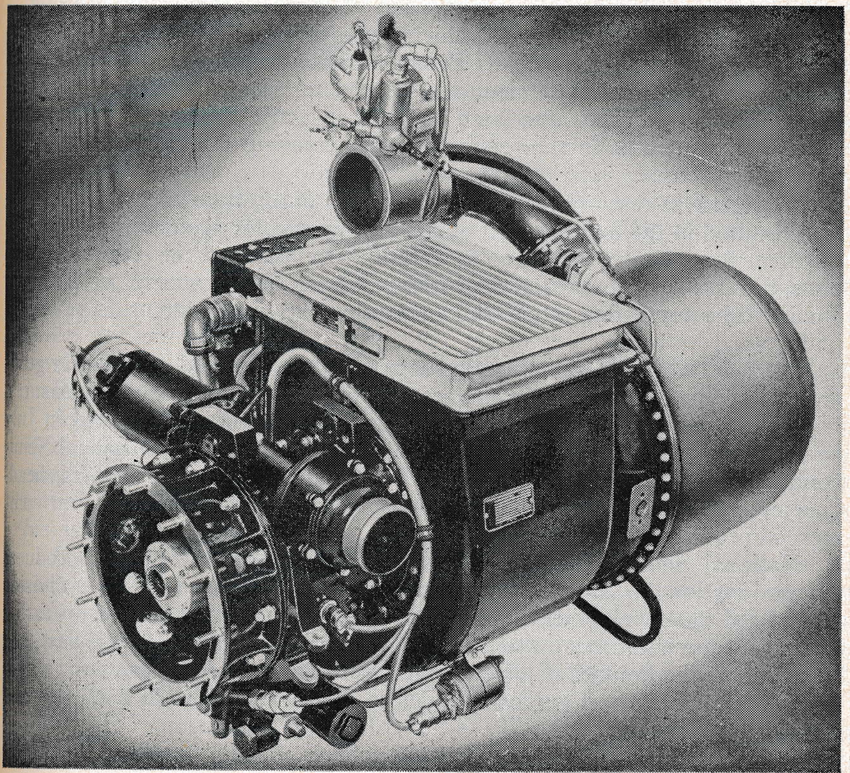
Also during 1955 the company resumed construction of a $65-million aluminum reduction plant at The Dalles, Ore., annual primary capacity will be 54,000 tons.

In 1955, Harvey completed the buildings housing the Air Force Heavy Press equipment. Installation of the new 12,000 ton and 8,000 ton hydraulic extrusion presses will be completed in 1956. The 12,000 ton unit is the largest extrusion press ever built in the U. S. It will enable Harvey to produce aluminum alloy extrusions of unprecedented size, weight, and length dimensions for aircraft and missiles. The huge press will extrude aluminum alloys into shapes up to 80 feet long and 25½ inches wide; and by utilizing special fabricating methods, Harvey will be able to produce panel-type shapes in single sections as wide as 60 inches. While the extrusion presses are being installed, Harvey engineers have been working with the aircraft industry on design studies concerning the utilization of heavy press extrusions. Auxiliary equipment being readied for installation in-

**Garret Corp.'s gas turbine compressor power unit**



cludes two hydraulic stretch-straighteners of 3-million and 1.5-million pound capacity.

Another highlight during 1955 was the perfection of no-draft, precision forging techniques, enabling Harvey to become one of the major airframe suppliers of aluminum press forgings. The expansion of the impact extrusion division and the development of new methods for the production of complex, close-tolerance impacts were other accomplishments.

Other developments by the company were the production of titanium alloy press forgings; and the fabrication of titanium and steel alloy extrusions on a production basis. The availability of production titanium extrusions allows airframe manufacturers to incorporate the performance characteristics of extruded titanium sections in production aircraft. With the installation of vacuum double-melting furnace equipment for the production of titanium alloy ingot, Harvey Aluminum emerges as the only integrated facility devoted to the extrusion and forging of titanium alloys for aircraft.

During 1955 **Hoffman Laboratories, Inc.,** wholly owned subsidiary of Hoffman Electronics Corporation, continued its research, development and production activities in the areas of airborne navigation, communications, radar, guided missile systems and electronic countermeasures.

Initial shipments were made during the year against government contracts for TACAN equipment. Products delivered included the ARN-21 airborne navigational equipment and related test units developed by Hoffman. The company has also been engaged in active research and development work aimed at further refining and increasing the capabilities of the TACAN system.

An intensive research program in the field of multi-color radar presentation resulted in the development of the Hoffman color system and the introduction of an experimental color cathode ray tube of the 2-gun, 2-color phosphor type for use in radar presentations. Development of a 3-gun, 3-color tube for radar scope and other presentation systems is presently under way.

During 1955, research was also carried on in the fields of missile guidance and control, ground surveillance radar and electronic countermeasures.

An expansion of Hoffman Electronics Corporation was effected in July by the acquisition of the National Fabricated Products and National Semiconductor divisions of the company. National Fabricated Products, headquartered in Chicago, produces electronic components and is the first commercial producer of silicon solar batteries.

National Semiconductor Products, located in Evanston, Ill., produces silicon junction diodes and other semiconductors. Late in 1955, this division announced the development of a silicon power rectifier capable of operating at ambient temperatures up to 200° C. This new power rectifier is expected to overcome the limitations of selenium, germanium and the vacuum tube in supersonic aircraft and guided missiles at a major savings in both size and weight.

During 1955, **Hydro-Aire, Inc.,** Burbank, Calif., supplied its Hytrol

Braking System equipment to three of the nation's largest aircraft builders for their latest jet aircraft. Republic Aviation Corporation is installing the system on its RF-84F Thunderflash; Douglas will equip all A3D Skywarriors and B-66's with Hytrol; and North American will use the system on its F-100. Already Hytrol equipped are the B-47 and the B-52. Hytrol is designed to assure smoother, shorter landings, provide savings in tire wear and prevent dangerous skids and blowouts on ice and rain-covered runways.

Hydro-Aire's line of HY-V/L (for high vapor-liquid ratio) fuel booster and transfer pumps were produced in volume during 1955. The basic pump design differs from the conventional fuel booster in that it handles the fuel vapors by integration rather than separation. HY-V/L pumps have been specified for the B-52, the F-100, the F8U-1, the Regulus Guided Missile and other applications.

The company also developed this year a "complete package" turbine-driven fuel booster pump for high performance jet aircraft. This unit combines a new accessory-drive turbine with the above-mentioned pump design. The turbine-driven fuel booster pump is now out of the development stage and units are in full production for a new Douglas airplane and another unit is being built for evaluation by North American, Columbus.

Electro-Aire, Incorporated, manufacturer of fractional horsepower motors for aircraft applications, became an operating division of Hydro-Aire, Inc., on Dec. 1, 1955. The concern had been a Hydro-Aire subsidiary since 1951. Earlier in the year the transistor production and development facilities of Hydro-Aire were purchased by the Marvelco Electronics Company. Hydro-Aire's Electronics Division continues to do research and development work in the field of transistor applications for aircraft; however, the company will not manufacture or sell transistors as an end product.

Other product developments were a new two-in-one pressure regulator and hot air shutoff valve operating at 1000° F and several other hot air valves for extremely high temperature jet engine applications. A group of new fuel gate valves were also developed during the year and ready for production.

Volume of business during 1955 remained substantially unchanged from 1954. The trend of Hydro-Aire's sales was toward fewer items in larger quantities. Major products as the company moved into 1956 were: Hytrol anti-skid braking system, fuel booster and transfer pumps, hot air valves, fuel valves.

