
ROHR 25th anniversary
1940-1965
US AIR FORCE
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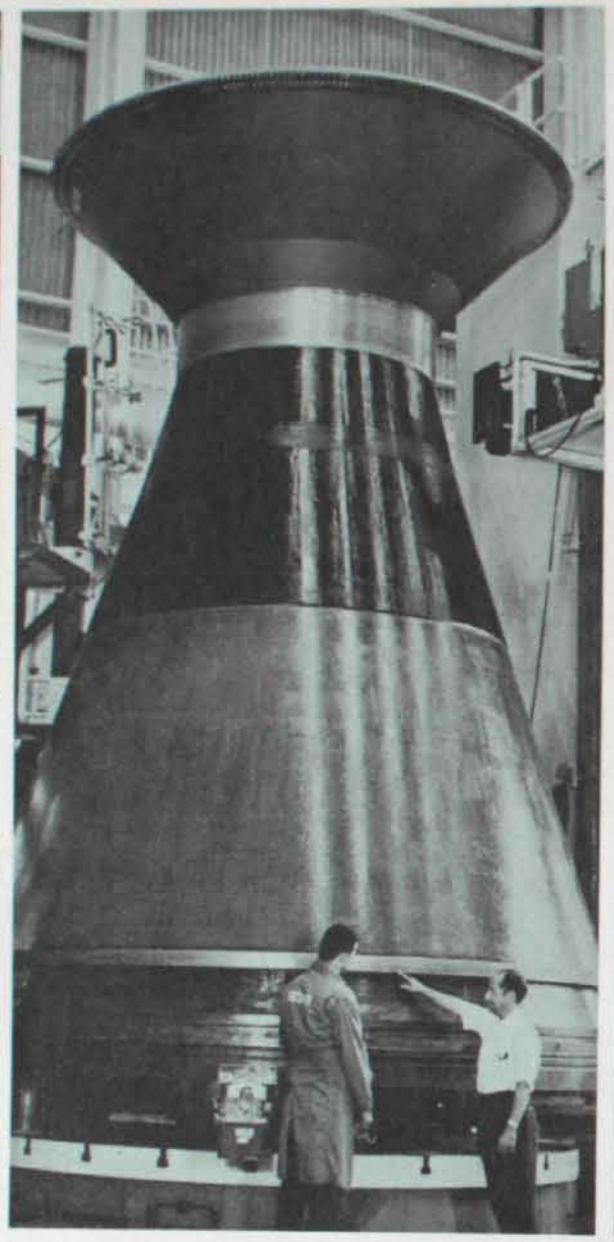


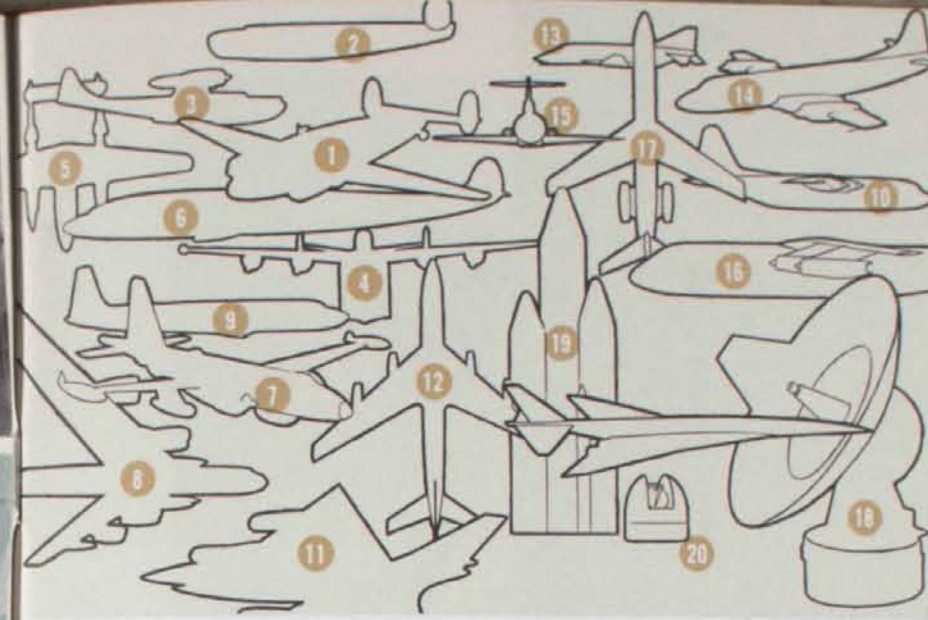
THE SHAPING AND SHIPPING OF THE WORLD'S LARGEST NOZZLE

This 10-ton solid booster nozzle, built by Rohr for Thiokol, gave a perfect performance at some 3 million pound thrust during recent test firing at Brunswick, Georgia, as a part of the Air Force's large, solid booster feasibility program.

This nozzle, built for Thiokol Chemical Corporation and the U.S. Air Force's Space Systems Division, is the largest ever built — 168" diameter at exit cone. The nozzle's tape-wrapped, ablative throat and liner sections consist of carbon, graphite and silica fabric impregnated with phenolic resins. They were wrapped (on a mandrel) under precisely controlled tension, temperature and pressure . . . then hydroclave cured at 350° F under a pressure of 1000 psi. During the critical fabrication process, the orientation of the fabric was controlled with tape angles varying from parallel to 60° from center line of nozzle using tape widths of 6 to 13½". The 4-ton exit cone section alone contains approximately 21 miles of ablative tape. The giant nozzle's structural housing employs thick plate weldments of 18% nickel maraging steel in the heaviest gauge ever fabricated and welded in the aerospace industry.

