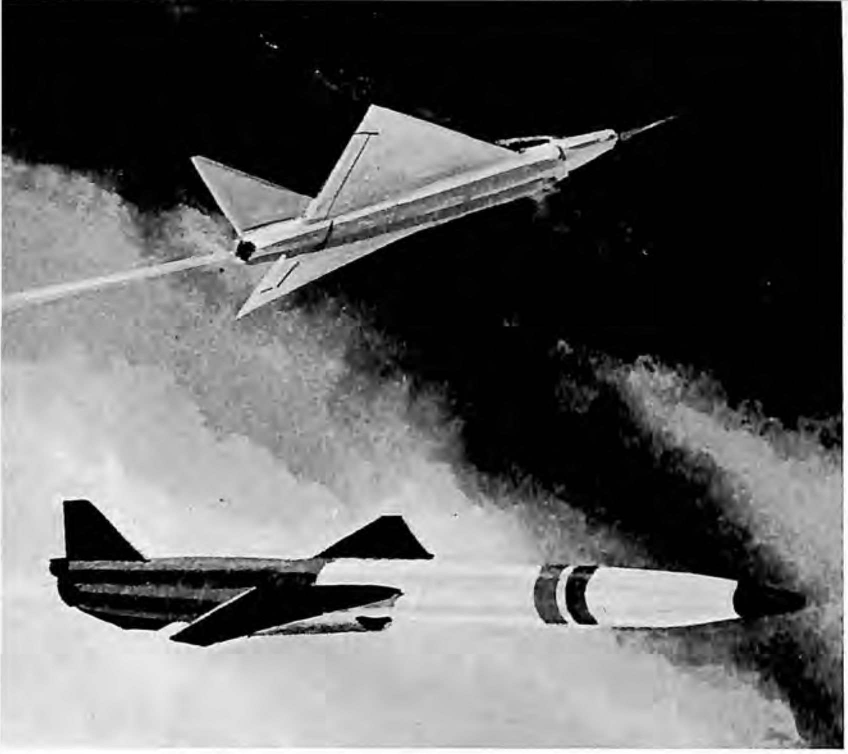


XQ-4

The XQ-4 is a high speed missile target developed for the Air Force by Radioplane Division of Northrop Corporation. About 33 feet long with a wing span of 11 feet, it is turbojet-powered and radar controlled. Launched from a "mother" airplane, it is supersonic.

Q-2A FIREBEE

Used by both the Air Force and the Navy as a target drone, the Q-2A Firebee weighs 1,800 pounds and is powered by a Continental J69 turbojet engine of 1,000 pounds thrust. It is 17 feet long, has a wing span of 11 feet, two inches and contains electronic equipment to score "miss distance" automatically. In photo, the Q-2A hangs under the right wing of a B-26; under the left wing is the Q-2C, a new and advanced version. Manufacturer is Ryan Aeronautical Company.



P106A

Under development by Aeronca Manufacturing Corporation is this advanced training target missile for use by the Army. A ram rocket propulsion system is used for a top speed of Mach 2.5 plus. The target, known as P106A, is 17 feet long, has a 40 inch wing span and weighs 365 pounds.

XKD2B-1

A Mach 2, liquid rocket propelled expendable target system, the XKD2B-1 is under development by Beech Aircraft Corporation for both the Air Force and the Navy. Weighing 560 pounds, it is 12 feet 10 inches long. Air launched, it can operate up to 70,000 feet. It will be used to simulate high performance aircraft flight. Range is 111 miles. The rocket engine is supplied by Rocketdyne Division of North American Aviation.

KDB-1

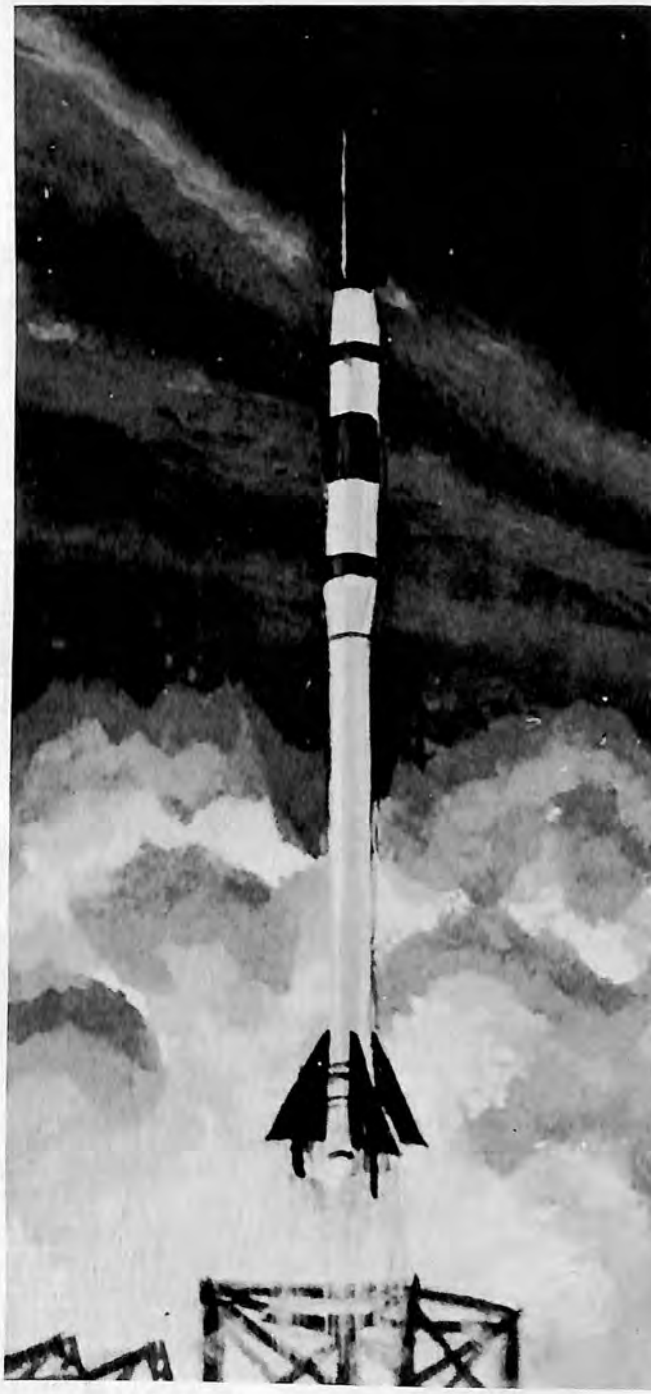
In production for both the Air Force and the Navy, the KDB-1 is a radio-commanded missile target built by Beech Aircraft Corporation. It is 15 feet long, spans 12 feet and weighs 600 pounds. Power is a 120 horsepower McCulloch turbo-supercharged engine, which gives the drone a top speed of 300 knots.

KDT-1

A low cost, expendable drone for use in air-to-air target, the KDT-1 is used by the Navy for training jet fighter pilots. Shown here on the wing of a McDonnell F3H, it emits a flare to permit visual tracking. It is 12 feet long and has a 59 inch wing span. The drone is built by Temco Aircraft Corporation.

POGO-HI

The advanced version of the Army's Pogo-Hi (right) is a missile target which can reach an altitude of 248,000 feet and a speed of Mach 4. It is solid propelled and a programmed guidance system is employed. The system is under development by Aeronca Manufacturing Corporation.



Q-5 KINGFISHER

The Q-5, or Kingfisher (left), is an Air Force target missile with a speed capability in excess of Mach 2. Ramjet powered in sustained flight, it is launched by solid fuel Thiokol boosters; Marquardt builds the ramjet. Air launched from a bomber, it is guided by a radio frequency command system. Fastest target missile in U.S. service, the Q-5 is built by Lockheed's Missile and Space Division.

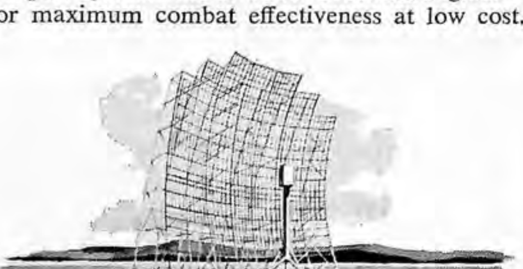
NEWS IS <u>HAPPENING</u> AT NORTHROP

NORAIR, outstanding creator of complete weapon systems including related airframes, is now producing the Snark SM-62 missile, the T-38 Talon trainer, and the multi-purpose N-156F Freedom Fighter.

NORTRONICS makes news with America's two most advanced inertial and astronertial guidance systems–LINS and A-5–is also a leader in automatic test equipment, mechanical ground support.

RADIOPLANE, foremost producer of multi-purpose drones and space age recovery systems, delivers unmanned aircraft that train men, evaluate weapon systems, fly photo surveillance missions.

INTERNATIONAL, Division for foreign operations, is now introducing the first multi-purpose weapon system–the N-156F Freedom Fighter–for maximum combat effectiveness at low cost.



PAGE COMMUNICATIONS ENGINEERS, builders of strategic global networks, selected by USAF to link England-Spain-Morocco with troposcatter, telephone, teleprinter and data communications.

NORTHROP
BRINGS THE FREE WORLD
SOLUTIONS TO DEFENSE PROBLEMS
–AT FEASIBLE COST

Shown on this page are five members of the Northrop family and some of their current advances.

The leadership of each of these Divisions typifies the years-ahead thinking of the entire Northrop Corporation. The Corporation's continuing goal: design concepts for tomorrow, hardware for today–developed, produced, and delivered on time–and at feasible cost.

SOME OF NORTHROP'S MANY HISTORY-MAKING "FIRSTS"

The first intercontinental guided missile, the SM-62 Snark

The first lightweight, high-performance supersonic trainer, the T-38 Talon

The first lightweight, multi-purpose supersonic fighter sponsored by the United States for our Free World allies–the N-156F Freedom Fighter

The first specifically designed night fighter, the P-61 Black Widow of World War II

The first American military rocket plane, the MX-324

The first jet airplane especially designed as an all-weather, high-altitude interceptor, the F89 Scorpion

NORTHROP

CORPORATION Beverly Hills, California

Bendix-built Talos Guided Missiles on the Navy's "U.S.S. Desert Ship" at White Sands Proving Ground—Official U.S. Navy Photo.

HOW THE MANY BENDIX MISSILE CAPABILITIES ARE IMPORTANT TO NATIONAL DEFENSE

Bendix* has been meeting and solving missile problems for many years. In addition to building the Talos, a U. S. Navy ground-to-air missile, we engineered and developed many of the major systems used in other key missiles. These include warheads, target-seekers, propulsion devices, controls, guidance and telemetering systems. Telemetering systems enable missiles to send back reports from space. More than 500 different channels of information can be transmitted, such as speed, direction, acceleration, roll, vibration, temperature, etc.