During 1955, **Jack & Heintz** continued to concentrate the major portions of its research, design and development organizations on new alternating-current generators, regulators, control panels, circuit breakers and all ancillary system components. The company received two prime a-c system contracts: the Convar F102A Supersonic Interceptor and the Douglas DC-8 Jet Transport.

The J&H air-cooled system for the F-102A is the first blast-cooled generator proved completely capable of meeting normal and overload requirements at ambient temperatures to 120° C sea level. It has a "Hi-Phase" voltage regulator protecting against phase overvoltage caused by asymmetrical fault conditions including open sensing leads, and a control panel using a new gas-discharge overvoltage detection tube insensitive to acceleration.

Jack & Heintz has also developed special oil-cooled generators to be installed on later F-102 models.

The J&H a-c system for the Douglas DC-8 consists of four constant-speed generators arranged to operate in parallel through a suitable bus arrangement or to operate isolated. Each generator is to be driven from a separate main airplane engine through a constant-speed variable-ratio drive. The system will supply power at 115/200 volts 3-phase grounded-wye 400-cycles for various plane loads. In addition to the generators, Jack & Heintz is also supplying regulators, control panels, generator buses and power relays.

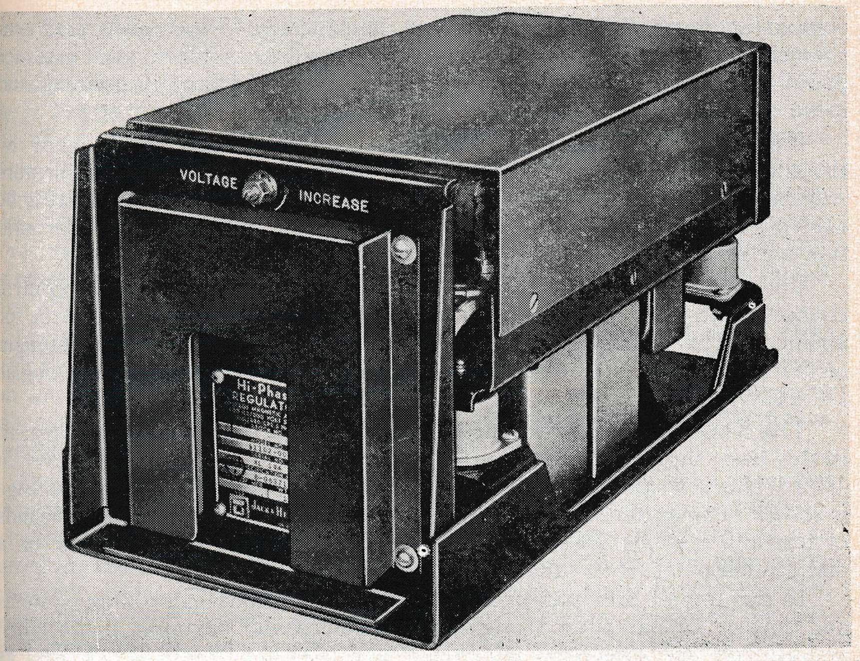
Concurrent with these 1955 developments were: an expansion of the J&H line of air-cooled, oil-cooled and vapor-cooled systems to include ratings from 3 through 160 kva; the development of new high-performance auxiliary components such as transformers, reverse power relays, phase sequence relays and others; and the development of 3,000-va inverters for the airlines. The latter machines—with 20 percent greater output than the largest inverter now available for commercial use—are expected to help airlines speed the expansion of a-c systems to include radar and other new a-c devices.

Total sales for the year were between $30-35-million and the backlog of unfilled orders was approximately $18.5-million. Employment totaled 2,800 and total productive floor space exceeded 600,000 square feet.

**Kaiser Aluminum & Chemical Corporation,** fully-integrated producer of aluminum and aluminum mill products, marked 1955 by embarking upon an additional expansion program. Following the completion in 1954 of a three-year $230-million expansion of basic production facilities, the 1955 program, requiring an investment of $90-million was directed toward the rounding out of the company's mill fabricating facilities, which supply the aircraft industry.

The company installed at its Trentwood mill (Spokane, Wash.) fully automatic immersion type ultrasonic testing equipment for detection of below-surface flaws in aluminum alloy plate. The unit provides for nondestructive testing of the large dimension aluminum plate increasingly in demand for machined aircraft applications. Ultrasonic inspection, plus the high quality ingot resulting from degassing and metal handling techniques developed by the company's department of Metallurgical Research, made available to the aircraft industry aluminum plate ideally suited to its critical requirements.

As part of the Company's $1.25-million expansion of plate facilities at Trentwood, the present aluminum plate stretcher of 5-million pound capacity, was being rebuilt to exert a 10-million pound pull. An additional




**Jack & Heintz hi phase regulator**

5-million pound stretcher will be installed. These additions were undertaken in 1955 to enable the company to provide the aircraft industry with a greater supply of critically needed stress-relieved aluminum alloy plate.

During the corporation's latest fiscal year, ending May 31, 1955, net sales were $268,133,000. Net earnings were $28,565,000. The corporation's production of primary aluminum amounted to 813-million pounds. During the first six months of 1955, Kaiser produced 27.4 percent of all primary aluminum produced in the United States.

During 1955 production of precision aircraft and optical instruments and systems and special purpose motors at **Kollsman Instrument Corporation,** wholly-owned subsidiary of Standard Coil Products Co. Inc., maintained a steady pace. The total Kollsman plant employment increased approximately 12 percent, representing production, engineering and office personnel. In November of the year, ground was broken for a new plant in Syosset, Long Island, N. Y., which will cover an area of 157,000 square feet.

In demand through the year, were the Periscopic Sextant, various types of electromechanical flight data computers, the company's line of sensitive altimeters, tachometer indicators and generators, standard and sensitive manifold pressure gages, and many types of special flight research units such as angle of attack indicators and machmeters. Synchrotels and synchrotel transmitters, pressure monitors, pressure switches and pressure pickups, and monitor servos gained wider use in industry in general, and more specifically in guided missile applications.

Following successful results of tests performed early in the year by the Air Force at Wright Air Force Base, Kollsman pressure ratio indicators were adopted by McDonnell Aircraft Corporation for use in the F-101, by Convair for the F-102A and TF-102, and by Republic Aviation Corporation for the F-105.

Put into production was an electric system with proportional control characteristics that introduced a new concept in cabin pressure control for airliners. This small, lightweight system which provides greater passenger comfort with low maintenance will be standard equipment on Douglas DC-7C's.

The Kollsman counter altimeter, marking the first radical improvement in this basic flight instrument, went into production for the U. S. Navy in 1955. The new altimeter registers altitude on a counter the way mileage is shown in an automobile. A two-digit counter shows altitude in thousands of feet and a single pointer makes one revolution per thousand feet on a dial graduated at 50 ft. intervals.

In the area of precision optics, Kollsman continued to produce systems and devices for automatic navigation, many types of sextants, bombsights, anti-aircraft sky sweepers, telescopes, and the sky compass, as well as optical components such as lenses, prisms, reticles, mirrors, hyper- and hypo-hemispherical sighting domes, retro-reflectors and many others.

The company expanded its line of precision motors and developed many new units for special applications. Production of motor-driven induction generators, servo motors and teletorques was especially high.

Research and engineering activities at Kollsman in 1955 were intensified and prototypes of advanced electromechanical-optical systems for the control and guidance of high altitude, high speed aircraft and missiles were supplied to the military and to commercial customers. Effort was directed in the field of automatic navigation equipment and air data computers with particular emphasis on simplicity of design.