This Rohr-built rocket nozzle is typical of the advanced technology and fabrication capability available to the industry today at Rohr's new "Hall of Giants" manufacturing facility. For complete information relative to your requirements, please contact Marketing Manager, Dept. 45, Rohr Corporation, Space Products Division, 8200 Arlington Avenue, Riverside, California.

SPACE PRODUCTS DIVISION
ROHR CORPORATION



THE COVER — This artist's montage illustrates some of the production milestones in Rohr's 25 years of operation.

1 Lockheed Hudson
2 Consolidated B-24 Liberator
3 Consolidated Catalina
4 Consolidated PB2Y3
5 Lockheed P-38
6 Lockheed Constellation
7 Lockheed P-2V Neptune
8 Boeing B-52
9 Douglas DC-7
10 Lockheed C-130 Hercules
11 Convair B-58
12 Boeing 707
13 McDonnell F4H Phantom
14 Lockheed P3-A Orion
15 Boeing 727 Trijet
16 Lockheed C-141 StarLifter
17 Douglas DC-9
18 210' Antenna for NASA
19 United Technology Center's Titan III-C
20 Tracking Radome & Radiotelescope

WHAT IS A POWER PACKAGE? A JET ENGINE POD?

A "power package" is a term used to describe the propulsion unit on the wings of an airplane propelled by a reciprocating, or piston, engine.

In building a power package we take the bare engine and to it attach the necessary engine mount, sheet metal cowling, panels, diaphragms, supporting structures, air ducts, fuel and oil lines, and electrical harness. In all, each power package contains from 1,500 to 3,500 Rohr-made parts, depending upon the type of engine.

Jet engine pods are built up in the same way around turbojet and turbofan engines, and contain up to 5,000 Rohr-made parts, again depending on the size and type of engine.

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ROHR MAGAZINE

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ROHR CORPORATION

25th YEAR

ROHR CORPORATION

Main Plant and Headquarters: Chula Vista, California. Manufacturing Plant: Riverside, California. Assembly Plants, Winder, Georgia; Auburn, Washington. Architectural Division: Fullerton, California.

In observing our 25th Anniversary and reviewing the accomplishments of a quarter-century in this changing, challenging industry, I should first like to pay tribute to the loyalty of a great many people. They include employees, some of whom have been with us since the beginning; shareholders, who support, through their financial confidence, the direction of the business, and our customers, who are at the heart of all we do. Associations through the years have created many warm friendships, and these I shall always cherish.

Ordinarily, we do not devote much time to looking back; we are too busy looking ahead. But anniversaries are a time of review, of taking stock, of catching our breath, so to speak, and that is the purpose of this special issue of Rohr Magazine.

It may be trite to say it, but nevertheless it is true, that we are living and working in the greatest age mankind has ever known. More progress has been made in the last 25 years in applying scientific knowledge to everyday life than in all the previous years of recorded history.

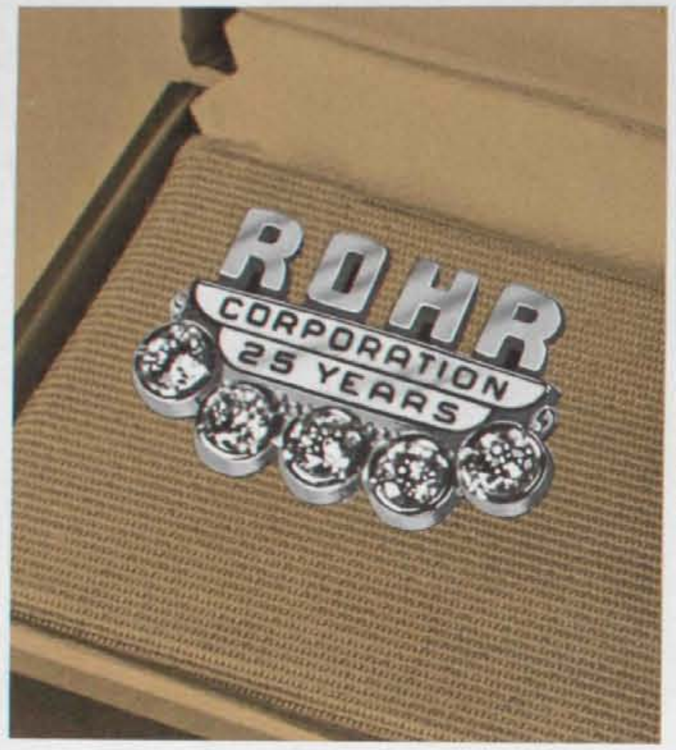
Twenty-five years ago we had no jet airplanes, no space vehicles, no satellites, no radar, no nuclear devices either for peaceful use or warfare, no television. Now, all of these devices, and many, many more, we take for granted.

What will the next 25 years bring? Since new ideas, new discoveries, and new inventions invariably set up a chain reaction that multiplies new products in ever increasing numbers, few of us would attempt to forecast precisely what the world of 1990 will be like. We know it will be different, we hope it will be better, and those of us with faith in human intelligence believe that it will be.

We take pride in the Company's 25 years of service to the aerospace industry, and we begin our second quarter-century with utmost confidence in the future of our Nation and its security, to which we are dedicated.

Fred H. Rohr

Chairman of the Board of Directors and Chief Executive Officer.



Five diamonds on the service pin designates the wearer as one who has served throughout 25 years of the Company's history.

Rohr's First 25 Years AND THE MEN WHO SAW IT ALL HAPPEN

By EDWARD T. AUSTIN
Director of Public Relations

THE night of February 14, 1942, was cool and clear, but around the loading platform at Rohr-Chula Vista the air was tense with excitement. Four power packages—the first ever subcontracted—were being loaded onto a big flat-bed truck. Midnight was the deadline for their delivery to Consolidated-Vultee (now Convair) 10 miles away.