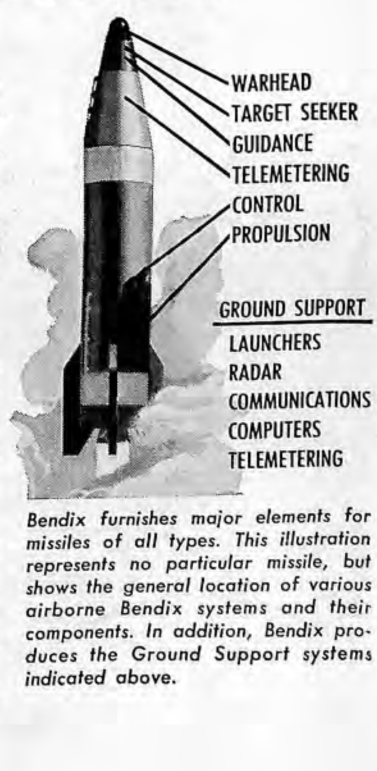
The Talos, for which Bendix is prime contractor, has, according to a Navy statement, "demonstrated a remarkably high degree of accuracy and reliability". As a result, the Navy is making direct shipboard installations on first-line cruisers without the intervening step of evaluation. This has meant a considerable money saving and has advanced this missile as a fleet weapon. It will be the major armament of the United States cruiser *Galveston* and will also be installed on a number of other cruisers, including the nuclear-powered *Long Beach*.

Because of the accuracy and extreme range of the Talos, the U. S. Army is also studying the feasibility of incorporating it into the Continental Air Defense System.

In addition to missiles and missile components, Bendix manufactures important Ground Support systems and devices.

Looking to the future, Bendix is engaged in an intensive *long-range* program, designed to help keep America foremost in the development of weapons vital to the preservation of our security and world peace.

*TRADEMARK



Bendix furnishes major elements for missiles of all types. This illustration represents no particular missile, but shows the general location of various airborne Bendix systems and their components. In addition, Bendix produces the Ground Support systems indicated above.

Bendix
AVIATION CORPORATION
Fisher Bldg., Detroit 2, Mich.

A thousand diversified products

United Air Lines pilots review flight plan calculated by Bendix G-15 Computer at UAL's Operating Base, Denver, Colorado.

UNITED USES "ELECTRONIC PLANNING" TO ADD SPEED AND COMFORT TO JET TRAVEL

To enhance its fine new DC-8 Jetliner Service, United Air Lines has taken two modern jet age steps so you will receive the best possible flight under the smoothest, safest conditions.

One step involves the use of a Bendix* G-15 Computer which solves difficult flight planning problems in seconds; the other makes use of Bendix* Doppler Radar, an airborne system for pinpoint navigation that is completely independent of ground facilities.

Your flight always starts and ends with a Flight Plan. It specifies the desired route, flying time, alternate airports and other important factors. Copies are filed with the Federal Aviation Agency to insure that a section of the skyways will be reserved for your flight.

Its preparation often required more than an hour of the Captain's time, as he studied a mass of weather data; calculated load, fuel supplies, ceiling limitations, wind speed, etc. His aim was to seek a route with the smoothest conditions and to take advantage of favorable winds. A Bendix Computer now performs this task. It pre-calculates flight plans for the entire system, which are as free from error as modern technology can make them.

Once in the air Bendix Doppler Radar lets the pilot know whether he is being slowed by head winds or speeded by "jet stream" tail winds. It gives him instant, constant navigation data that previously required continual calculation. At a glance he reads his ground speed, drift angle, actual course and distance-to-go and, therefore, his exact position. Thus, he can quickly adjust to take advantage of the most favorable winds.

Bendix Doppler Radar bounces beams off the earth's surface, gives pilot pinpoint navigation data, permits him to take advantage of most favorable winds.

United's first use of Bendix Doppler Radar will be over its route to Hawaii, which requires about five short hours and places our fiftieth state within commuting distance of the mainland.

Bendix
AVIATION CORPORATION
Fisher Bldg., Detroit 2, Mich.

A thousand diversified products

*REG. U. S. PAT. OFF.

UNITED STATES

CHRONOLOGY

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 make 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.

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.

1887, January 30—Thomas E. Baldwin makes his first parachute jump at San Francisco.

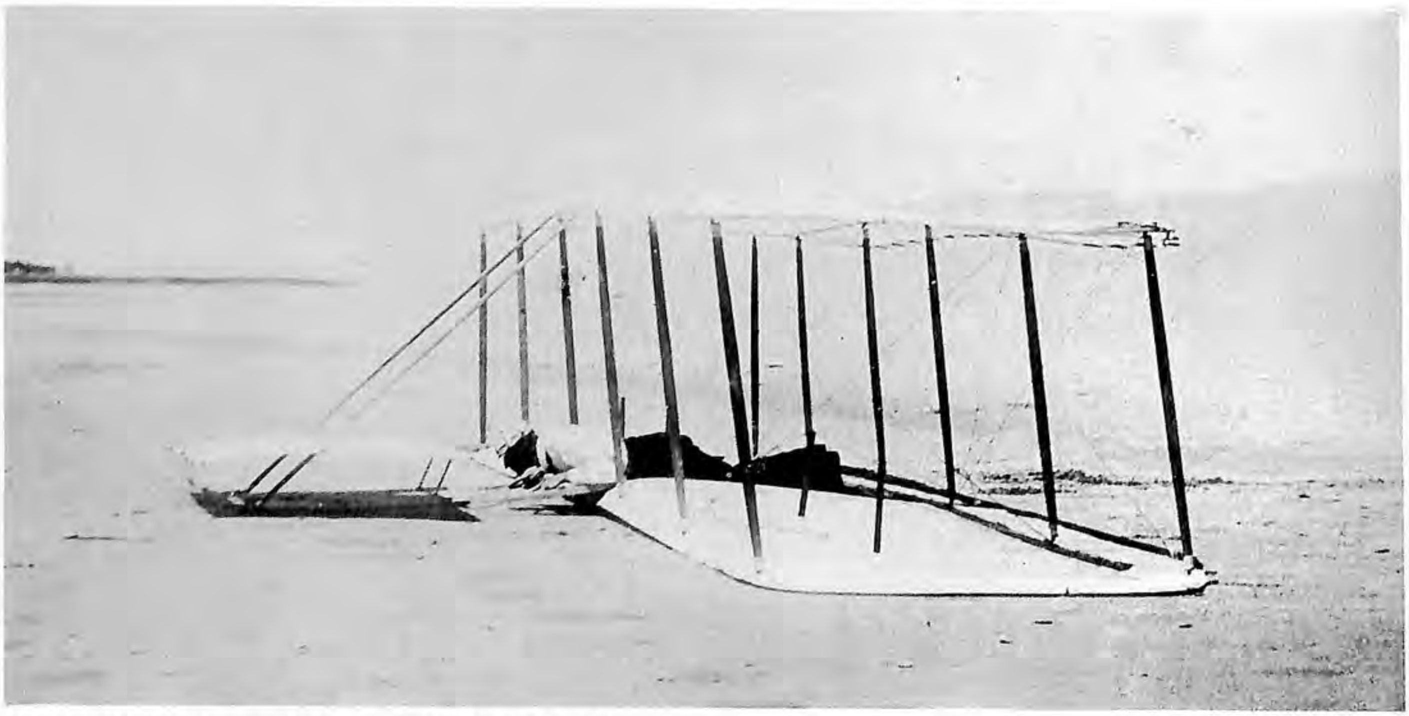
1886, July—W. E. Irish, publisher of *Aeronautical World,* proposes balloon radio.

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.*

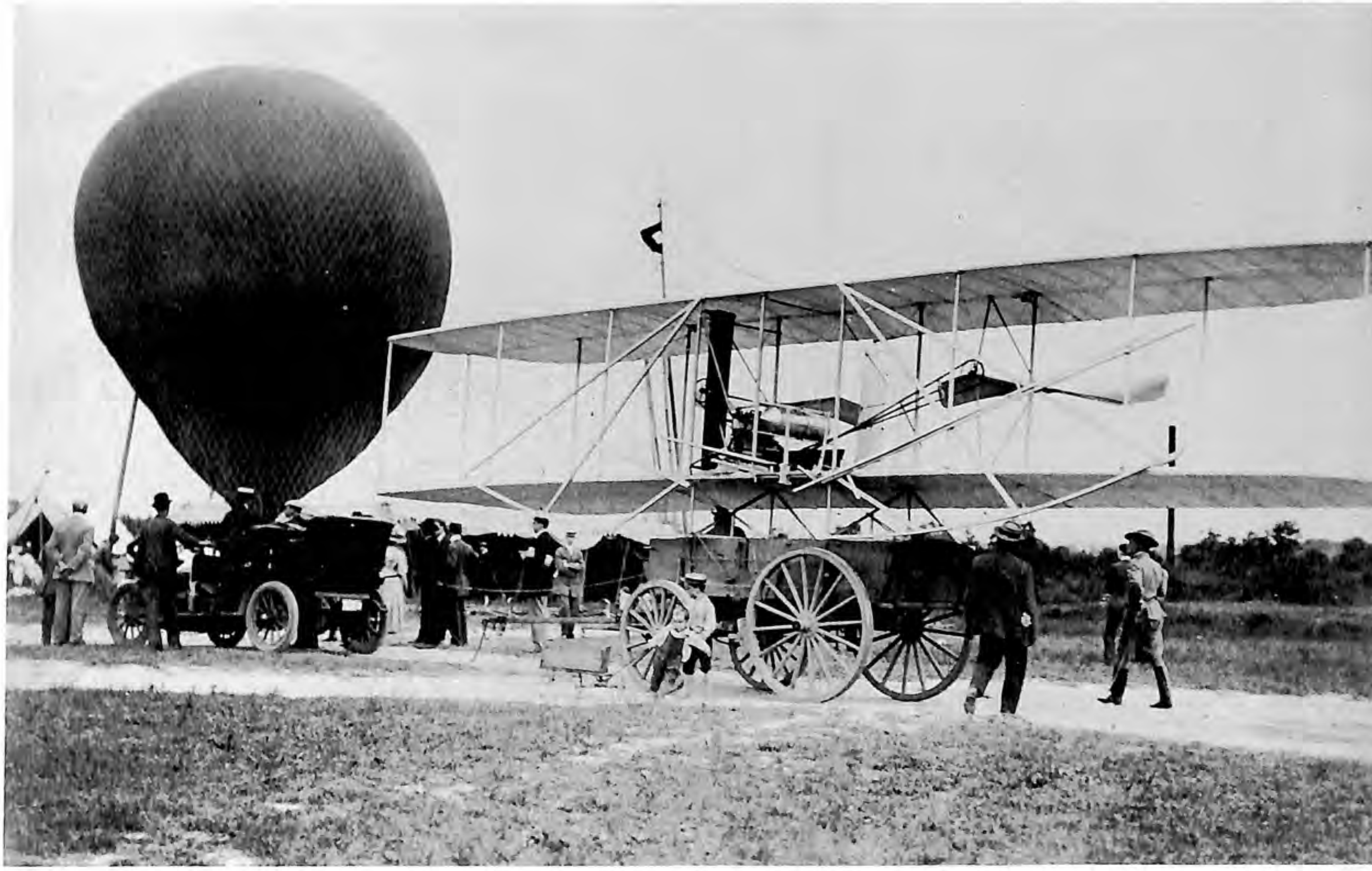
1890, July 31—During the month, L. Gathmann, of Chicago, explodes a shell at high altitude in attempt to produce rain.