**Lear, Incorporated,** Santa Monica, Calif., estimated shipments for 1955 of approximately $60-million. The backlog increased $8-million during the first six months of the year to $46-million; at the same time the proportion of commercial sales, as compared with military, increased. Acquisition of 25 percent additional floor space brought total square footage to more than 700,000; and employment increased approximately 25 percent by mid-year to nearly 5,000.

Development of the European market for the company's high-precision aircraft instruments, accessories, and electronic products was given intensified significance when a distributor agreement was signed with Dassault of France.

The Grand Rapids, Mich., Division during the year continued development of advanced flight control and stabilization systems. Among important new products announced was the L-10 autopilot for supersonic aircraft, ordered for the first US jet tanker-transport, the Boeing KC-135. The L-10 combines such features as automatic Mach hold, automatic G-control, all-attitude maneuverability, automatic heading selection, command maneuvering optional by control stick or conventional controller, continuous side-slip control, and continuous automatic trim control for all control surfaces. Other products of advanced design developed during the year were a miniature rate gyro, an all-steel displacement gyro, a miniature power unit for remote actuation, and a complete range of thin-package actuators for all types of missile and jet aircraft requirements.

Initial deliveries were made of gyro-stabilized angular reference platforms for the Boeing Bomarc and for other missiles. High volume production continued on vertical gyro indicator systems and various automatic flight control systems. The new Electro-link remote positioning system was introduced for industrial control applications.

The LearCal Division at Santa Monica, Calif., continued quantity production of aircraft radio, automatic stabilization, and navigation devices, including the Arcon automatic rudder control system. Production was started on the Nafli "natural flight instrument" system. Other new products announced during the year were an airline automatic direction finder, electric pitch trim system, sub-miniature loud speaker amplifier for aircraft, and a line of light-weight portable electric power generators.

Developed and produced during the year at the Lear-Romec Division, Elyria, Ohio, were a cooling unit for airborne electronic equipment, piston-type oil-free air pump, and a submerged fuel booster pump for inverted flight. Quantity production continued on military type submerged fuel booster pumps, water injection pumps, engine- and electric motor-driven fuel, oil, hydraulic, alcohol, and ethylene glycol pumps, ground test sets, universal bombsight desiccators, and pressurizing equipment for microwave units operated at high altitudes.

Continuing to make news at the Aircraft Engineering Division, Santa Monica, Calif., was the high-speed, high-performance executive plane, the Learstar. The Learstar was CAA-certificated in the airline transport category at a gross weight of 22,500 lbs. and an increase in gross weight to 24,000 lbs. was later authorized.

This marked the 35th year the **Liquidometer Corporation** of Long Island City, N. Y., has devoted to the development and production of a wide range of tank contents gages and position indicating systems for aircraft, diesel locomotives, industrial and airport storage tanks and surface and undersea marine craft.

In the field of aircraft fuel measurement Liquidometer further expanded the range of control functions which their gaging systems can perform. These include the control of complex fuel sequencing programs and various methods of detecting trapped fuel and eliminating its quantity from the total indication.

New applications were made of the company's Capacitor Type True Weight Gaging System which employs an electric hydrometer known as the Liquidensitometer to directly measure fuel density. Whereas the so-called gravimetric uncompensated and compensated capacitor type fuel gages depend upon the loose relationship between fuel density and its dielectric constant, the True Weight System measures fuel density and volume as two independent variables and multiples them electrically to produce an indication of the true weight of the fuel. As a result, a gage response error of less than ±1 percent is achieved.

A new remote reading dial type indicator for measuring the contents of airport fuel storage tanks was also announced. Known as the Model 216 Indicator, it contains 20 inches of scales length while occupying a panel area of only 3 x 10 inches. The system is Underwriters approved for gaging hazardous liquids.

In addition to plants in Long Island City, Liquidometer maintains other manufacturing facilities in Bellows Falls, Vt., and St. Johns, Quebec, and overhaul and engineering facilities in Los Angeles and Montreal, Canada.

During 1955 **MacWhyte Co.,** Kenosha, Wis., continued production of Hi-Fatigue cable assemblies, Safe-Lock terminals and Hi-Fatigue aircraft control cable. Lightweight and flexible wire rope slings were also manufactured by the company for use in handling and shipping of aircraft.

MacWhyte also manufactures tie rods for external and internal bracing of aircraft.

**Minneapolis-Honeywell** began production in 1955 of its newest system, the MB-3 Autopilot, which features control stick steering, for installation in the North American F-100D. With the introduction of the MB-3, Honeywell now is producing autopilots and dynamic stabilizers for all front-line USAF supersonic aircraft—the F100, F-101 and F-102.

In addition to autopilots, Honeywell introduced its precision inertial guidance system for aircraft and missiles. The company expanded its line to include precision inertial gyros and accelerometers and a smaller HIG series for stabilization.

Following its introduction of the transistor fuel gage in 1954, Honeywell followed in 1955 with its fully transistorized Exhaust Gas Temperature Indicator. It also put into production Pressure Ratio System.

During 1955, the company established an Aeronautical Division of Canada, located in Toronto. Ground was broken for an addition to aeronautical engineering facilities in Minneapolis. An engineering facility serving West Coast airframe companies was established in Los Angeles in June.

Honeywell's active research program resulted in advances in the following fields: nuclear propulsion controls problems; improved gyro and accelerometer components for inertial guidance and navigation equipment; utilization of digital computer techniques in control problems of weapons systems; human engineering of helicopter controls; basic instrumentation; hydraulic controls; and non-linear and sampled-data systems.

The **New York Air Brake Company's** Watertown Division, Watertown, N. Y., continued in 1955 as a supplier of both fixed displacement and variable delivery hydraulic pumps to builders of military aircraft, rockets and guided missiles as well as those producing transport and civilian planes.

The Stratopower 65F series fixed displacement pumps and the 65W series variable delivery pumps, both new developments, went into production. These pumps are engineered to meet the aircraft industry's demands for smaller, lighter hydraulic pumps capable of dependable service at higher speeds, higher temperatures and higher altitudes.

Laboratory and test faciilties were expanded to include equipment enabling full evaluation of the new Stratopower 65F series and 65W sreies pumps under high speed, high temperature conditions.

Further progress was made in the engineering of electric motor-driven pump units. Several new models were developed to provide hydraulic power for primary, secondary and emergency circuits.

**Norden-Ketay Corporation,** New York City, continued during the year its growth in the instrument and electronics field. 1955 products of Norden-Ketay included a complete line of precision servomechanism components, aircraft instruments, computers and complete automatic control systems.

Products of the Corporation's subsidiaries also cover a wide range. The Frohman Manufacturing Co., Inc., of Miami, Fla., manufactures precision and high speed shafts, precision gears, and gear trains. Scientific Specialties Corporation, of Boston, Mass., is engaged in the research, design, development, and manufacture of technical and scientific equipment of all kinds. Vari-ohm Corporation of Amityville, Long Island, manufactures a revolutionary line of high precision light weight potentiometers and precision resistors.

Other subsidiaries are Ketay Ltd. of England, which is manufacturing high precision synchros, servo motors, and resolvers for Western Europe; and Nuclear Science and Engineering Corporation of Pittsburgh, a service research and development firm for private industry in the nucleonics field.