At ten o'clock loading was completed. Fred Rohr, accompanied by executives, supervisors and guards, jumped aboard and drove into the Consolidated plant with their Valentine greeting more than an hour ahead of schedule.

That was the beginning of the type of production for which Rohr Aircraft Corporation became famous. Since then the Company has produced more than 70,000 piston and jet engine power packages, more than any other company in the world, along with scores of other components and assemblies for the nation's multi-engine aircraft, both military and commercial.

Late in 1941, Fred Rohr convinced Consolidated management that he could produce power packages faster and at less cost than they could produce them. Demand then was heavy for the B-24 and the Consolidated management broke precedent and gave Rohr an order. No airframe manufacturer, until then, had let the important power unit out on subcontract.

The power package idea came to Rohr while he was employed at Boeing, in Seattle, in the early '30s. Shortly thereafter he returned to San Diego as Factory Manager at Ryan Aeronautical Company, but the idea of a "feeder" plant persisted. In 1940, when it appeared to be only a matter of time until we entered World War II, then raging in Europe, and that the demand for military aircraft would increase, he resigned and founded the Company that ever since has borne his name.

The Company's beginning was modest. With five employees, Rohr set up drawing boards in his garage and began planning a factory. He leased a three story building in San Diego's industrial district and began production of small parts, including cowling for Lockheed's Hudson bomber.

B. F. RAYNES, *President and General Manager, joined Rohr in October, 1940 as chief inspector. He moved up through positions as tooling superintendent, several management positions with International Detrola during the time Rohr was a subsidiary, and back at Rohr as chief tool engineer, vice president-manufacturing, senior vice president and executive vice president. In 1961 he was elected to the Board of Directors and in December, 1963 to his present position. He has held leading positions in many professional associations, including the Aerospace Industries Association, Society of Automotive Engineers and California Manufacturers Association, as well as in civic, political and social organizations. Born in Indiana, he is a mechanical engineering graduate of Rose Polytechnic College. Mr. and Mrs. Raynes and their son and daughter live in a suburban area east of Chula Vista.*

JACK T. MALONEY, *Senior Welding Engineer, Manufacturing Research, joined Rohr on Dec. 17, 1940 and was the first production welder hired by the company. He moved up to welding foreman in due course, a position he held for 13 years before assuming his present duties. In his capacity with Manufacturing Research, Maloney has been involved through the years with the deveolpment of welding techniques and equipment for new or unusually difficult jobs. Maloney's off hours are spent mainly with his family — three children and five grandchildren — and on a very occasional golf game.*

"Fred used to go out days and get orders, then come into the plant at night and show us how to make them," one old-timer recalls.

Employment gradually increased with the volume of orders Rohr brought in, and late in 1941 he decided the Company was ready to begin putting his original idea into effect on a broader scale. Land was obtained on the Chula Vista waterfront for the first factory and the Company began a growth that, except for a brief post-war period, has continued.

The first unit of the Chula Vista plant consisted of one 30,000 square foot building, now a small part of Building 1, and a rented barn on adjoining property which was used temporarily for offices. When the new building was completed, it now is recalled by some of the pioneers, they wondered if perhaps the new company hadn't overbuilt. They also recall that the temporary offices leaked badly during the wet winter of 1941-42.

During the war the Company concentrated on the production of power packages for the B-24, the PBY series, and modification work on some of the PB4Ys. Employment moved up to keep pace with the building program, and by 1944, the plant area was 600,000 square feet, and sales for the fiscal year ended July 31, 1944, were $70,-658,893. At the peak of wartime production employment reached 9,800. Net earnings that year were $1,825,703, substantially more than the total sales of the Company three years before.

Through the war, the new Company established several records. For one, it was the first industrial plant in the United States to sign up 100 percent of its employees in the War Bond drive. This was accomplished in less than 24 hours, which also set a record. It produced 31,761 power packages for the B-24, at times reaching a peak rate of 56 units a day, and became the world's largest producer of airplane propulsion units, a distinction it still holds.

G. F. BRUST, *Production Superintendent, Rohr-Winder, joined Rohr in December, 1940 as a sheet metal worker and progressed to leadman, foreman, general foreman, factory superintendent, project superintendent, to his present position. Active in Winder community affairs and a member of the South western Yacht Club of San Diego, his wife, and daughter enjoy boating and fishing.*

his management team planned for the lull they knew would come with the cessation of hostilities. As a result of this planning, when production contracts on virtually every major project were cancelled, they were able to close down department after department in an orderly manner. Employment dropped to 675 and a number of buildings were closed entirely.

Proof that the earlier planning paid off is the fact that despite its drastically curtailed production the Company continued to earn a profit, in contrast to many others in the industry during that period. Although sales dropped from a high of $70,658,893 for fiscal 1944 to $6,069,100 in 1946, the latter year showed a net of $390,043.

Anticipating a drastic reduction in military production and a postwar demand for commercial products, Rohr in 1945 joined and became a subsidiary of International Detrola Corporation, which later became Newport Steel Corporation. International Detrola had several plants in the middle west producing radios, washing machines, refrigeration equipment, furniture and steel. Rohr experimented with several products, but none ever went into production at Chula Vista because the aircraft industry began a more rapid comeback than had been expected. The Company's production record during the war had been noted by the major airframe manufacturers, so when the airlines began ordering to replace worn out or obsolete commercial transports, the airframe makers turned to Rohr for power packages. By 1949 sales had moved up to $24,674,488, which produced net earnings of $1,233,709.

When it became evident that aircraft production would continue on a scale sufficient to provide the Company with a substantial share of business, Rohr and a group comprised largely of those in active management organized a new corporation and purchased the assets of the Chula Vista plant from Newport Steel Corporation. Since then no other company has owned any part of Rohr Corporation.