1890, October 1—President Harrison approves legislation creating the Weather Bureau and reestablishing 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.



Wilbur Wright lands glider at Kitty Hawk, 1901.



Automobile pulls Wright military airplane on wagon at Fort Myer, Virginia, 1908.

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.

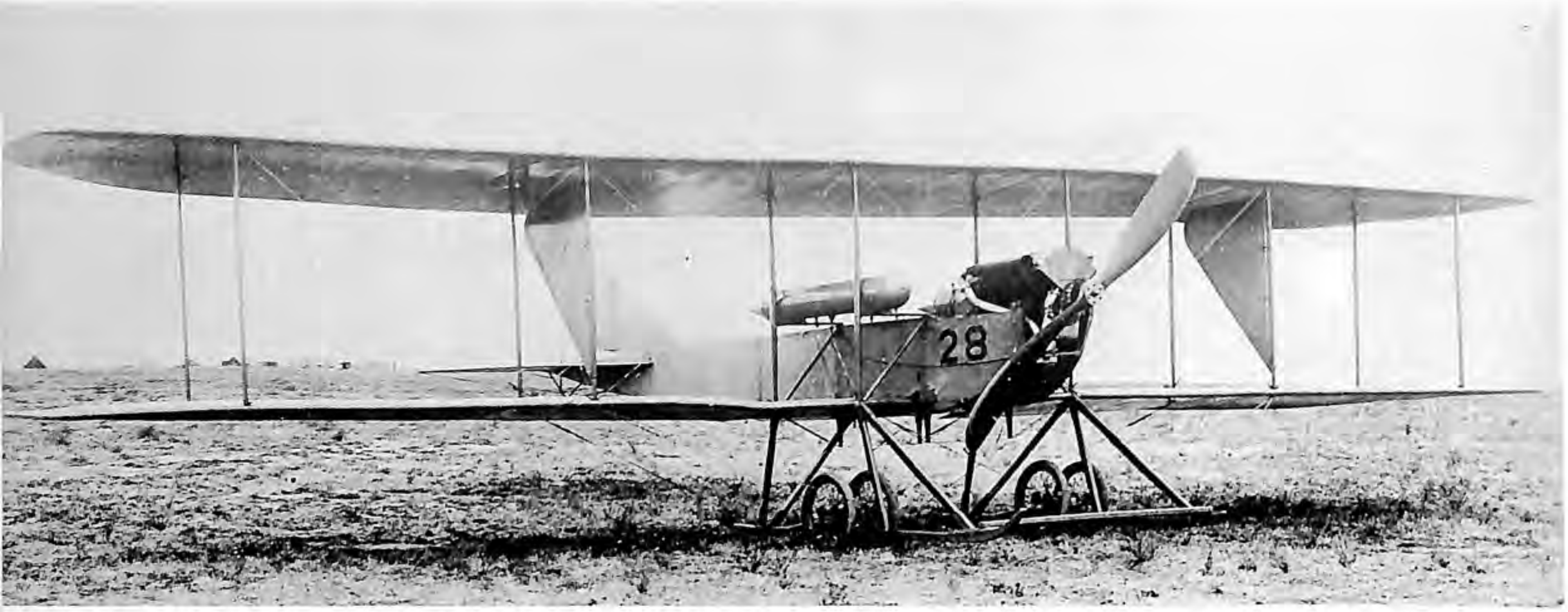
1901, September 1—Simon Newcomb, Ph.D., LL.D., writes in *McClures* for September: "The first successful flyer will be the handiwork of a watchmaker and will carry nothing heavier than an insect."

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,



Burgess Military Tractor "C," 1911.

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.

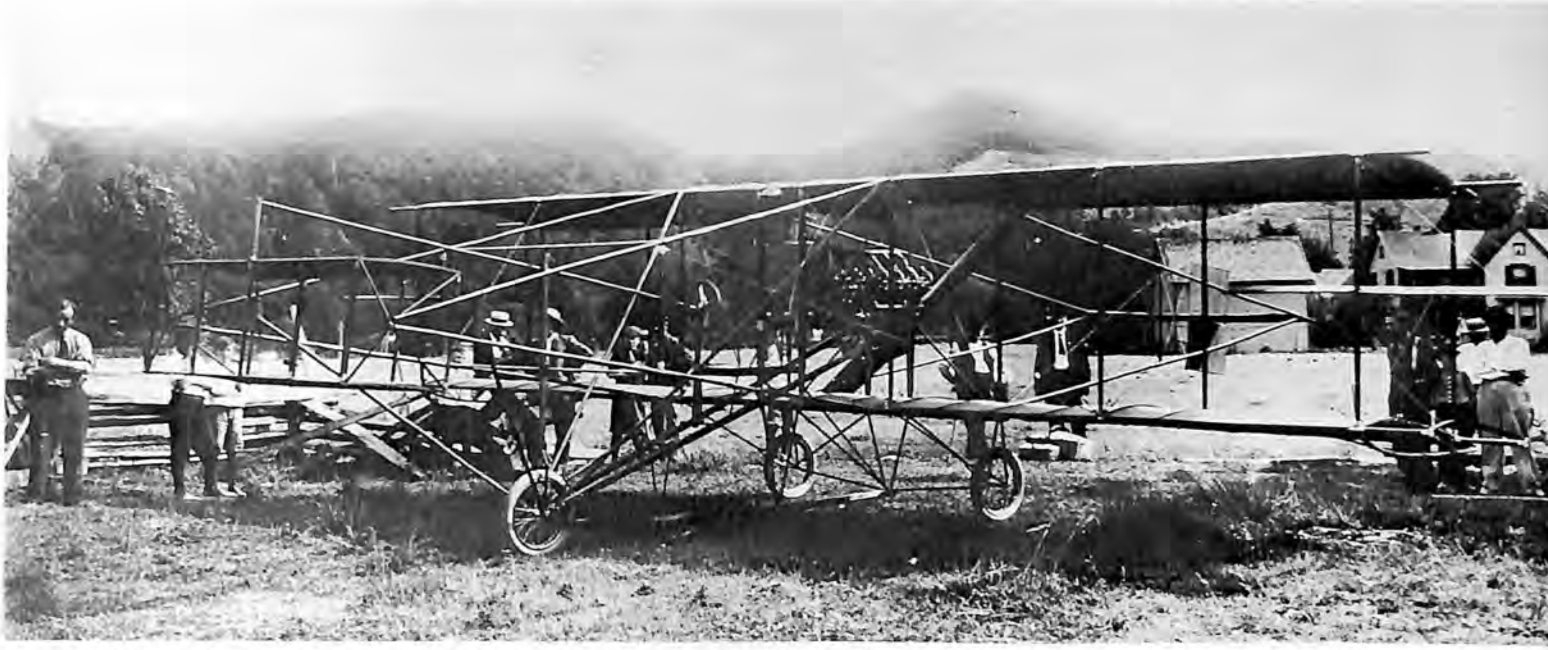
1907, October 1—Aerial Experiment Association formed by Dr. A. Graham Bell, F. W. Baldwin, J. A. D. McCurdy, Glenn H. Curtiss and Thomas E. Selfridge.

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.



Curtiss Golden Arrow is winner of Gordon Bennett International Cup Race, 1909.

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.

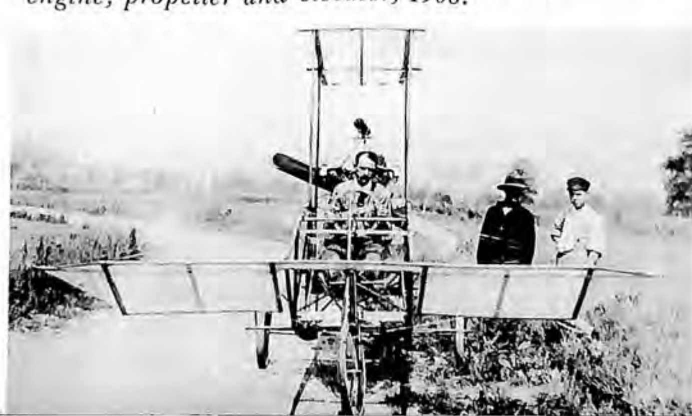
1907, December 23—Chief Signal Officer advertises for airplane bids, after visit of Wrights.

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.

Curtiss vehicle consists of tricycle gear, wing section, V-engine, propeller and elevator, 1908.



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.

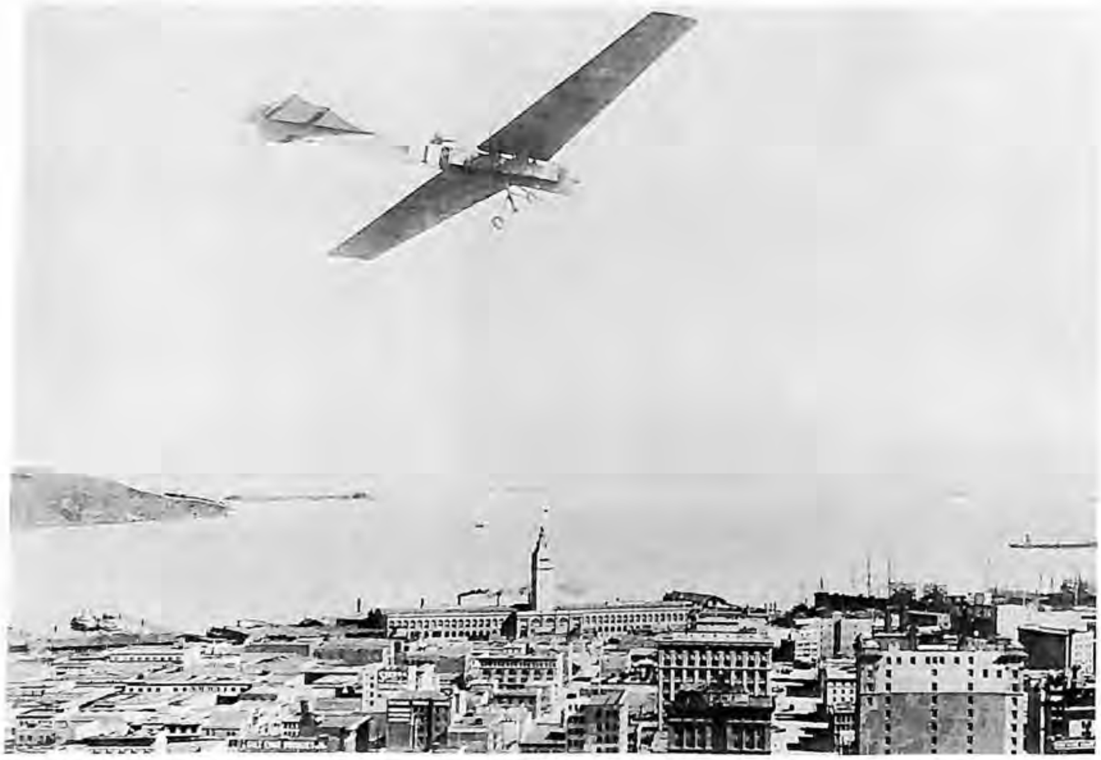
1908, July 17—First air ordinance passed by Kissimmee, Fla., with registration and regulation.

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.