**Parker Appliance Company's** Rubber Products Division in Berea, Ky., continued in 1955 as a leading supplier to the aircraft industry of synthetic rubber o-ring seals to meet the various military specifications for fuel, oil and hydraulic service. Successful formulation of new Parker compound number 47-671 made available o-rings for the operating temperature of minus 65° to plus 250° F in hydraulic service.

Parker's Tube & Hose Fitting Division continued producing tubeworking equipment such as hand benders, cutters and flaring tools as well as bench-mounted benders and power flaring machines. A new toggle clamp, for easier and speedier operations, was introduced as an improvement for the Parker Model 824 tube bender. The new Tork-grip hand tool for non-slip tube bending and Exactol crank-operated bender were also introduced.

During 1955, the **Radio Corporation of America** intensified its activities in the field of aviation electronics. The year was marked by important design and development progress on such equipments as tracking radars, guided missile systems, and infrared detection devices, and by accelerated production of a wide range of airborne communications and intercommunications equipment.

For the U. S. Air Force, production was carried forward on the RCA-developed AN/ARC-21, a pressurized transceiver which can be operated on 44,000 different frequencies and on full power at altitudes up to 50,000 feet; Loran; Shoran; Navigational Radar; and Fire Control Radar.

RCA, working with the U. S. Signal Corps, continued to advance techniques for Airborne Reconnaissance Television. RCA cameras were installed in L-20 reconnaissance planes for use in intelligence gathering, artillery spotting and the relay of vital information to command posts.

Commercial aviation activities increased at RCA during 1955 with full scale production of the AVQ-10 airborne weather radar—the first such system designed for commercial use. The system is a C-Band (5.6 cm) radar built entirely to ARINC specifications. The equipment weighs less than 115 pounds and employs conservatively-rated tubes and components for maximum reliability and long life.

During 1955, RCA's reliability program for military electronic equipment, with particular emphasis on airborne electronics, was expanded and intensified. Extensive testing and theoretical analysis were carried forward, with the resultant development of both theoretical techniques and factory test methods which simulate actual field experience and which represent important contributions to the advancing reliability art.

To acquaint designers, manufacturers, and users of military electronics with advanced ideas and techniques for designing greater operating reliability into increasingly complex equipment, RCA and the U. S. Air Force jointly prepared and sponsored Reliability Conferences which were presented in Philadelphia and Dayton. Information disseminated by RCA participants focused largely on procedures and techniques employed to advance reliability in the design of recent airborne electronic systems for military use.

**Reynolds Metals Company** expanded its mill product availability, added new higher strength alloys and introduced advanced quality control measures during 1955.

A tapered sheet mill at its McCook plant was scheduled for operation by the first quarter of 1956. The mill is a Navy owned facility that will be operated by Reynolds for producing tapered sheet and plate in sizes up to 40 feet long, 120 inches wide and .032 to 3 inches thick.

Expansion and modernization at both of the company's extrusion plants at Grand Rapids, Mich., and Phoenix, Ariz., occurred during the year. A 6,000-ton extrusion press was ordered and is under construction.

Reynolds designed and built a 78-inch wide foil mill during 1955 which has operated successfully from the time it began production. A second mill is in the process of completion and will be followed by others. The mill rolls wide foil in thicknesses down to .00035 inches. This wide foil is of particular interest to the aircraft industry because of its advantages in the fabrication of aluminum foil honeycomb structures for use in "sandwich" panels.

Research and development work on titanium extrusions was conducted during 1955. In connection with this work a survey was made of the aircraft industry to determine their current and future requirements for titanium extrusions. This work is being continued.

**Rohr Aircraft Corporation,** Chula Vista, Calif., added more than 500,000 square feet to its manufacturing, warehouse and office space, bringing the total to 1,858,225 square feet. Completion of a metal-bonding building at Riverside, opening of an assembly plant at Winder, Ga., and election of several structures at Chula Vista resulted from expansion of the company's activities.

Rohr Aircraft during the year was awarded a contract for manufacture of the power packages (complete engine assemblies) for the Lockheed Electra, new turbo prop airliner, and for the new Convair 440 Metropolitan.

Also in 1955 the company manufactured power packages for 12 different airplanes. The commercial plane power packages were for the Convair 340 Liner, the Douglas DC-7 and the Seven Seas, and the Lockheed Super-Constellation. The military planes are the Boeing B-52 Stratofortress, and the KC-97 Stratotanker, the Convair T-29 Navigation Trainer and C-131 Samaritan, the Fairchild C-123, and the Lockheed P-2V Neptune Bomber, C-121 Picket, the R7V, and the turbo prop C-130 Hercules. The company was also tooling and preparing to go into production on power packages for the Boeing KC-135 jet tanker.

Other major components manufactured by Rohr were aft fuselage sections and flap tracks for the B-52, stabilizers, elevators, jet tailpipes and variable nozzles, reciprocating engine exhaust turbine nozzle boxes, and pneumatic system components for other airplanes. In all the company produces more than 30,000 separate parts for aircraft assemblies. The company was also engaged during the year in a research and development contract with the Wright Air Development Center in exhaust system inerting. This contract involves the design, tooling and manufacture of prototype articles to determine the practical aspects of a crash fire prevention system for both reciprocating and turbine powered aircraft.

Company sales for the year ending July 31 amounted to $82,407,804 and employment averaged 7,383.

During 1955, the **Russell Manufacturing Company,** Middletown, Conn., continued to produce for the aircraft industry seat belt webbing and hardware, seat belts, elastic shock absorber cord, shock absorber rings and web straps.

Net worth of the company was $4.2-million, and employees totaled 780 at year-end.

**Simmonds Aerocessories, Inc.,** worked in 1955 toward improving reliability, reducing weight, simplifying installation and reducing costs of capacitance type fuel measurement and fuel management systems. In this connection, the M-1 lightweight fuel gage tank unit was produced. This unit is made of resin impregnated Fiberglas and is highly rugged and fuel resistant.

The M-1 tank unit can be used with several combinations of intermediate device and indicator. A two-unit system consists of the M-1 unit and (1) an indicator which also houses a transistorized amplifier-bridge, or (2) a combined indicator and vacuum tube amplifier-bridge unit. In order to give maximum accessibility to the vacuum tube amplifier-bridge, and to provide for mounting separate from the indicator, this amplifier-bridge section of the combined unit is available separately in a three-unit system consisting of the M-1 tank unit, an indicator and an amplifier-bridge. The amplifier-bridge is procurable in either of two separate cases, one featuring a cylindrical case for clamp or panel mounting, the other allowing for rack mounting.

Also in production by Simmonds were thermistor level swtiching devices for low level and high level switching, as well as for fuel pump sequencing operations.

The new lightweight Pacitron Fuel Gage System has been installed on several aircraft for the U. S. Air Force and the Bureau of Aeronautics, as well as on the Vickers Viscount turboprop transport.

At year-end, Simmonds was working on development and perfection of Explosion Suppression, a new protective technique against explosions resulting from the ignition of fuel-air mixtures.

Work continued during the year in the development and manufacture of precision push-pull controls, heavy duty aircraft latches and fasteners, and a related line of aircraft and engine accessories.