With the outbreak of the Korean war in 1951, the Company began an expansion program reminiscent of the early '40s. The old war time Camp Anza Army post at Riverside, California, was purchased in 1952 and in July of that year ground was broken for a new plant to handle the overload from Chula Vista. By December the first unit of the plant was completed on land that since the war had reverted to a wheat field. One of the army barracks, in which production of small parts began shortly after its purchase, was converted to offices and a warehouse. The first power packages for the KC-97, one of the programs moved from Chula Vista, were shipped from the new plant on January 10, 1953. Thus, from wheat field to producing factory in six months set another record.

One of the policies that has guided the Company throughout its 25 years has been its superior service to its customers. To augment this service an assembly plant was established in 1954 at Winder, Georgia, to better serve Lockheed, at that company's plant at Marietta, about 35 miles away.

The assembly plant idea not only improved service to one of the Company's major customers, but it resulted in a considerable saving in freight costs. Engines for Lockheed airplanes built at Marietta no longer have to be shipped from the east coast engine manufacturer to California to be fitted with some 3,000 parts that comprise a power package, and then shipped back to Georgia. Instead, the parts, manufactured at the two California plants are shipped to Winder, where the engine manufacturer sends the engines. There, the power packages are assembled and sent to Marietta.

The system worked so well that in 1956 another assembly plant was opened at Auburn, Washington, near Seattle and Renton, to provide the same service to Boeing.

In addition to serving Lockheed, the Winder plant also enabled the Company to obtain contracts from Grumman Aircraft Engineering Corporation, Bethpage, Long Island, New York, and two years ago a new facility was built to replace the old. This now provides Rohr with the capability to participate in eastern subcontracting programs.

Throughout the war years the Company had little time to devote to engineering and research. Military models of aircraft were pretty well frozen, and production to the limit of the Company's capabilities was demanded.

But when production of commercial aircraft—and later on, military—picked up after the war, Rohr expanded its engineering facilities.

JOE PFLIMLIN, JR. — *Storekeeper for honeycomb scheduling, began at Rohr on Dec. 20, 1940 in the tool crib at 8th and J. At that time they had a combination tool crib, stock room and first aid station. Most of his spare time is taken in working in his yard, modernizing his home, and making things in his home workshop.*

PAUL K. WILTON, *Foreman C-141 exhaust nozzle assembly, began his career at Rohr in the cutting department on December 10, 1940. His hobbies are varied and include golf, hunting, baseball, softball, and bowling. In two years of war time service he was in the infantry artillery, and Air Force.*

JOSEPH M. OHLSON, *General Supervisor, Master Scheduling, with Rohr since Nov. 13, 1940, originally hired as shop foreman. His present assignment includes scheduling, detail ordering, assembly ordering and change coordination. He has a wife and four children. Family and church work, he's the church treasurer and a Sunday School teacher, take up most of his spare time.*

HUGH M. RUSH, Jr., *Chief of Manufacturing, started with Rohr on Oct. 9, 1940 as a layout man, subsequently rose to jig design engineer, project engineer, assistant chief engineer, manager of the laboratory, and then to chief of mfg. research. Majoring in mechanical engineering, and working as a pilot and flight instructor before coming to Rohr, Rush's favorite topics include sailing and the old days of flying. He and his wife are both ardent sailors. Weekends and vacations may find them on their 30-foot schooner, "Miss Prim."*

F. E. McCREERY, *Senior Vice President, started at Rohr on Aug. 26, 1940 as assistant chief engineer, was subsequently promoted to executive chief engineer, to vice president-engineering, vice president-manufacturing, then to senior vice president of the corporation. Mc Creery is a member and officer in several engineering and aeronautical societies, and active in the Boy Scouts of America. He and his wife have three young boys.*

GUY M. HARRINGTON, *Treasurer, Member of the Board of Directors, joined Rohr on Oct. 1, 1940 as an accountant. He advanced from accountant to controller to treasurer and member of the Board of Directors. Harrington is treasurer and a director of the San Diego County Association for Retarded Children, and an active member of the tax committee of the California Manufacturers Association. For many years a small boat sailor, Harrington now devotes most of his spare time to golf.*

DON E. WEST, *General Foreman 727, Processing C-141 thrust reverser doors. Started working at Rohr on Dec. 16, 1940 doing sheet metal assembly work in what is now trim and drill. He had spent two years in Alaska with a gold dredging outfit, and it was there that he received a telegram to come to work for Rohr. He came out of Alaska in record time, travelling by dog team, boat, and airplane.*

JOSEPH J. JABLONSKI, *Foreman C-141 exhaust nozzle assembly, began at Rohr bucking rivets in the B-24 panels on Dec. 16, 1940. His rivet partner also is still with the company. He and his family, wife and one daughter, like to travel and occasionally go surf fishing.*

LESLIE W. GUE, *Project Superintendent, hired in at Rohr Nov. 18, 1940 as riveter-assembler. He subsequently was promoted to leadman, assistant foreman, foreman, general foreman, assistant superintendent, superintendent, and at present, project superintendent on second shift. In his 25 years of service, approximately 17 years of this time has been on second shift. Gue and his wife, Jean, enjoy deep sea and surf fishing.*

HARRY GOODELL, *Administrative Services Manager, began work at Rohr Dec. 26, 1940 as a riveter. Commissioned in the U. S. Army in 1944, returned to Rohr in 1947 in Tool Liaison — tool control and scheduling. Recalled in 1951, Goodell spent another 16 months in the service during the Korean action. Returning to Rohr as a purchasing supervisor in 1952, was subsequently promoted to Riverside purchasing supervisor, purchasing agent, and production manager. Transferred to the Auburn, Washington plant in 1959 as manufacturing services manager, was promoted in 1964 to administrative services manager, Chula Vista. He is active in community projects, member of several professional societies.*