Hubert Latham pilots Antoinette in first flight over Golden Gate, January 7, 1911.

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.

James Nolan's 1910 biplane with tail in front, engine in rear, had 32 horsepower Metz engine.

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.

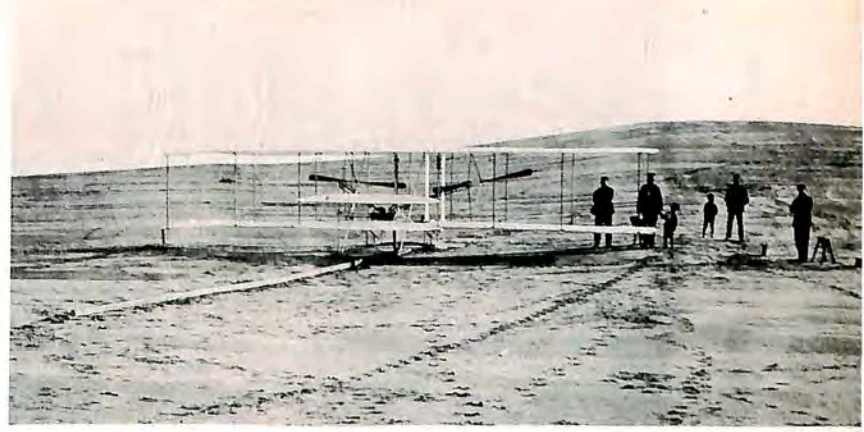
1910, September 2—First American woman pilot solos: Blanche Stuart Scott. First exhibition at Fort Wayne, Oct. 22.

1910, October 8-10—Former President Theodore Roosevelt is flown at St. Louis exhibition by Arch Hoxsey.

1910, October 15-17—Wellman airship, *America,* abandons trans-Atlantic trip after some 800 miles.

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.

Curtiss Goupil "Duck," 1914.



First trial of Wright airplane, December 14, 1903.

Boeing 40-B flies mail over Mt. Rainier.

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.

Calbraith Rodgers (right) stands by Wright's EX, transcontinental airplane, with Stewart I. de Graff.

Whit Beck Special, mail plane, 1922.

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.

Curtiss and Ellyson with Curtiss Triad, first hydroaeroplane purchased by Navy.

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.

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.

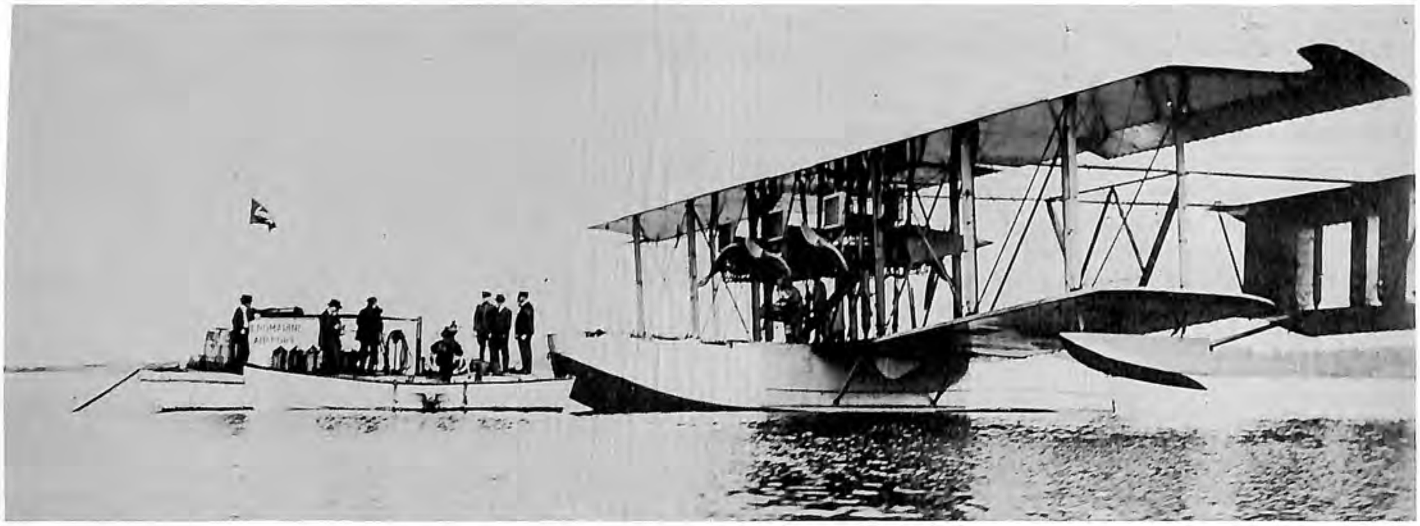
1911, October 10—Bombsighting and dropping device demonstrated by Riley Scott, College Park, Md.

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.

Curtiss Condor B2 is piloted by robot.



NC-9 refuels enroute to Detroit from Washington, D.C., 1922.

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 Peck 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. Dargue 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.

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-county 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,[illegible].

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.

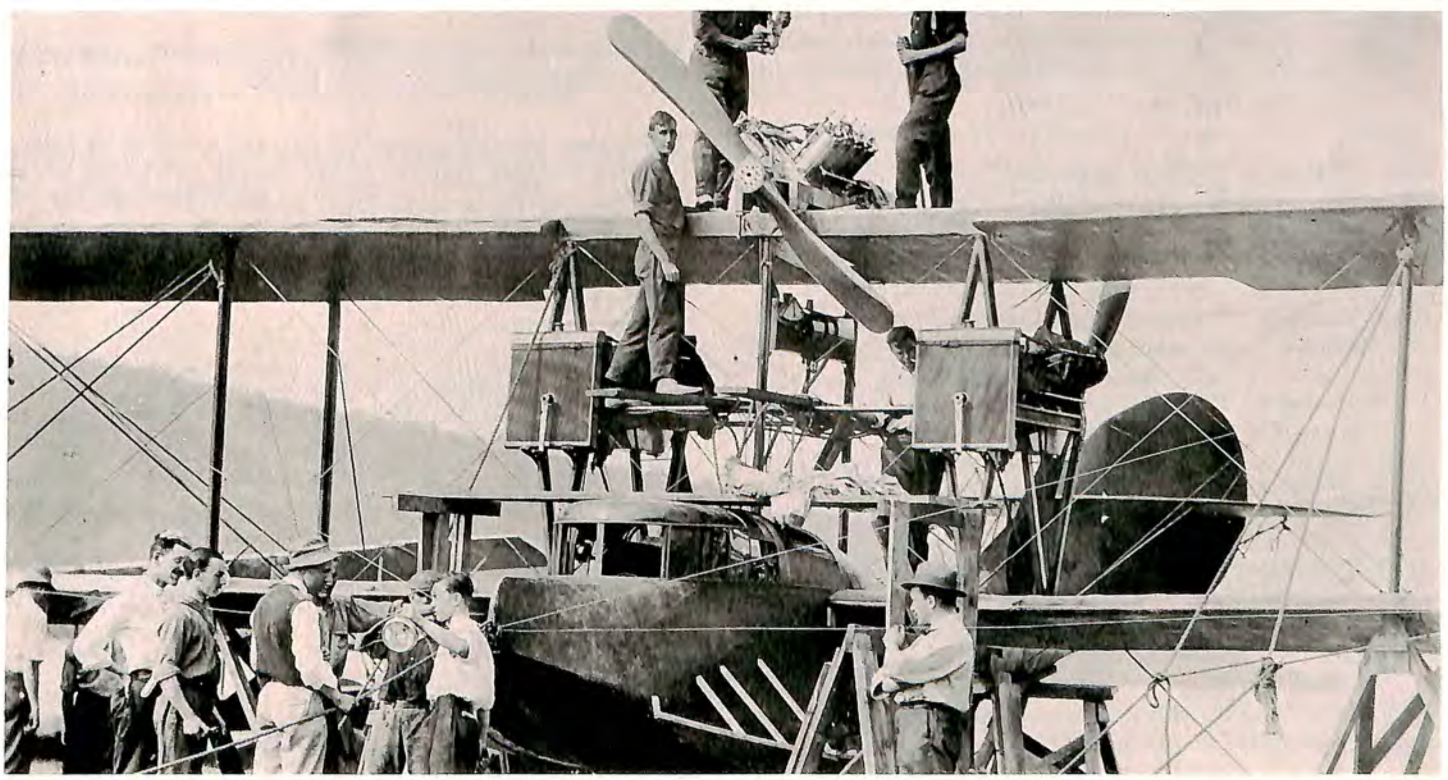
1918, May 11—U. S.-built DH-4 Liberty planes received by AEF.

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.



Third engine is mounted on top wing of Curtiss America, 1914.

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 tree 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 nonstop 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 14½ 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.

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—Trancontinental 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 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.

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.

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-county 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.

Lockheed Vega Yankee Doodle set two transcontinental records in 1928.

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, Colombia, flight by Capt. Benjamin Mendez, 4,600 miles.

Spirit of St. Louis at Omaha Airport.

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, Md.

1930, June 11-July 4—World endurance record of 553 hr. 41 min. 30 sec. established by John and Kenneth Hunter (Stinson-Wright 200).

Beech AT-11, 1941.

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, non-refueled, set by Walter E. Lees and F. A. Brossi, Bellanca, Packard Diesel 225 hp; 85 hr., 32 min., 38 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, in 14 hours. 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, October 3-5—Trans-Pacific non-stop airplane flight by Clyde Pangborn and Hugh Herndon, Samushiro Beach, Japan, to Wenatchee, Wash.

1931, October 3-5—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 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 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-Mar. 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.

Martin Caroline Mars sets a nonstop flight record for seaplanes in 1948.

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 nonstop 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 takeoff 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 airpo 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 American 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 2—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. Councill, 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.

Bell P-59A (foreground) is first U.S. jet.

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.

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. Charles 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 lightplane distance record, crossing from Honolulu to Oakland, Calif.

1949, February 7—Eastern Air Lines reports new transcontinental 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 non-stop 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, August 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 mins.

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 sets new record for flight without refueling, landing at Key West, Fla., after 200 hrs. 4 mins. 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.

North American F-100 sets speed record in 1953.

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, 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 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 turbotjet 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, 6 hours, 18, minutes, 57.4 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 Edwards 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.