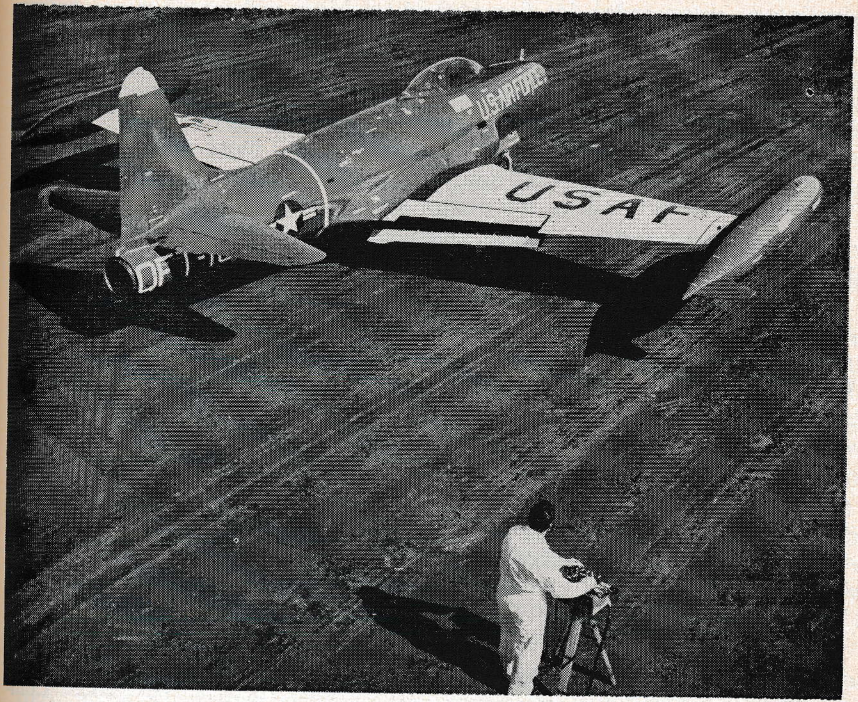
**Solar Aircraft Company,** San Diego, Calif., in 1955 completed an expansion program to provide work area for the production of its two small gas turbines, an increasing backlog of airframe components and guided missile fuselages, and other aircraft and commercial fabrications. Floor space now totals 1,178,895 sq. ft.

Sales for the year ending April 30, 1955, were $63,915,568. Total employment averaged 4,653

Solar's two gas turbines, the Mars® engine, rated at 50-60 hp, and the Jupiter engine, of about 500 hp, were turned out in production quantities. Aircraft auxiliary power units driven by Mars turbines are now used on the Douglas C-124C Globemaster, the Lockheed C-121C, military transport version of the Super Constellation, and the Convair C-131B.

Solar continued in 1955 to produce large bellows type expansion joints for such applications as wind tunnels and atomic energy plants and small size bellows for aircraft ducting systems. This department of the firm had the largest backlog of orders in its history.

A research and development program on high temperature resistant, light weight, all-metal sandwich structures assembled by means of high temperature brazing, was continued in 1955.




**QF-80 pilotless jet is equipped with Sperry's command guidance system**

In October, 1955, security wraps were removed from Solar's Microjet controls, a pneumatic principle which has been exploited for simple, light weight and fast response control of turbojet and ramjet engines. Already more than 1,000 control systems and devices using this principle have been built by Solar for the prime engine contractors in various applications.

Research and development continued on coatings for the protection of both high and low alloy steels against oxidation and corrosion. Advanced knowledge and techniques improved the new Solaramic aluminizing process which uses ceramic methods for the aluminum coating of high temperature parts.

The design, development and manufacture of advanced aviation equipment received greater emphasis at the **Sperry Gyroscope Company** in 1955 than at any time in the company's history. Systems, components and products for electronic control, navigation and guidance of transports, bombers, fighters, helicopters, missiles and drones far exceeded equipment being designed and produced for ground forces, naval and merchant shipping.

Manufacturing volume continued high in the fields of (1) pulse and continuous wave radar for fire control-tracking, airborne beacon, navigation-search and air-to-air rendezvous equipment—as well as radars for other airborne and ground-based navigation and guidance missions, (2) K-bombing systems, providing for automatic navigation, target identification and bombing, (3) electronic counter measures and (4) automatic fire control systems leading to the development of still more advanced systems to meet strategic and tactical requirements of bombers, fighter-bombers and interceptor aircraft, still in the design stage.

The Aeronautical Equipment Division was created for development and production of flight and engine control systems and instrumentation.

Progress was highlighted during the year with solid achievements in flight control equipment for manned aircraft, pilotless aircraft or remote control operations, and guidance gear and flight control systems for missiles.

The company's earlier efforts in helping to develop two advanced guided missiles were rewarded during the year when both were included in the nation's defense arsenal. The supersonic Sperry Sparrow I, first air-to-air guided missile to reach operational status, was put into volume production for the U. S. Navy at the Sperry Farragut Division's specially-designed, new missile-manufacturing plant in Bristol, Tenn. At the same time, fully automatic flight controls and obedience systems for the Navy's Regulus were advanced by Sperry to the volume production stage at its Great Neck, N. Y., plant. Late in the year Sperry organized a Special Missiles Systems Division.

In 1955 Sperry and the USAF Air Research and Development Command announced a new, simplified electronic drone control system for QF-80 fighter aircraft. Utilizing uhf radio transmitters and receivers, the Sperry system enables pilotless fighters to make take-off, landing, climbing, diving, level flight and orbiting maneuvers under precise and instantaneous command of accompanying "director" aircraft and ground station controllers. QF-80 aircraft were used for obtaining data during nuclear tests.

During the year, Sperry developed a miniature flight control system, specially designed for rotary wing aircraft. The compact, fail-safe system provides helicopter pilots with an option for either greatly-simplified manual control or fully automatic operation of rotorcraft. Yet basic units of the system—including automatic trim devices, altitude and speed controls—weigh only 60 pounds.

Extensive surveys by Sperry of flight operations personnel in all parts of the nation led to additional visual refinement of the company's latest Integrated Instrument System, production versions of which now are being adopted by leading airlines.

The system—combining a horizon flight director, pictorial deviation indicator and gyrosyn compass—portrays even more graphically than before the heading and displacement of an aircraft in flight, and in relation to VOR-OMNI and ILS beams. Sperry's IIS enhances margins of air safety by reducing the number of instruments pilots must check and by making it virtually impossible for them to misinterpret the information portrayed—even in busiest flight situations.

Completion early in the year of a $3-million factory for the Sperry Electronic Tube Division at Gainesville, Fla., was followed almost immediately by additional expansion of the facility there. Production of high-power klystron and traveling wave tubes was broadened considerably in response to military demands for new types of microwave tubes used in radar, missile guidance and air navigation systems.

The company also increased production of microwave test and measuring equipment, including that used for maintaining weapons systems in the field.

Sundstrand Aviation, Division of **Sundstrand Machine Tool Company,** Rockford, Ill., continued during 1955 to manufacture mechanical-hydraulic constant speed drive systems and related products for aircraft. Aircraft now flying with the Sundstrand Drive include the B-36, P5M, F3H, B-47E, RB-66, KC-135 prototype, F-101, F-102, XP6M, and two missiles. As of 1955, over 7,000 Sundstrand Drives were in use all over the world.

Among new products for the industry introduced in 1955 were constant speed drives built for operation in conjunction with oil-cooled alternators, field test stands and overhaul test stands for both the military and industry, special gearboxes, a new magnetic trim control for drive governing, and a new line of aircraft hydraulic motors.

To keep pace with demand for constant speed drives, a new plant was constructed in Denver, Colo. Completed Nov. 1, 1955, the new plant has a total space of 161,000 sq. ft., of which 131,000 sq. ft. is devoted to manufacturing. The new plant, located on a 32-acre tract northwest of the center of Denver, initially was planned as an additional production facility exclusively, with several models of drives scheduled to be built there. The new facility became known as Sundstrand Aviation-Denver.