LANGFORD L. BROWN, *Chief Inspector with Rohr since Dec. 16, 1940. His first job with the company was installing Sperry bombsight and doing mod work on the LB-30 the English version of the B-24. He subsequently transferred to inspection and has since been associated with all phases of fabrication and assembly inspection, laboratory and X-ray inspection. In 1952 was appointed chief inspector. His outside interests revolve around his family, various community and civic activities and several professional societies. His main hobby, travelling, has taken them to Europe and the Orient a number of times.*

JAMES L. HOBEL, *Vice President-Industrial Relations — joined Rohr on Dec. 11, 1940 as clerk in the controller's office. He advanced to secretary to the controller, to office manager, to labor relations manager, to director of personnel, to industrial relations manager and then to Vice President-Industrial Relations. Active in many civic organizations, and a member of the Governor's committee of several states, Hobel originated the nationally accepted idea of supervised Halloween programs. Combining a love for golf and trailering, Hobel manages to play on a number of courses throughout the nation. When he's not travelling or golfing, making furniture in his home workshop takes up his spare time.*

ALFRED M. HARTNETT, *Molder A Foundry with the company since Nov. 9, 1940, began working with lead plates in the foundry, and has continued in the same department ever since. He has a workshop at home where he does woodworking and cabinet work.*

GEORGE B. LACEY, *Conservation, started working for Rohr on October 25, 1940 as a drophammer operator. He and his wife have two daughters and three grandchildren, and spends most of his spare time hunting and fishing.*

HAROLD E. ALTIG, *Foreman Foundry began at Rohr on October 5, 1940 installing drophammer equipment. He and his wife love to camp in the rough country in Arizona, where he enjoys hunting for deer, elk and javelina. He has a daughter and two grandchildren.*

CARLOS A. "Chuck" MARTINEZ, *Tool and Manufacturing Engineer, first began work on the punch press on Jan. 6, 1941. During the years he has worked as assistant foreman in resistant welding, in the hangar on conversion, in production control, as a tooling planner, a tool engineer, and as tool and manufacturing engineer.*

C. J. PFRUNDER, *Foreman Assembly, Riverside, first began working at Rohr doing resistance welding on Dec. 11, 1940. Since then most of his work has been in resistance welding and assembly work. His wife, two boys, and two girls share his hobbies of photography, camping and fishing.*

R. C. BLEDSOE, *General Foreman in Assembly, Riverside, on the C-141 aft cowl panels, nose cowls, and wing to body fairings, and the 320 and 720B nose cowls, first began work at Rohr on Nov. 4, 1940, as a riveter on the Hudson bomber. One grandchild, fishing, hunting for elk in Montana and playing golf take up most of his spare time.*

KERMIT W. "Bud" MAYNARD, *Project Superintendent, Hi-Temp Sandwich Structure and Core Manufacturing, and one of the original five employees on the company payroll, hiring in Aug. 26, 1940. Began as maintenance superintendent and helped work with Fred Rohr in the design and building of the drophammer equipment. Factory manager during World War II, "Bud" now works with the production of all types of Hi-Temp welded honeycomb core, and the development of core machines and related equipment. In 1933 "Bud" rode in the Indianapolis 500-mile race as a mechanic. He now navigates for his son-in-law driver in sports car rallyes.*

S. B. HOUSER, *Director of Facilities, with Rohr since Sept. 6, 1940, hired in as plant engineer. He made the installation at the Rohr plant at 8th and J street, then came to Chula Vista where he completed the original building and installations on Jan. 15, 1951. In 1955 he was promoted to Director of Facilities, responsible for site selection and acquisition of all plant facilities. President of the Chula Vista Chamber of Commerce in 1952, he also served on the advisory committee of the Chula Vista public schools. He has served as director of the Boys' Club of America, Chula Vista, since its inception, and is currently education chairman of the Chula Vista Cancer Society.*

WILLIAM J. BERGGREN, *Assembler, joined Rohr on Dec. 20, 1940. His first job was assembling and riveting on the nose ring of the old Hudson bomber. He spent 17 years working on the motor line. He and his wife and two boys, ages 20 and 22, love to travel.*

W. B. LEE, *Assembler, C-141, with Rohr since Dec. 10, 1940 has spent the last 13 years at Riverside. His first job was running a uni-shear or hand shear, cutting both aluminum and steel. He loves to bowl, and is especially proud of his seven children and 15 grandchildren.*

LLOYD E. ANDERSON, *General Foreman, Weldments, began working at Rohr on Nov. 28, 1940, in the drophammer department. After the war, in 1946, he went into weldments on engine mounts and has been with the department ever since. He has three children, all of whom are married, and 10 grandchildren.*

MATTHEW J. MOSCHETTI, *Foreman, drophammer and punch press, began his career at Rohr degreasing and hand washing parts on Dec. 6, 1940. He has spent 22 of his 25 years at Rohr in the same area. He has three children, a daughter and two sons, and two grandchildren. His youngest boy is in Viet Nam in the Marines.*

Airframe manufacturers were impressed with the Company's record and sought aid in the design and engineering of power packages and other components. Before long they were relying upon Rohr engineers for both design and production engineering.

This became particularly important as the jet engines began replacing the old piston engines. In the so-called "hot" areas of the jet engine pods, as contrasted to the piston engine power packages, an entirely new concept of design, engineering and manufacture was required.

The jets also brought about another change in aircraft manufacture. Because of the greatly increased speed of jets over piston power — about double — and the larger seating capacity of commercial jet airliners, fewer airplanes were needed to meet the requirements of the airlines. To a great extent, the same situation was true with the military.