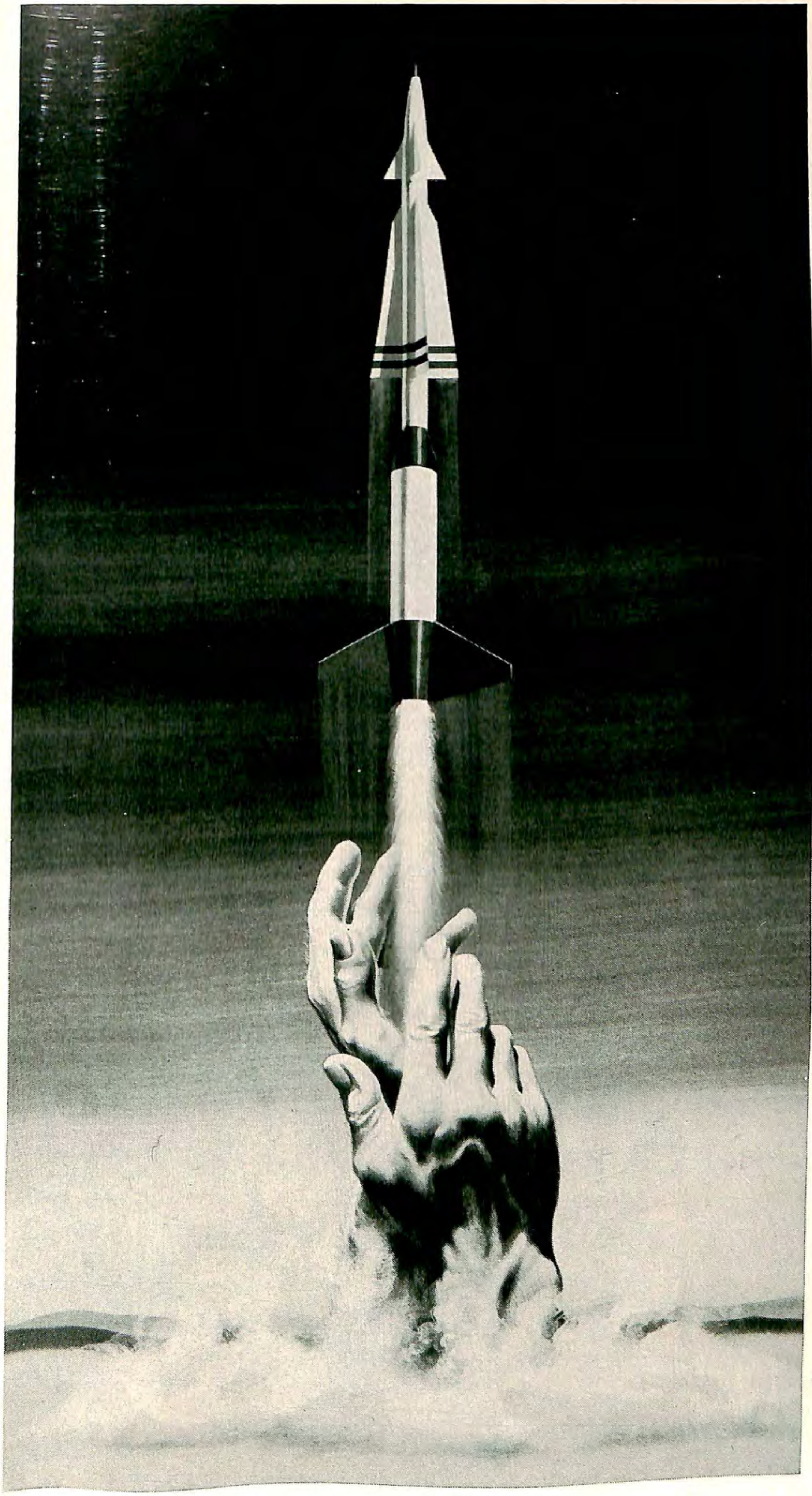
1959, November 20—Discoverer VIII, the nation's 15th satellite, is launched into orbit from Cape Canaveral, Fla.

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-43B 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.



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1959 DAY BY

DAY CHRONOLOGY

JANUARY

• *January 1*

Civil Aeronautics Administration is absorbed by newly-created Federal Aviation Agency. Federal Council for Space and Technology is created.

• *January 7*

Pratt & Whitney Aircraft Division's JT12 will power the North American T-39.

• *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.

• *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, 6 hours, 18 minutes, 57.4 seconds.

• *January 27*

Convair 880 jetliner makes maiden flight at San Diego.

• *January 30*

McDonnell Aircraft Corporation rolls out first Model 119 trainer-transport.

FEBRUARY

• *February 6*

Air Force-Martin-Titan ICBM is successfully launched in test shot at Cape Canaveral, Florida.

• *February 11*

McDonnell Model 119, utility cargo, makes 45-minute maiden flight at Lambert Field, St. Louis.

USAF-Northrop T-38 Talon made its first flight in April.

• ***February 17***

20.74-pound Vanguard II weather satellite is launched into orbit by Navy for an expected lifetime of ten years or more.

• ***February 28***

Air Force launches Discoverer I, 1300-pound satellite from Pacific Missile Range into polar orbit.

MARCH

• ***March 3***

Army, under supervision of NASA, sends Pioneer IV off launching pad at Cape Canaveral, Florida, into orbit around the sun.

• ***March 4***

Vertol Aircraft Corporation receives Army contract for Chinook (YHC-1B) transport helicopter.

• ***March 10***

North American X-15 research vehicle makes first captive flight under the wing of a Boeing B-52 intercontinental bomber.

• ***March 24***

Sikorsky HSS-2 (S-61) twin-turbine antisubmarine warfare helicopter, built for Navy, makes first public flight.

APRIL

• ***April 7***

Nose cone of Douglas-built Thor-Able rocket is successfully recovered from the Atlantic ocean, 5,000 miles distant from its launch site at Cape Canaveral, Florida.

First production model Snark makes 5,000-mile test flight.

• ***April 9***

National Aeronautics and Space Administration announces names of seven astronauts who will be this country's first pioneers in space.

• ***April 10***

USAF-Northrop T-38 Talon space-age trainer makes first flight, lasting 40 minutes, over Edwards Air Force Base.

• ***April 13***

Discoverer II, weighing 1,610 pounds, is launched into polar orbit from Pacific Missile Range by Thor-Hustler launching vehicle.

• ***April 14***

American Airlines' Boeing 707 jet averages 575 miles per hour in setting New York-Los Angeles record of 4 hours 46 minutes.

• ***April 20***

First flights are made by Grumman Aircraft's turboprop observation plane, the YAO-1 Mohawk, powered by two Lycoming turboprop engines, rated at 1005 eshp each; and by Bell Helicopter Corporation's XV-3 convertiplane, believed to be first VTOL aircraft to shift gears in flight.

• ***April 21***

Chance Vought Aircraft, Inc. is awarded NASA contract for four-stage, solid-propelled project scout vehicle.

• ***April 22-23***

Navy launches first two of its new fleet of 18 guided-missile-destroyers, the Henry B. Wilson and the Towers.

• ***April 27***

Cessna Aircraft Company announces new helicopter, designated the CH-1C.

• ***April 29***

Douglas Aircraft Company, Inc. gets NASA contract for Delta launching vehicle.

MAY

• ***May 7***

Convair gets $33.5-million NASA prime contract for Vega, a two-or-three stage rocket weighing 295,000 pounds and capable of putting 5,000 pounds into earth orbit.

• ***May 11***

Flight demonstration of Vertol 107 twin-turbine powered transport helicopter is made at Philadelphia International Airport.

• ***May 18***

Thomas V. Jones is elected president of Northrop Corporation.

• ***May 19***

Thomas S. Gates, Jr. is named by President Eisenhower to succeed late Donald A. Quarles as deputy defense secretary.

JUNE

• ***June 4***

Republic Aviation Corporation successfully test flies F-105D Thunderchief, automatic all-weather fighter-bomber.

• *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, Florida naval auxiliary air station.

North American X-15, piloted by Scott Crossfield, makes six-minute powerless flight over Edwards Air Force Base, California.

• *June 11*

The Doak 16, designated VZ-4dA VTOL by Army, accomplishes successful in-flight transition from vertical to horizontal flight and back to vertical in tests at Edwards Air Force Base, California.

• *June 15*

Douglas Aircraft Company announces production plans for advanced jet transport, the DC-9.

• *June 30*

Northrop N-156F fighter makes first flight at supersonic speeds.

JULY

• *July 15*

Seventeen airframe manufacturers, seven engine builders, and 21 companies heavily involved in aviation products, are listed among the nation's top 500 industrial firms in Fortune magazine's annual directory.

• *July 16*

June traffic on domestic trunklines increases by nearly 15 percent over a year ago, to set a new record of 2.61 billion revenue passenger-miles.

• *July 18*

First air-launch of test version of Navy-Temco Corvus is successfully completed at the Pacific Missile Range.

• *July 20*

Navy reports completion of its safest flying year with a rate of 2.6 major aircraft accidents per 10,000 flight hours.

• *July 24*

Pan American World Airways' Boeing 707 Intercontinental sets New York-Moscow nonstop flight record in 8 hours, 45 minutes.

• *July 27*

Navy BuAer awards first contract for development of nuclear aircraft engine hardware to Pratt & Whitney; at the same time, Martin Company receives a Navy research contract to study airframe designs for a nuclear-powered antisubmarine seaplane.

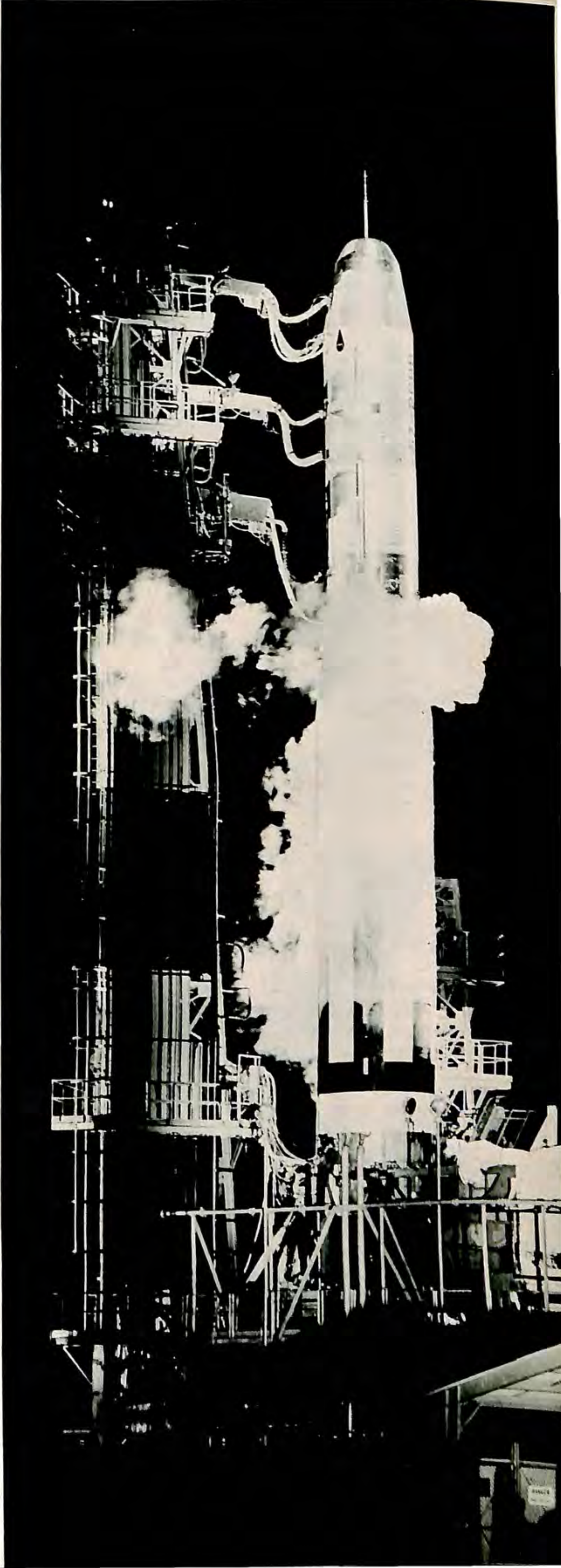
AUGUST

• *August 7*

Explorer VI, Paddlewheel satellite, goes into orbit following a launching by NASA at Cape Canaveral, Florida.