The Rockford plant was expanded by 28,000 sq. ft. to accommodate new heat treating facilities, 33 percent more test facilities including a new environmental chamber, and other expansions made necessary by production demands.

**Thompson Products, Inc.,** Cleveland, Ohio, continued in 1955 to produce jet engine compressor blades, turbine buckets and fuel system equipment. Also, with expanded facilities and continued emphasis on research and development, Thompson Products was selected to manufacture its unique electronically controlled air-turbine drive for 400-cycle alternators used in one of our most modern jet engine type bombers.

The main feature of this alternator drive is the integral four-unit electronic load-sensing and control system having extremely acurate and automatic regulation characteristics. Another important feature is the use of transistors and magnetic amplifiers in place of corresponding circuits embodying electronic vacuum tubes. Production facilities are in the company's

Pneumatics Division where the alternator unit and drive are assembled and shipped to the aircraft manufacturer.

The Gas Turbine Laboratory, located east of Cleveland on the shore of Lake Erie and operated by Thompson Products for the U. S. Navy, was completed early in November of 1955 and engine tests were conducted later in the same month. Each test cell at this facility is designed to accommodate engines developing up to 30,000 pounds thrust.

The company's staff research and development programs included a project in turbine fuel voltatility characteristics at temperatures up to 450° F. Previous data on fuel volatility characteristics represented temperatures up to 250° F.

Other activities at Thompson Products included auxiliary power units, fuel flow distributors and variable area fuel nozzles for gas turbine engines, vapor utilizing fuel systems for high-altitude aircraft engines, afterburner pumps, high-energy fuels and research in high-temperature alloys.

**Vickers Incorporated,** Detroit, Mich., manufacturer of oil-hydraulic systems, again expanded the company's El Segundo Division during 1955 to provide complete facilities for the design and manufacture of special oil-hydraulic valves for airborne application.

Development of complete systems and sub-systems through cooperation between Vickers application engineers and airframe manufacturers was expanded during 1955. Reduction in system weight in the early design stages (with ultimate proportional reduction in airframe weight) and minimized plumbing through the manifolding or "packaging" of hydraulic components are two of the inherent advantages gained where the "system concept" has been applied. An additional user benefit is that of undivided responsibility for system as well as component performance.

The year 1955 also saw an expansion of activity in the Vickers organization in the field of jet engine controls. One significant move by the company was the establishment of a special group within the Aircraft Products Department for design and development of jet engine hydraulic control systems. Another was the Vickers' announcement of the first Jet Engine Conference scheduled to be held in Detroit in February, 1956.

Also underway at Vickers were: (1) a program for the development of high temperature hydraulic system components and (2) a long range study of higher pressure systems (above 3,000 psi). Test and development work was also going on in the field of in-flight refueling systems, including controls for both the handling of fuel as well as drogue and probe systems.

Four system component developments announced by the company during 1955 were the Constant-Speed Motor, the Thermal-Vented Relief Valve, the 55 hp Servo Controlled Pump, and the Packaged Constant Gain Nose Wheel Steering Valve.

The Constant Speed Motor has an integral speed control which maintains motor speed within plus or minus 3 percent of a pre-determined setting (from no load to full load). The Thermal-Vented Relief Valve is basically a 3,000 psi relief valve which includes an integral temperature control element. The temperature control prevents fluid in the working circuit from exceeding a maximum safe operating temperature.

The Servo Controlled Pump introduced during 1955 is rated at 55 hp and delivers 35 gpm at 3,500 rpm. It is available as one of a variety of hydraulic transmission assemblies, built up as packaged units to meet the specific job requirements in oil-hydraulic servo systems having intermittent operating pressures up to 4,500 psi. The Constant Gain Nose Wheel Steering Valve is representative of advantages possible where the "system concept" approach is applied. This rotary input valve contains, within a single housing, the functions of all the necessary control elements for automatic nose wheel steering and caster control. This compares with a conventional steering system where four or five separate valves are required. The "packaged" design results in weight saving (up to 500 percent) and simplified maintenance.

**Wyman-Gordon Company,** which operates the largest single unit in the United States Air Force heavy press program, placed a 35,000-ton and a 50,000-ton capacity closed die forging presses into operation in 1955. The plant is in North Grafton, Mass.

The 35,000-ton press was the first of the program to be placed into operation anywhere. First forging off the press, on March 11, 1955, was a wing spar for the new Convair F102. Of aluminum, it was 10 feet, 6 inches long and 3/16 inch thin in some sections. Convair said each spar represented 68 "bits and pieces" and 800 rivets and 25 pounds of metal made unnecessary compared to the old method of making planes.

The 50,000-tonner went into production in the fall. It was last of the closed die giants to go into service.

First forgings off the 50,000-tonner were aluminum landing gear support ribs for Lockheed's new Super-Constellation, capable of 6,500 miles of non-stop flight. The ribs were 105 inches long, 28 inches wide, more than 4 inches thick in places and ¼ inch in others.

Assembly of the 35,000-ton capacity press was completed Feb. 17, 1955. It weighs 7,180 tons, stands 45 feet above the operating floor and 62 feet below it. Assembly of the 50,000-tonner was completed Aug. 24, 1955. It rises 48 feet above the floor and goes 60 feet below it.

**Zenith Aircraft,** Division of Zenith Plastics Co., continued during 1955 to produce approximately 50 percent of all the reinforced plastic components used by the aircraft industry. These included electronic components such as radomes, external stores such as developmental fuel tanks, aircraft and guided missile structural components such as wing and missile components.

The work force was increased 30 percent over its 1954 figure, and at year-end the total employment was over 1,000. Keeping pace with the increased personnel was a corresponding increase in plant facilities and area, primarily in tooling and press molding, of over 40,000 sq. ft. Zenith Aircraft now possesses such equipment as a Pratt & Whitney BG 22 automatic contour milling machine, a specially designed 60-in. Axelson contouring lathe and complete supporting equipment such as milling machines, shapers, and special welding equipment.

In the press molding field, the company installed a Zenith and HPM designed 600 ton capacity molding press having a platen size of 75 in. by 104 in., with daylite of 27 ft. no inches between platens. This press enables the molding of reinforced plastic components in matched metal dies up to 10 ft. in length.

In the final stages of completion at year-end was a research and development laboratory covering over 4,000 sq. ft. and including a complete complement of testing equipment such as tensile tester, impact testers, laboratory presses, mettalograph equipment, salt-spray and humidity cabinets, muffle furnaces and other high temperature ovens, hardness testers. Zenith engineers and technicians are developing high temperature resins and reinforcement materials for aircraft and guided missile components of the future.

Active research continues toward the use of reinforcing agents other than fibrous glass. Indeterminate results are being achieved with such materials as asbestos, silicones, and ceramics. In the electronic field, new techniques are being developed for the marriage of reinforced plastics with ceramics so as to achieve supersonic materials resistant to ram air temperature and rain erosion effects.

# CHAPTER TWO

## Research and Development

### Industry

THE AVIATION INDUSTRY is plowing back some 65 percent of its earnings, a substantial amount of which are used for research. This makes aviation research spending, including electronics, larger than that of any industry in the world.

The wellspring of aeronautical research is in the industry itself and while private enterprise turns to the universities and government for help and advice, it is today the major source of progress in aviation advances.

During 1955 three parameters were set for basic research and development procedures.

First, the Air Force is tempting to cut development time by contracting for new planes on a prototype-production basis rather than on a prototype-evaluation basis.

Second, development time and costs are cut by leaving the responsibility for a certain project with the prime contractor alone.