To fill the gap in production during the period of readjustment to changed conditions, Rohr accelerated its program of diversification. At the same time, the Company management took a long, hard look at the many routes some of the other companies were taking. Having made its reputation as a manufacturer of structural components, it decided to stick to those things which it best knew how to build and leave for others some of the more glamorous avenues of manufacture.

The Company's first major venture beyond the aircraft field was the creation of a department to build large tracking antennas. This decision was based upon its proven ability as a structural manufacturer which, when teamed up with its now greatly expanded engineering facilities, seemed to make it a natural line of endeavor.

The first antenna, a tracking unit 60 feet in diameter, was erected in Alaska, and was successful. Then followed other contracts for various types of 85-foot tracking and communications antennas. The engineering department was further expanded to include outstanding experts in the antenna field, with the result that in less than five years the Company has become one of the nation's largest antenna builders.

As the antenna volume grew to include radio telescopes, troposcatter antennas, microwave relay horn antennas for commercial communications, observatory domes, and the largest of all deep space tracking antenna, a $12 million, 210-foot diameter unit being erected at Goldstone, California, the Company placed this activity into a separate Antenna Division. This shortened lines of communication and responsibility and made for more economical operation, and as one result the Antenna Division now accounts for about 10 per cent of the Company's sales and earnings.

The development of supersonic aircraft created a demand for more heat resistant metals, not only in the "hot" areas of the engines but for wing and fuselage coverings where high speeds and the resultant air friction with skin surfaces elevated the temperature of aluminum to near the melting point. Steel was better, but it was too heavy.

Several companies had experimented with steel honeycomb, a process whereby thin ribbons of steel were formed into a honeycomb pattern, each cell welded to the other, the core then faced with thin sheets of steel and the entire assembly brazed into a single panel. These panels reduced weight, provided sufficient strength, and withstood vibration better than steel sheets. But they were expensive, the earlier panels costing about $1,000 per square foot.

One cause of the heavy expense was the slow process available for making the "core." Machines then in use formed the honeycomb, one cell at a time, in narrow strips which had to be "tacked" or welded together to make a panel. Fred Rohr was convinced that there could be a faster, more economical

JEROME L. GUDDE, *Assember A, first began work at Rohr on Dec. 17, 1940, in the Trim and Drill Department. He spent five years in tooling and three years in conversion. He now works on the P-3A assembly line. Two of his five children work at Rohr, one son does experimental work, and another is a design engineer. Eleven grandchildren and his hobby of automotive mechanics keep him occupied in his spare time.*

JOHN K. PETTIT, *Supervisor, Shipping and Spares, with Rohr since Oct. 4, 1940. Pettit's first job was to build a fence around the 8th and J building. In the Shipping Department he helped to establish the Spares Department. Photography and horseback riding are his hobbies. His wife, four children and three grandchildren love to ride horses up in the mountains when time permits, and at their home in Bonita between times.*

LESLIE E. BORDWELL, *presently in Tool Liaison on the JetStar, began working at Rohr on Dec. 18, 1940. He started making templates for the Lockheed Hudson bomber and worked on the LB 30 and Sperry Gyroscope contracts. He has been in tooling work ever since. He and his family, consisting of wife and three girls, like camping.*

OTIS BEATTY, *Foreman, Hydro press, joined Rohr Dec. 30, 1940, starting in the foundry and drophammer department. Most of his career at Rohr has been with the hammers and the presses, first as a leadman, then as assistant foreman, then foreman. He met his wife, a Rohr employee, during the war. Golf and orchids keep his spare time occupied.*

method. A machine was designed which formed six cells at a single stroke and also made complete core panels to any desired size instead of "tacking," or welding the strips together.

The machine was built by Rohr technicians and became so successful that others were added until there are 17 of these machines in the Chula Vista plant making core not only for the Company, but for others as well.

The Company has become a leader in the manufacture of brazed stainless steel honeycomb panels, some of which have been used on supersonic airplanes, such as the Convair B-58 Hustler, the McDonnell F4H, and the North American B-70. Honeycomb panels also have been used on some space vehicle components, and are being designed into supersonic aircraft now in development.

While the Chula Vista plant was developing stainless steel honeycomb, the Riverside plant added metal bonding to its long list of accomplishments. The bonding of dissimilar metals together with nonmetallic adhesives, then baking the unit in an autoclave, under pressure, provided a material of great strength with a significant weight reduction. Demand for metal bonding in the industry became so great that three autoclaves were added, one of which has inside working dimensions of 15 by 35 feet, making it one of the largest in the nation. In it is processed the petal cargo door for Lockheed's C-141 StarLifter, the largest metal bonded component ever made.

The use of numerical or tape

RAYMOND R. PARKES, *Zero Defects Project Coordinator and Discrepancy Analyst, first started to work at Rohr on Dec. 16, 1940, doing fitting, trim and drill work, and final assembly on the skirt panels of the Lockheed Hudson bomber. Interim responsibilities include assembly foreman, Manufacturing Methods and Planning. He is Past Master of the Chula Vista Masonic Lodge, and he and his wife both take an active part in lodge activities.*

FRANK VIRGIL, *Assembler, now working on the Boeing 727, hired in at Rohr on Dec. 17, 1940, and began building and countersinking nose cowl rings for the Hudson bomber. Through the years he has been leadman, and foreman. Once he had a crew of 1 man and 25 women working on the P-38.*

ELWYN S. OPPENHEIMER, *Supervisor, Assembly Ordering, began working at Rohr on Oct. 24, 1940, in timekeeping, picking up time on various projects. He says one of his prime interests through the years has been watching this company grow. He and his wife have four boys and a girl, find that working in the yard and adding to their home in Bonita takes up most of their spare time.*

controlled machines has been developed to an extensive degree at Rohr. As rapidly as was practicable boring and milling machines, skin mills and Drivmatic riveters were converted to tape control and today, in mid-1965, there are 18 units in operation. This conversion is in line with the Company's policy of keeping abreast of modern manufacturing developments. The United States Chamber of Commerce a year ago said Rohr was the nation's outstanding user of numerically controlled machines.