• *August 14*

Fairchild Engine & Airplane Corporation contracts with Umbaugh Aircraft Corporation to manufacture the Umbaugh-18-rotary-wing aircraft.



Titan was launched at Cape Canaveral, Florida.

North American X-15 is tucked under wing of Boeing B-52 bomber.

• ***August 17***

Trunkline carriers have record second quarter in 1959 as operating revenues passed $400 million.

First of two Nike-Asp sounding rockets is launched by NASA from Wallops Island, Virginia.

• ***August 27***

A Polaris test vehicle is successfully launched for the first time from the USS Observation Island at sea off Cape Canaveral.

SEPTEMBER

• ***September 1***

Malcolm MacIntyre, former Under Secretary of the Air Force, is named president and chief executive officer of Eastern Air Lines, effective October 1.

• ***September 9***

"Big Joe" boiler-plated capsule, is successfully fired on top of an Atlas missile as first test of Mercury escape capsule.

• ***September 14***

Russia's Lunik II, 860-pound missile containing instruments and the Soviet coat of arms, hits the moon.

• ***September 16***

Harvey Gaylord, president of Bell Helicopter Corporation, is elected president of the parent Bell Aircraft Corporation.

• ***September 17***

North American's rocket-powered X-15 makes first powered flight at 1400 miles per hour at Edwards Air Force Base, California, with pilot Scott Crossfield at the controls.

• ***September 18***

Vanguard III, the nation's eleventh earth satellite, is catapulted into orbit expected to last 30 years.

• ***September 24***

President Eisenhower declares December 17 as Wright Brothers Day in response to a congressional resolution.

Air Force cancels multi-billion dollar program for F-108 Mach 3 interceptor.

OCTOBER

• ***October 6***

NASA successfully tests its Little Joe dummy space capsule.

Republic Aviation Corporation delivers F-105B aircraft to Tactical Air Command to fill complement of first two squadrons.

• ***October 8***

Lockheed's JetStar is named winner of Air Force UCX competition for a small, off-the-shelf jet transport to be used as a navigation trainer.

Beech Aircraft Corporation introduces Model 65 Queen Air twin-engine six-place executive aircraft.

• ***October 10***

Pan American World Airways begins round-the-world jet service with Boeing Intercontinentals; elapsed time will be just over two days.

• ***October 13***

Explorer VII, composite radiation satellite weighing 91.5 pounds, is launched into orbit.

NOVEMBER

• ***November 4***

Second Project Mercury Little Joe firing to test the capsule's escape rocket system is complete success.

• ***November 7***

Discoverer VII satellite is launched into orbit by Air Force.

• *November 10*

First Boeing 720 is rolled out at Renton, Washington.

Air Force gives responsibility for Dyno-Soar project to Boeing and Martin.

• *November 16*

Captain Joseph Kittinger, Jr. makes record parachute jump from open gondola at an altitude of 76,400 feet.

• *November 17*

Whitney Gillilland and Alan Boyd are sworn in as members of Civil Aeronautics Board.

• *November 20*

Discoverer VIII satellite is launched into orbit from Cape Canaveral, Florida.

• *November 23*

Boeing 720 medium-range jet transport makes its first flight.

• *November 27*

Hiller X-18 tilt-wing research transport completes its first flight at Edwards Air Force Base.

• *November 30*

Boeing B-47 bomber sets jet endurance record of 80 hours and 36 minutes of continuous flight.

DECEMBER

• *December 1*

Defense Secretary Neil H. McElroy resigns; Thomas S. Gates succeeds him.

• *December 4*

NASA successfully recovers seven-pound rhesus monkey from the ocean after it had flown to an altitude of 55 miles in a Project Mercury capsule.

• *December 6*

Navy announces new altitude record of 98,558.61 feet set by McDonnell F4H Phantom II powered by two General Electric J79 engines, at Edwards Air Force Base, California.

• *December 9*

Kaman H-43B establishes new helicopter altitude record of 30,100 feet.

• *December 11*

Republic F-105 sets 100-kilometer closed circuit speed record, flying at 1216.48 miles per hour.

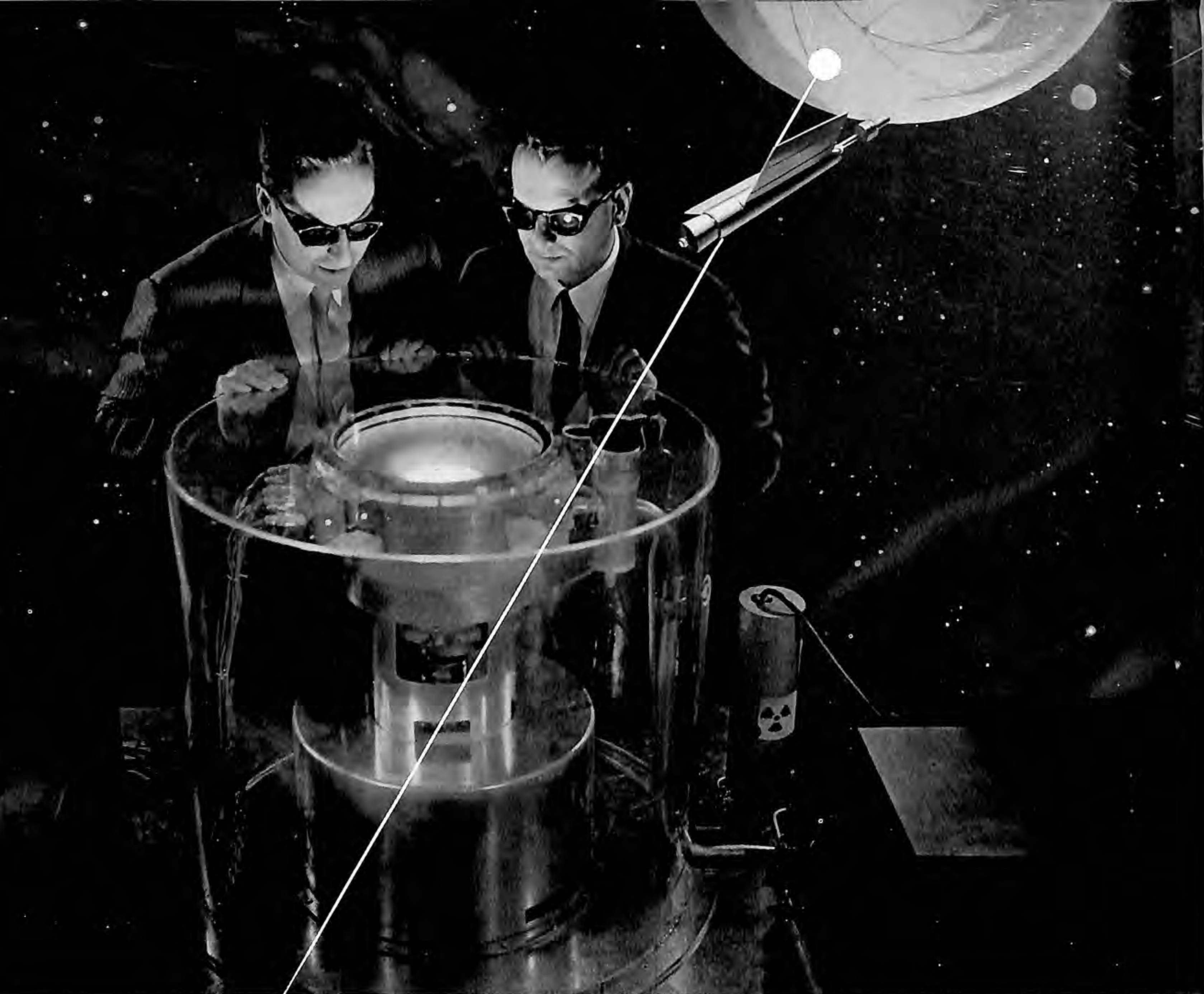
• *December 15*

Lockheed F-104C climbs to 103,395.5 feet to set new world record.

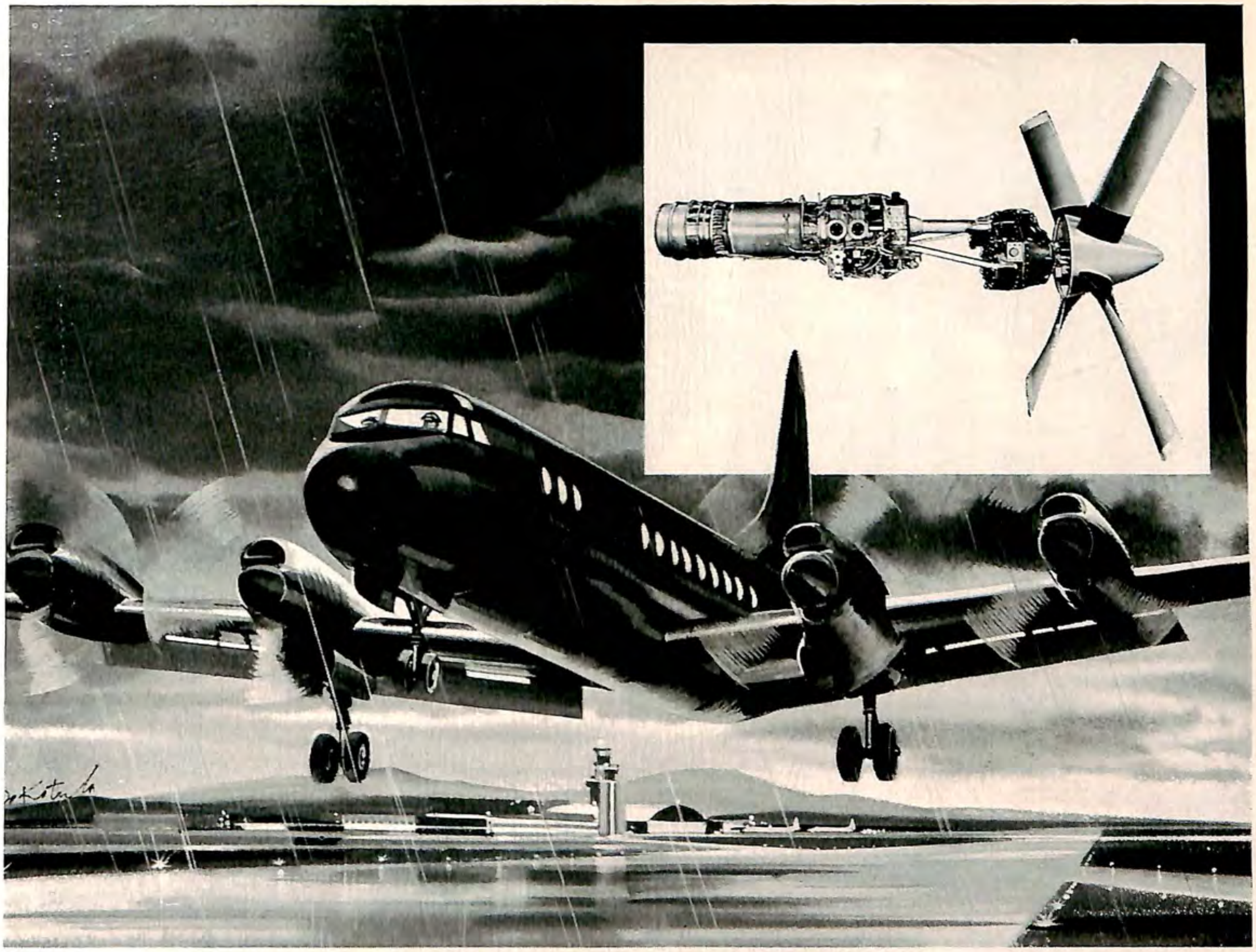
Convair F-106 makes record-breaking flight at 1525.9 miles per hour over straightaway course.