Third, all military services try to draw small businesses into the research and development picture, granting them substantial contracts for first-phase type work.

Most of the research work conducted by private companies is carried out in strict secrecy ; but although little or nothing can be said about specific projects, it is possible to summarize the various fields of research and development trends.

For example, great emphasis is put on improvement of propulsion systems such as the turbojets and turbo-props. Short-take-off-and-landing aircraft, using deflected slipstream, boundary layer control or direct jet lift are also studied intensively by many companies. Convertiplanes, different vertical-take-off aircraft and faster rotary-wing planes are on most companies' research and development lists.

At least two companies (Martin and Convair) are working on anti-gravity devices based on electromagnetic field physics.

Several companies are engaged in high-altitude rocket and satellite research studies.

Extensive industry-government research programs are also conducted in the fields of nuclear propulsion. Organizations and firms engaged in development of atomic powerplants and aircraft currently include the Atomic Energy Commission, in particular the Oak Ridge National Laboratory, Oak Ridge, Tenn., where radiation shielding and investigations on reactor materials and heat exchange media are being conducted. National Advisory Committee for Aeronautics, at its Lewis Flight Propulsion Laboratory, Cleveland, Ohio, is also engaged in powerplant studies. The Air Force and AEC are jointly behind ground test installation for atomic aircraft powerplants in conjunction with the National Reactor Testing Station at Idaho Falls, Idaho (cost $33-million), which is operational this year.

The Martin Company of Baltimore is conducting preparatory studies on atomic reactors and the Union Carbide and Carbon Corporation is engaged in an atomic engine program.

North American Aviation Inc., which started out on its own and abandoned its plans, now carries out radiation research and preliminary studies on reactors. Plans call for a $10-million reactor at Santa Susana, Calif. Phillips Petroleum Company has a contract for operation of a material testing reactor for the AEC at Idaho Falls, Idaho.

General Electric Company began work in 1951 on aircraft reactors. The AEC is to provide a total of $5.6-million for General Electric's development work during the 1955-56 fiscal year.

Pratt & Whitney Aircraft Division has been working since 1953 on an alternate engine program to General Electric's. The AEC is to subsidize Pratt & Whitney's work with $8.6-million in the 1955-56 fiscal year.

With Boeing Airplane Company, development work has been going on since March, 1952, on an atomic airframe, presumably for Pratt & Whitney power-plants.

Convair (Division of General Dynamics Corp.) has been engaged in the field with development work since 1951 on an airframe, under an Air Force contract, supposedly to be fitted with General Electric atomic engines. Convair also has a test reactor in operation at Fort Worth, Texas.

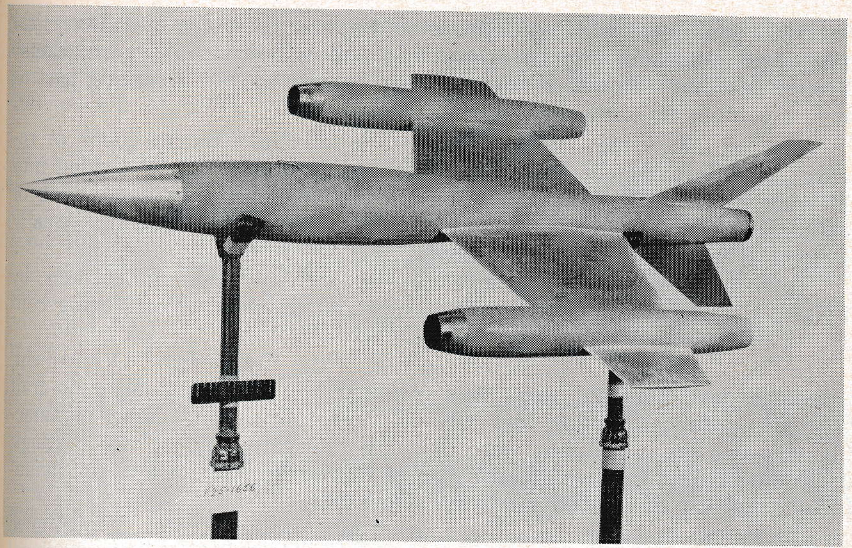
Lockheed Aircraft Corporation is said to have several years of experience in development work on an atomic airframe although participation was not announced until 1953.

In 1955, Curtiss-Wright announced breaking ground for a new atomic aircraft engine plant in Pennsylvania, although it has not been disclosed whether the company has been awarded any fixed contracts.

The trend in research and development is now toward greater spending on industry-conducted programs, in other words, the individual companies will spend more of their own money and conduct programs independent of government projects. All of the aircraft manufacturers now have their own research programs under way.

Ryan, for example, devotes considerable attention to research and development in the rapidly expanding field of electronics. Since the creation of its *Firebird* missile and later the *Firebee,* Ryan research showed tangible results in 1955 with award of a $5-million contract from the Navy for an automatic navigator device.

Research in the jet engine field is expedited by its jet engine test cell which went into full-scale use in 1955, including testing of jet engines in



**Rocket-propelled research test model fired at supersonic speed over Atlantic Ocean to obtain information on flight characteristics**

the vertical position. The test cell, valued at $375,000 with instrumentation, is the first of its kind in the United States designed and instrumented for testing jet engines in the vertical position.

This feature is of particular interest to Ryan, where characteristics of jet engines in vertical position comprise information vital to its VTO project and to other airframe projects still in the development stage.

Research of importance to the armed forces as well as to the commercial aircraft industry was conducted during the past year in the use of titanium for various aircraft structures, in pneumatic ducting for supplying heat and power for planes in flight and in welded honeycomb or sandwich structures to provide rigid structures at light weight.

A unique concept of scientific climatization has been largely responsible for the development of advanced models of interceptor electronic control systems and *Falcon* guided missiles at Hughes Aircraft Company.

Scientific climatization, as applied to the research and development laboratories, consists of providing the scientist and engineer with the freedom to develop his own theories, extensive facilities for experimentation, skilled labor, precision tools and the necessary materials to construct experimental prototypes.

The service organization which backs up Hughes' research program includes such innovations as specialized machine shops which tailor-make intricate components to the specifications of researchers, often without benefit of blueprints; labs equipped with complex analog computers and other electronic equipment which will prove or disprove the value of a theoretical component before it is even fabricated; and self-service "supermarkets" through which a scientist or engineer may browse to find a specific part to fit into equipment being developed.

Most of the systems laboratories' work falls into the category of research and development leading to volume production. It is divided into different departments, each assigned the responsibility for some type of technical work. Development of any one electronic control system is usually performed within several departments.

Extensive research and development activity was undertaken by TEMCO in 1955 with preliminary design and proposal efforts being conducted in many, varied military aircraft fields.

In the Materials and Processes Section of the Engineering Department, extensive developmental work was conducted in titanium, large no-draft forgings, chemical milling and welded steel fabrication. New manufacturing processes introduced were dry film lubricaton, phosphate coatings, cadmium plating, furnace brazing, use of reinforced plastics and the manufacture and use of bonded sandwich structures.

Operations research, including market and product research, continued at TEMCO with extensive research being conducted on the operational problems of military weapons systems and feasibility studies of military and civilian aircraft.

In the field of research, the stringent scientific requirements of several immediate and long-range programs under way at the Convair Division of General Dynamics Corporation in 1955 led to the appointment in March of 14 scientists from the nation's leading laboratories and universities. These consultants were engaged to study problems of basic nuclear research and industrial applications of nuclear power, and to consider special problems in the development of military aircraft and strategic missile systems for which Convair is responsible to the armed services.