For several years Rohr management watched the rapid approach of the space age and, consistent with its policy of diversification in areas of manufacture best suited to its capabilities, moved into the missile and rocket field. One of its earlier challenges was the fabrication of filament-wound rocket engine and fuel cases. After a few pilot runs with conventional filament winding machines, Company engineers and technicians devised a machine to be operated by numerical or tape control, the first of its kind in the industry.

Moving rapidly into the manufacture of space products, the Company followed the policy that has enabled it to be prepared to manufacture anything the industry requires. It built a 70-foot high structure at the Riverside plant and installed large boring mills, curing ovens, hydroclaves, capable of handling the largest rocket and missile components. It has fabricated several rocket nozzles, all of which have successfully been fired. One of the nozzles for a 156-inch solid fuel Thiokol space booster, was test fired in February, 1965. The engine to which it was attached produced more than 3 million pounds of thrust. In 19 test firings, no Rohr-built part has failed.

With the demand for space components increasing, Rohr next established the Space Products Division for the same reasons that led to the successful creation of the Antenna Division, and Company foresight in building the Hall of Giants, as the facility is known, has been more than justified.

As the Company's diversification program broadened, it was decided in 1961 to drop "aircraft" from the corporate name, and henceforth be known as Rohr Corporation. This in no way meant that there would be a slackening of efforts in the aircraft industry which still accounts for approximately 88 percent of our total sales volume. Rather, it meant that in view of the larger area covered by the Company's activities in the entire areospace field the word "aircraft" might be construed as limiting its objectives.

The Company last year created the Architectural Division to take over research, development and production in the field of home building, which began on an experimental scale three years earlier at Riverside. A plant was acquired at Fullerton, California, where limited production got under way several months ago.

The period of research and development has reached the point where plant facilities are capable of increased production, and it is anticipated that further write-offs of developmental costs will become unnecessary by the end of the year.

In 25 years the Company that started with one man's idea and a determination to serve one of the nation's most important and fastest growing industries, has come a long way. From a beginning, when a few small parts were made by hand for the aircraft of that day, it has grown to become one of the industry's largest subcontracting firms. Except for the bare engines themselves, it is capable of manufacturing any structural part or assembly for any airplane or space vehicle, either commercial or military.

Progressive leadership enabled the Company to make the transition from the now obsolete piston engine aircraft to the modern jets and on into the space field. By always looking ahead, anticipating what the industry will need next year, five, ten, or more years ahead, and preparing with capable manpower and the modern facilities, Rohr has proved that there's always a reward for those who keep busy and do not waste time listening to the pessimists who loudly proclaim that it can't be done. □

REINHARD W. ELSNER, *Foreman, Hand Forming, started working in the foundry and in the planish departments at Rohr on Nov. 27, 1940. His entire time spent at Rohr has been in related departments. He is especially proud of two great-grandsons.*

MAYNARD A. JOSEPH, *Tool and Methods Liaison, began his career at Rohr on Dec. 18, 1940, working in production on the Hudson bomber. His Rohr job was the second permanent job he had held. He and his family, wife, boy, and girl, love to travel in the Northwest.*

A. L. "Buff" BUFFINGTON, *General Foreman, Spot Welding and Processing, first started working at Rohr on Dec. 19, 1940, as a bench assembler. His outside interests are diversified, but he especially likes to listen to jazz music.*

GILES H. COOK, *Foreman, hydro press, began his career at Rohr on Nov. 25, 1940, as a drophammer operator. With the exception of 1½ years spent in honeycomb core manufacturing operations, he has spent the greatest portion of his time in the drophammer and hydro press departments.*