NASA launched the Little Joe booster.

Republic delivered the F-105B to TAC.



Republic's new $14,000,000, Research and Development Center, is scheduled for operation early in 1960.



Instant power on demand

from Allison constant-speed Prop-Jet engines!

The constant in-flight engine speed of the Allison Model 501-D13 Prop-jet provides power for any necessity—instantly! Flexibility of operation is assured in all speed ranges — from airport traffic patterns' velocities, up to and beyond 450 m.p.h.

The 501's inherent characteristics for split-second corrections, provide outstanding take-off, climb, cruise and landing performance. Braking action of the propellers is at hand for positive stops — even under extreme runway conditions. The 501 performs at altitudes up to 30,000 feet without penalty. Its 2.1 power-to-weight ratio is the best of today's prop-jets.

Modern Allison-powered Lockheed Electras and C-130 military transports are accumulating more than 125,000 hours of flight experience a month. Airlines utilization has averaged as much as 10.5 hours a day. Public acceptance is demonstrated by continuing high load factors. The Allison 501-D13 Prop-jet Engine with its matched Aeroproducts Turbo-propellers is also the logical choice for conversion of piston-powered aircraft.

Allison-powered Lockheed C-130

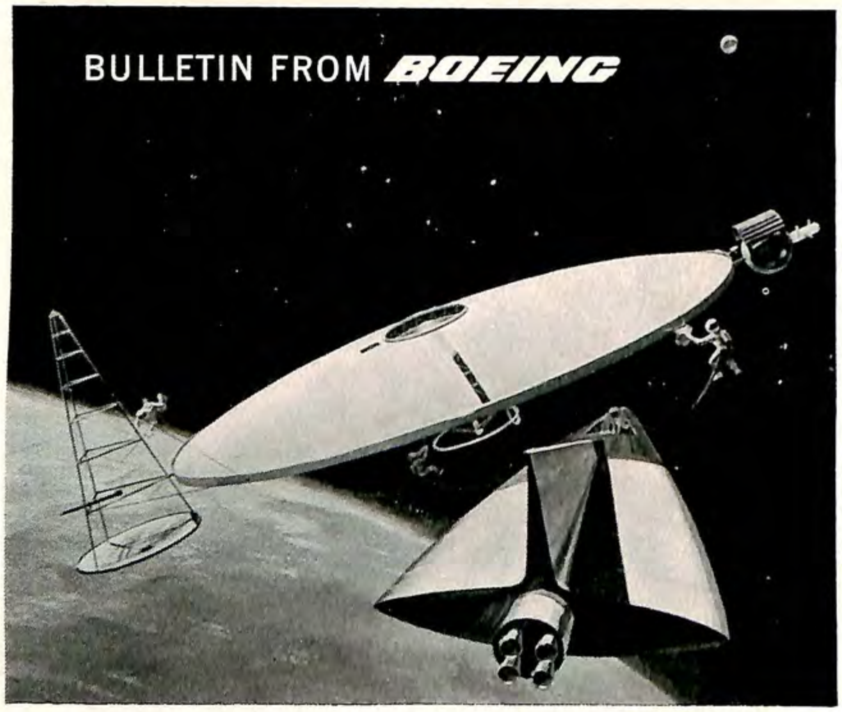
Allison-powered Lockheed Electra

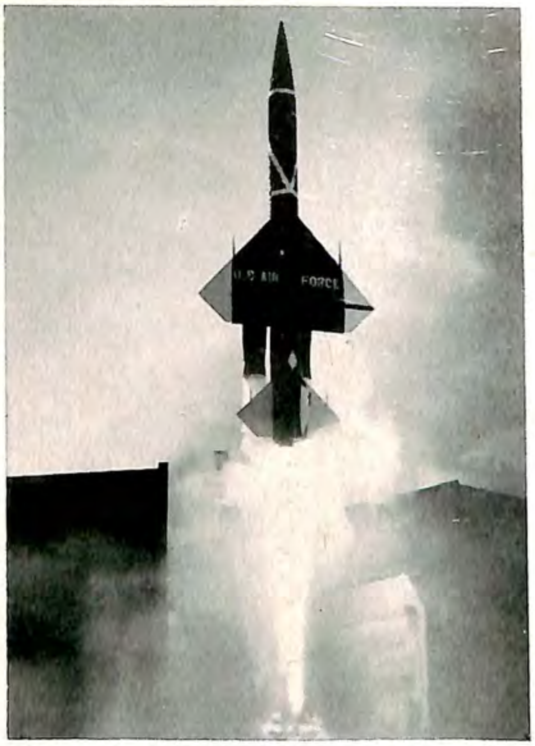
Allison-powered Convair 340

ALLISON PROP-JET POWER

...utilizing the worldwide resources of General Motors

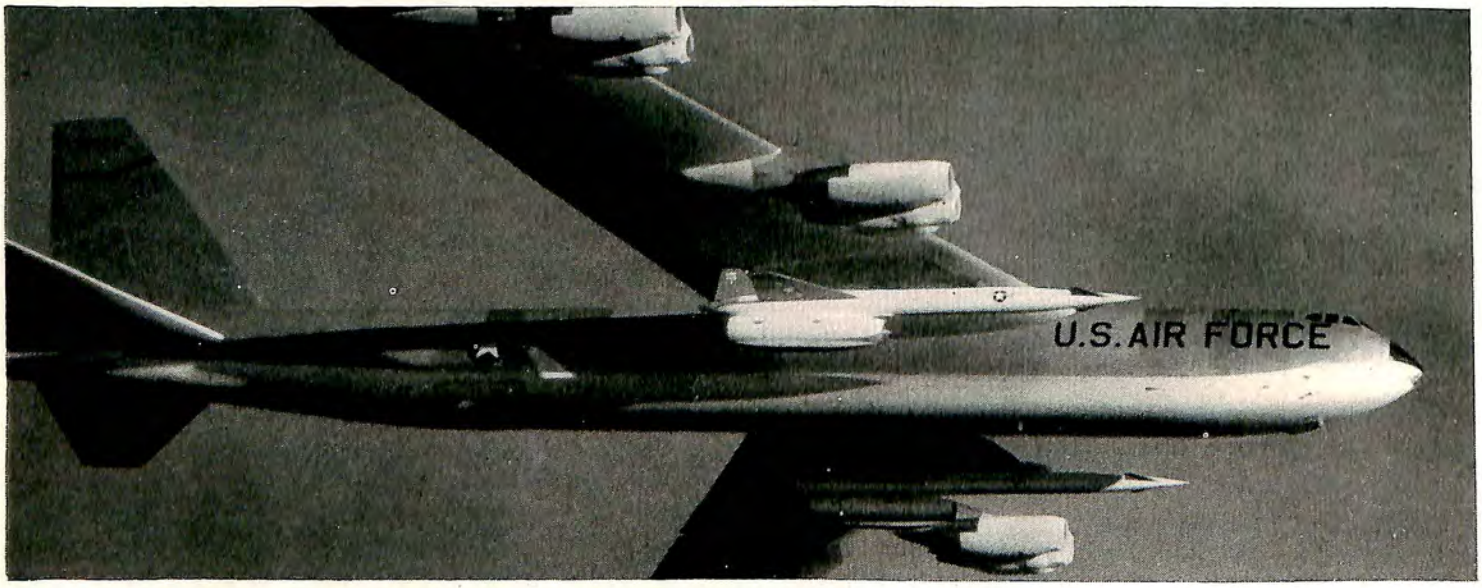
GM JET POWER





MARS VEHICLE. Drawing of Martian space vehicle based on advanced study by Boeing scientists. Launched from an orbiting platform, vehicle would make reconnaissance trip to Mars and return, propelled by an ion accelerator. Other advanced Boeing studies include lunar, orbital and interplanetary systems. Boeing is also contractor for the development of the Air Force's Dyna-Soar boost-glide vehicle, which will have ultimate capability of global range.

SUPERSONIC BOEING BOMARC is longest-range defense missile under production for the U.S. arsenal. The advanced "B" model is designed for 400-mile range. Boeing, in addition, is weapon system integrator of the Air Force's planned advanced solid-propellant ICBM, Minuteman.



AIR-BORNE MISSILE LAUNCHER. The Boeing B-52G carries supersonic Hound Dog missiles for in-flight launching toward targets several hundred miles away, as well as nuclear bomb load. On a single retaliatory defense mission, the B-52G could strike several targets thousands of miles apart.

BOEING 720 JETLINER, offering lowest seat-mile cost of any jetliner in its class, will enter commercial service in 1960. It is shorter-range sister-ship of famous Boeing 707, the most popular airliner in aviation history. Leading world airlines have ordered more jet airliners from Boeing than from any other manufacturer.

BOEING

OFFICIAL RECORDS

The Federation Aeronautique Internationale, Paris, France, better known as the FAI, currently composed of the National Aero Clubs of forty-seven nations, is the governing body of the world for official aircraft records and sporting aviation contests. The FAI was organized in Paris in October, 1905, by representatives from Belgium, France, Germany, Great Britain, Italy, Spain, Switzerland, and the United States. Representing the FAI in the United States is the National Aeronautic Association, organized in 1922.

The rules for all official world and world "class" aircraft records are proposed initially by the various National Aero Clubs who are members of FAI. Later, they are evaluated by the International Sporting Aviation Commission of FAI and then submitted, for final approval, to the delegates of the many national Aero Clubs who attend each annual FAI conference. Developed over a period of fifty-three years, the rules are markedly complete. All attempts to establish official aircraft records must meet identical FAI standards.

FAI-NAA rules have these goals: (1) an equal opportunity to every competitor, (2) competent, unbiased judging, and (3) scientifically accurate recording.

The National Aeronautic Association not only supervises the establishment of official World and World "Class" Records in our nation, but accords its stamp of approval also on aircraft performances which have a special national interest, such as aircraft speeds between cities.

OFFICIAL RECORDS ESTABLISHED (OR CLAIMED) IN U. S. DURING 1959

WORLD RECORDS (Regardless of Type Aircraft)

MAXIMUM SPEED OVER A STRAIGHTAWAY COURSE (UNRESTRICTED ALTITUDE) .... 1525.95 mph*

Maj. Joseph W. Rogers, USAF, Convair F-106, Pratt & Whitney J75 engine, Edwards AFB, Calif., December 15, 1959.