Research and development programs were initiated and continued at Convair's four plants throughout the year: at San Diego and Pomona, Calif., and at Fort Worth and Daingerfield, Texas.

At Pomona, Convair and the Navy are joined in a comprehensive program of research, development and quantity production of superonic surface-to-air operational Terrier guided missiles. Work at Pomona includes weapons, systems analysis, and the preliminary design of new and improved missiles and components. These projects were being undertaken in the Naval Industrial Reserve Ordnance Plant facilities, operated by Convair under contract to the U. S. Navy Bureau of Ordnance.

Convair's Daingerfield plant, otherwise known as the Ordnance Aerophysics Laboratory, continued functioning for the Navy Bureau of Ordnance under the technical direction of The Johns Hopkins University Applied Physics Laboratory. OAL is principally engaged in developing and testing supersonic ramjet-powered guided missiles for the Navy's Bumblebee program. OAL also conducts considerable developmental test work for the Navy Bureau of Aeronautics and the U. S. Air Force. The Laboratary comprises essentially a supersonic wind tunnel, two sea-level ramjet engine test cells, a high-altitude ramjet engine test cell, and necessary supporting groups. Daingerfield employment totaled 285 on Oct. 24, 1954, and 298 on Oct. 23, 1955.

In August, a separate department was established at Fort Worth to direct the plant's research and development work on atomic-powered aircraft, a program that had been initiated in 1951 by the Air Force. Also under way at Fort Worth was a research program to determine the ultrasonic effects of jet engine noise and aerodynamic friction on various aircraft materials. Engineers and chemists were studying the effects of ultrasonics (20 kc and up) on fuels, lubricants, hydraulic fluids, plastics, and adhesives, as well as possible changes in the explosive limits of fuel. The research will aid Convair in designing future arcraft to withstand any possible effects of intense ultrasound.

During the year, Fort Worth developed a new-type ejection seat for crew members operating in high-speed aircraft. Called "SacSeat," the seat sets new standards for safety and comfort, and is adaptable to airplanes using any method of takeoff: conventional, catapult, or vertical. Various research and development projects of a classified nature were begun or continued at Fort Worth in 1955.

At San Diego, the largest wide-rang temperature research cell on the West Coast for testing effects of extreme high and low temperatures on aircraft structurs was placed in operation. Capable of testing full-size test sections of aircraft, the cell is 20 feet long, 10 feet high and 10 feet wide. Temperatures in the 2,000-cubic-foot chamber can be controlled from −100° F to +300° F within four hours.

Another vital research project undertaken during the year was a study of metals and aircraft construction designed to withstand high temperatures encountered at supersonic speeds. Metals under study included titanium and precipiation-hardened stainless steel. Wing and tail assemblies incorporating honeycomb sandwich panels were being tested.

In the electronics research field, San Diego continued development of new types of high-resolution radar mapping antennas and compact radar mapping systems for both guided missiles and piloted aircraft.

New techniques were studied in connection with precision ground-based tracking systems. A study of cooling methods for electronic components in high-speed aircraft and missiles was undertaken, as was the development of flush-mounted antennas for navigation and communication on supersonic aircraft. During the year, San Diego developed a unique method of utilizing an analog computer to determine hydrodynamic stability characteristics of water-based aircraft under various conditions of hull design, wave action, ski design and other factors, all of these and other studies thus being conducted in a minimum of time by use of the computer.

## Air Force

Dramatized on the eve of the new year, 1956, by Defense Secretary Wilson's announcement that research and development on guided and ballistic missiles would go forward at an accelerated pace, that branch of defense activities anticipated early expansion all along the line.

Even training of engineers came in for additional emphasis and development. The Air Force expanded its program to improve the technical competence of its officer personnel during 1955.

Air University and the Air Force Institute of Technology produced an increasing number of qualified engineers and scientists for use in research and development.

The USAF Institute of Technology offered undergraduate and graduate work both in residence courses and courses in the nation's highest quality academic institutions in all fields of engineering and science required by the Air Force.

Between fiscal years 1950 and 1955, the Air Force Institute of Technology has placed in training 1,673 officers in engineering; 404 officers in sciences; and 141 officers in engineering administration and research and developmet.

ARDC receives approximately 90 percent of the USAFIT graduates in engineering, 85 percent of the science graduates and all of the research and development management graduates. In addition, the Air Force is conducting well-designed and timely technical training and education programs for civilian personnel. These are all calculated to continue to improve the technical competence of research and development personnel within the Air Force.

The Air Force has taken many progressive management actions, paramount of which was the establishment of a single command responsible for all research and development. USAF has subsequently been engaged in numerous actions to improve the operation of this organizational concept. It will continue to make advances in management improvement and will continue to study and implement recommendations for further advancement.

The subcommittee of the Committee on Appropriations has recommended that the Secretary of the Air Force modify existing Air Force procurement regulations to take into account the coexisting Air Force policy with respect to material support and research.

Since the organization of the Air Research and Development Command, there has also been a progressive improvement change in the Air Force procurement policy.

The Air Force is, further, giving serious consideration to organizing top-level civilian scientists and technicians employed by USAF both at staff levels and at operational research and development field activities into an advisory committee which would participate with the Air Force's highest planning councils.

In support of the Air Force attitude toward the use of civilian scientists, there are several prominent groups which are being used for the prosecution of high priority research and development programs. Included in these are the Science Advisory Committee to project *Atlas,* the Ballistic Missile Defense Committee and the Air Research and Development Command Research Committee. In addition, the ARDC now has frequent technical meetings of the key civilian scientists and engineers from each center to discuss technical problems. These meetings have proven to be most profitable to the overall technical management and have increased both the recognition and use of civilian scientists and engineers.

In addition, the Scientific Advisory Board, organized in December, 1944, provides a means for civilian science to make its views known and provide assistance to the Air Force research and development structure. The board consists of 66 civilian scientists who are considered among the most prominent men of science in the United States.

It has been recommended that the Assistant Secretary of Defense for Research and Development take steps to direct that formulation of a uniform policy, applicable to all military departments, designed to prescribe the conditions necessary for the most effective administration of military research and development programs in order to assure maximum attraction and use of our national scientific and technical personnel resources and maximum use of our national scientific facilities.

The Air Force agrees that the formulation of such a policy would be desirable. The Air Force members of the Research and Development Policy Council, under the Assistant Secretary of Defense for Research and Development, are assisting that office in the preparation of such a policy statement.

The USAF research and development organization is necessarily a highly heterogeneous mixture of scientific, technical, and military activity. Each Research and Development Center is different in the basic nature of its mission, in the composition of its working force and in its facilities. Management at each center must be arranged as the circumstances dictate and there must exist the freedom to fill management needs as the demand occurs.

Air Force research and development organizations recognize the need to separate base support from research and development. This has been done in every instance where advantage has been evident. The support needs of each research and development center must be considered in terms of the individual character of each activity. The uniform mandatory type organization for support cannot be expected to properly provide for the many different circumstances which now exist or which may exist in the future.

A systematic program of basic research has therefore been recommended to the Secretary of Defense, with funds authorized for expenditure by the Assistant Secretary of Defense for Research and Development.

A total of 87 percent of the Air Force research and development project funds last year went to contractors in industry and universities.

Air Force Research and Development is under two major commands, the Air Research and Development Command, which carries through the stage of development testing and the Air Proving Ground Command, which has the responsibility for operational suitability testing. The reason for the separate commands, reporting separately to the Chief of Staff, is to have a two-way check on the development itself in behalf of the operational