WORLD "CLASS" RECORDS—CLASS C—GROUP I (Turbojet Powered Aircraft)

MAXIMUM SPEED OVER A STRAIGHTAWAY COURSE (UNRESTRICTED ALTITUDE) .... 1525.95 mph*

Maj. Joseph W. Rogers, USAF, Convair F-106, Pratt & Whitney J75 engine, Edwards AFB, Calif., December 15, 1959.

SPEED FOR 500 KILOMETERS IN A CLOSED CIRCUIT WITHOUT PAYLOAD .... 816.3 mph

Capt. George A. Edwards, Jr., USAF, McDonnell RF-101C, 2 Pratt & Whitney engines; Edwards, Calif., April 15, 1959.

SPEED FOR 1000 KILOMETERS IN A CLOSED CIRCUIT WITHOUT PAYLOAD .... 700.047 mph

Col. E. H. Taylor, USAF, McDonnell RF-101C, 2 Pratt & Whitney J57 jet engines; Edwards-San Francisco-Oakland-Edwards, April 8, 1959.

SPEED FOR 100 KILOMETERS IN A CLOSED CIRCUIT WITHOUT PAYLOAD .... 1,216.48 mph*

Brig. Gen. Joseph Moore, USAF, Republic F-105, Pratt & Whitney J75 engine, Edwards AFB, Calif., December 11, 1959.

ALTITUDE, WITHOUT PAYLOAD .... 98,558.51 feet*

Cmdr. Lawrence E. Flint, Navy, United States, McDonnell F4H Phantom II, 2 General Electric J79 engines, Edwards AFB, Calif., December 6, 1959.

ALTITUDE, WITHOUT PAYLOAD .... 103,395.5 feet*

Capt. Joe E. Jordan, USAF, Lockheed F-104C, Two General Electric J79 engines, Edwards AFB, Calif., December 14, 1959.

LIGHT AIRPLANES—CLASS C-1.c

AIRLINE DISTANCE .... 6,957.08 miles*

Max Conrad, United States, Piper Comanche, N11LF, Lycoming, 180 hp engine, from Casablanca, Morocco to El Paso, United States, via Trinidad, November 24-26, 1959.

LIGHT AIRPLANES—CLASS C-1.d

AIRLINE DISTANCE .... 7,668.48 miles

Max Conrad, United States, Piper Comanche 250, Lycoming 0-540-AIA5 250 hp engine, from Casablanca, Morocco to Los Angeles, United States, June 2-4, 1959.

SPEED FOR 2000 KILOMETERS (1242.739 miles) IN A CLOSED CIRCUIT .... 226.972 mph

Miss Jerrie Cobb, United States, Aero Commander 680-E, 2 Lycoming GSO-480 engines, hp 340 coch, McCarron Field, Las Vegas, Nevada, April 13, 1959.

CLASS E-1-D—HELICOPTERS

ALTITUDE .... 30,100 feet*

Capt. Walter J. Hodgson and Maj. William J. Davis, USAF, Kaman H-43B, Lycoming T-53-L-1B engine, Bloomfield, Conn., December 9, 1959.

NATIONAL TRANSCONTINENTAL AND INTERCITY RECORDS

WEST TO EAST TRANSCONTINENTAL (COMMERCIAL JET TRANSPORT)

Captain Charles A. Macatee, pilot; Captain Louis Szabo, 1st officer, Norman Rice, flight engineer, 5 stewardesses, 57 passengers; American Airlines' Boeing 707, 4 Pratt & Whitney JT3C6 turbojet engines, from Los Angeles International Airport, Los Angeles, California, to Idlewild International Airport, New York, January 25, 1959. Distance: 2,469.92 statute miles. Elapsed time: 4 hours, 03 minutes, 53.8 seconds.
Average speed .... 609.472 mph

EAST TO WEST TRANSCONTINENTAL (COMMERCIAL JET TRANSPORT)

Captain Charles A. Macatee, pilot; Captain D. S. Shipley, 1st officer; J. P. Ekstrom, flight engineer; 4 stewardesses, 106 passengers; American Airlines' Boeing 707, 4 Pratt & Whitney JT3C6 turbojet engines, from Idlewild International Airport, New York to Los Angeles International Airport, Los Angeles, California, April 14, 1959. Distance: 2,469.92 statute miles. Elapsed time: 4 hours, 46 minutes, 57.6 seconds.
Average speed .... 516.432 mph

LOS ANGELES, CALIFORNIA TO WASHINGTON, D. C.

Richard J. Scoles, pilot; Loren W. Davis, co-pilot; Barney Parker, flight engineer; Douglas RB66A, 2 GE CJ805 turbojet engines, International Airport, Ontario, California to Andrews Air Force Base, Maryland, January 20, 1959. Elapsed time: 3 hours, 35 minutes, 59.1 seconds. Distance: 2,269.33 statute miles.
Average speed .... 630.413 mph

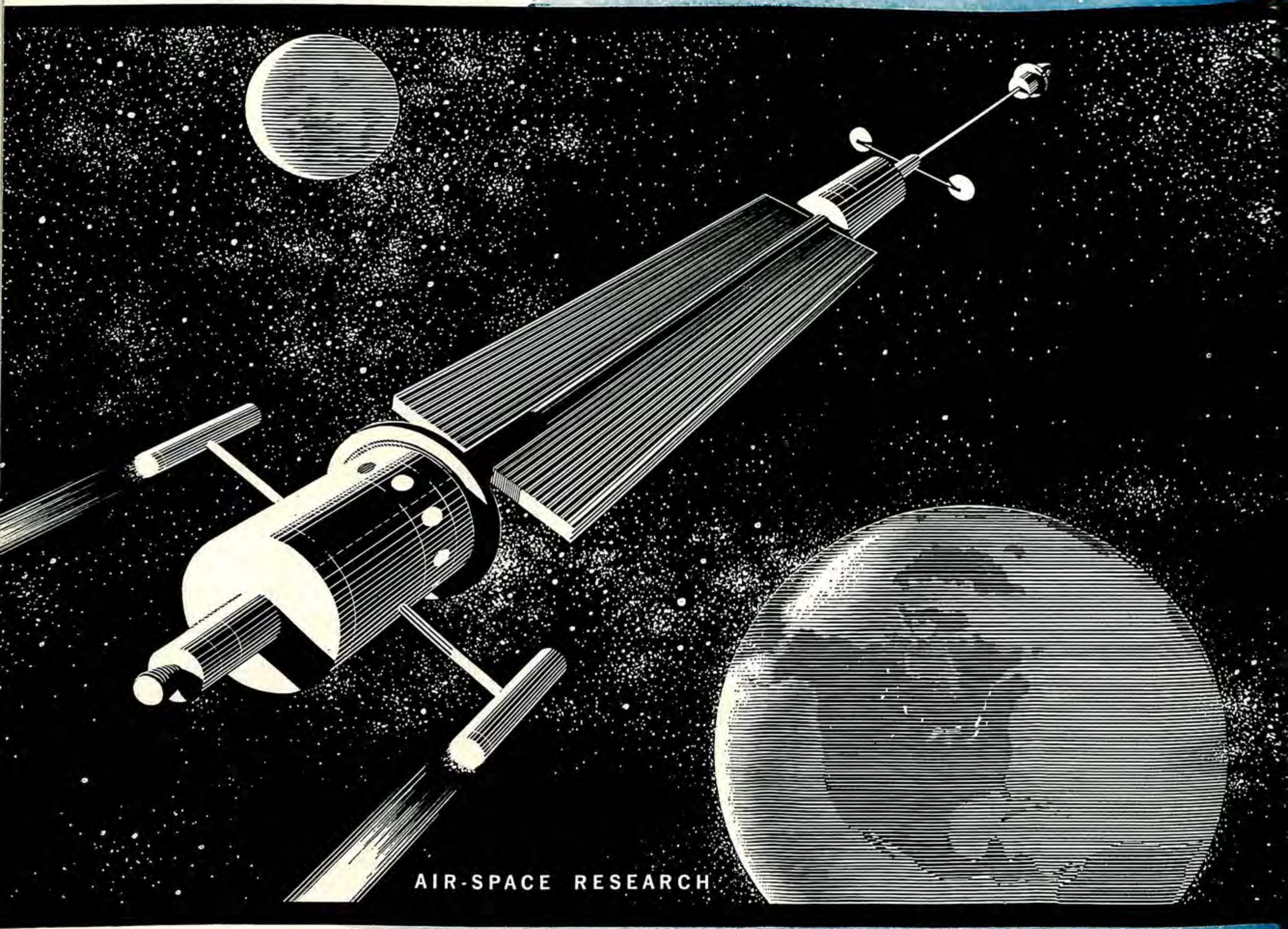
WASHINGTON, D. C. TO LOS ANGELES, CALIFORNIA

Richard J. Scoles, pilot; Loren W. Davis, co-pilot; Barney Parker, flight engineer; Douglas RB66A, 2 GE CJ805 turbojet engines, Andrews Air Force Base, Maryland to Ontario International Airport, Ontario, California, January 22, 1959. Elapsed time: 4 hours, 58 minutes, 15.9 seconds. Distance: 2,269.33 statute miles.
Average speed .... 456.506 mph

*Records not yet officially documented nor homologated by F.A.I.

New Concepts for the Space Age Mark 15 Years of Progress by MARQUARDT

When founded in 1944, Marquardt was an organization devoted exclusively to research and development of the ramjet propulsion principle. Today, in its fifteenth year, the Corporation employs more than 5,000 in the creation and exploration of new concepts for the space age. Marquardt is now diversified, operating in five basic areas—all primarily related to the search for earlier and ever more effective solutions to space-age problems.



NEW CONCEPTS IN AIR-SPACE RESEARCH spring from ASTRO—Marquardt's Air-Space Travel Research Organization—where studies of an ionic rocket capable of powering future space vehicles are in progress. Other imaginative ASTRO studies span a broad spectrum including high-energy fuels, exotic materials, nuclear powerplants, advanced optics, cryogenics, space medicine, communications and guidance.

NEW CONCEPTS IN POWER SYSTEMS are in the making at Marquardt's Power Systems Group. Within the Group, Propulsion Division is engaged in continuing studies of a Hyperjet (rocket-ramjet) configuration capable of lifting future satellites from launch pad to upper atmosphere. Controls and Accessories Division is currently developing attitude controls for reconnaissance satellites, while Test Division is capable of ground-testing space-age hardware.

NEW CONCEPTS IN MANUFACTURING are typified by the first-of-its-kind Hufford Spin-Forge at Marquardt's Ogden Division. This 250-ton machine will contribute advances in space-age metal working state-of-the-art, while augmenting the Division's production of supersonic ramjet engines for the Boeing Bomarc IM-99.

NEW CONCEPTS IN SPACE-AGE TRAINING are an important product of Marquardt's Pomona Division—creators of a unique system which realistically simulates a 4,000 mile mission on an 8-foot map. The system will ground-train air and spacemen without risk and at great savings in cost.

NEW CONCEPTS IN RESEARCH ROCKETRY and instrumentation come from Cooper Development Corporation, a Marquardt subsidiary. Cooper has contributed to programs including Explorer and Sunflare projects, and Falling Sphere—is now at work on Project Mercury.

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