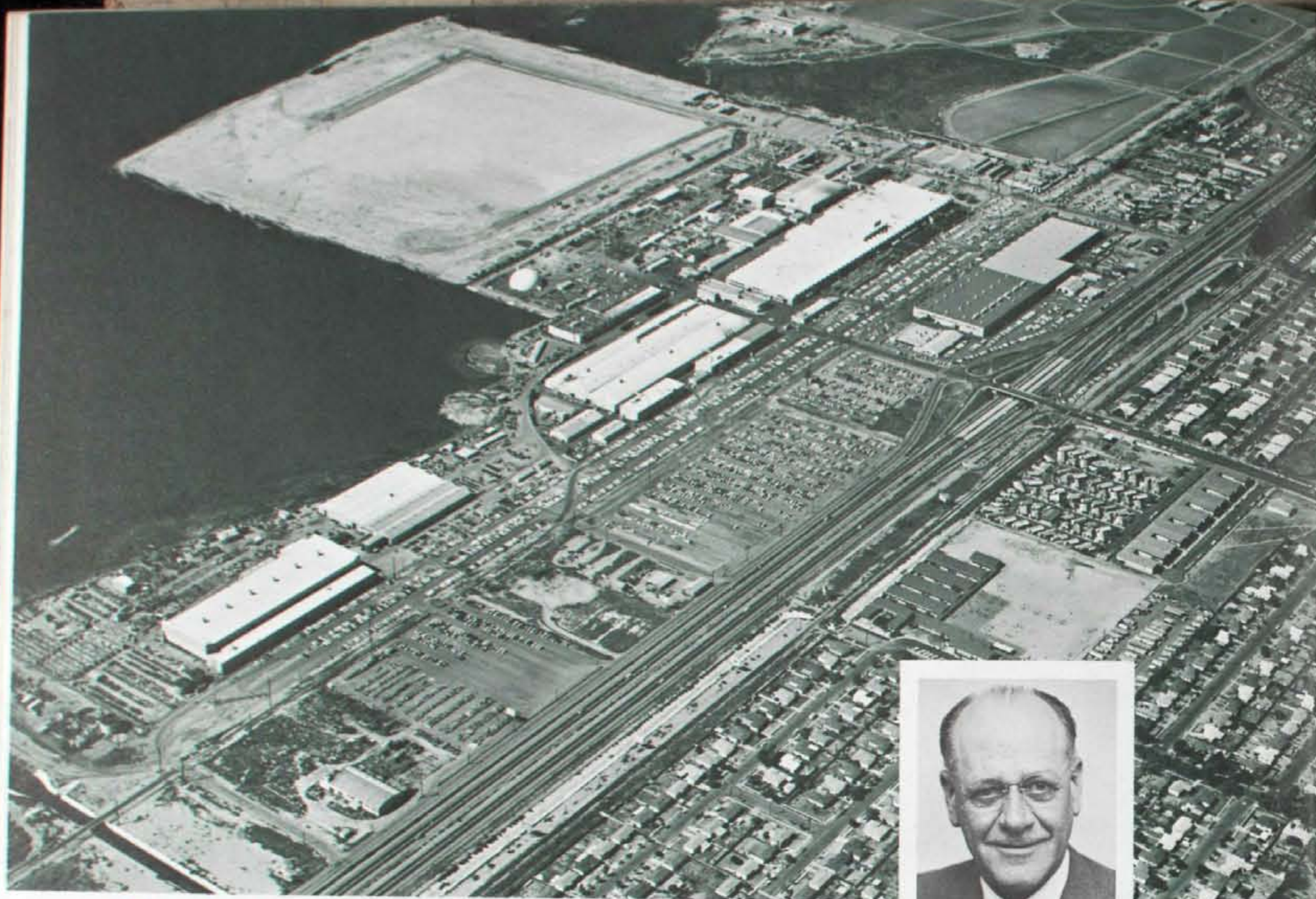
I. DAGAN, *Director of Quality Assurance was hired as a sheet metal inspector on Jan. 2, 1941. He progressively engaged in all functions of the Inspection Department through various supervisory ranks. Appointed Quality Manager in 1951, he was later promoted to his present position. Holding membership and offices in a variety of professional societies, golfing in the low 80's, and trying to keep up with the activities of two young sons, Dagan finds his spare time is well occupied.*

ARLAND V. PHELPS, *Project Scheduler, with Rohr since Dec. 13, 1940, started in as a timekeeper, soon moved to production control and has been in that department ever since. He, his wife and two teenage sons spend most of their spare time swimming and scuba diving off the coast of Mexico, near Ensenada.*

A. F. KITCHIN, *Vice President-Administration, with Rohr since December 5, 1940. Kitchin was first employed as a buyer in the Purchasing Department, was subsequently promoted to production coordinator, assistant production manager, production manager, and then to Vice President-Administration. A member of several civic and professional organizations, he is a director of the Sheltered Workshops of San Diego. His family consists of his wife, two girls and a boy. Outside interests are listening to hi-fi, playing golf and fishing.*

MERLIN L. KUHLE, *Foreman, Cutting, started at Rohr on Nov. 12, 1940, in the cutting department, working with shears. Most of his time at Rohr he has spent in the cutting and stringer area, with some time as foreman in the Punch Press Department. He has worked continuously at Rohr except during a short time when he was with the Army's First Infantry Division in Germany. He was injured in the service, spent some time in the hospital, then returned to Rohr again in 1946.*

DAYTON L. ROBERTSON, *Supervisor Plant Engineering, Planning and Scheduling, hired in on December 18, 1940, and immediately started helping the electricians install conduit in the original part of Building 1 preparatory to moving the plant to the Chula Vista location. He recalls it rained 27 inches that year and sometimes there was water 3 feet deep. Robertson has worked as maintenance foreman, supervisor of plant layout and plant engineering. He loves to bowl, play golf, and visit with his five children and 10 grandchildren.*



Rohr-Chula Vista, California

By S. B. HOUSER
Director of Facilities

The initial Rohr plant in San Diego.

25 Years of Growth

MEETING INDUSTRY DEMANDS IS CONSTANT CHALLENGE

TWENTY-FIVE years ago Rohr Corporation came into being in a rented, three-story building which contained 15,000 square feet of floor space.

The building was in San Diego's wholesale district, a location that made everything easier because when we needed tools and metal supplies to fill our first orders, we simply walked over to Western Metals Company, bought what we needed and carried our purchases back to the plant. If an order was too heavy, we hired a truck.

But business increased, right from the start, and right away it became apparent that we would need more room. Land was acquired at the lower end of San Diego Bay, in Chula Vista, and we built our first building, now a part of one of the main plant structures.

The new building had an area of 37,500 square feet, and when we moved in on January 15, 1941, and saw the vast expanse of floor space, several of us were certain that we never would need additional space.

But a steady influx of orders dispelled that notion in a hurry. An expansion program began that saw building after building erected, and in three years we were occupying 600,000 square feet.

With few interruptions, the expansion program has continued and now, 25 years after our first steps, the Company operates in five plants — Chula Vista, Riverside, and Fullerton, in California; Winder, Georgia, and Auburn, Washington. The five plants occupy a total of 67 buildings, floor space of 2,300,421 square feet under roof, plus 220,000 square feet of outdoor manufacturing space used by the Antenna Division. These plants are situated on 459 acres of Company owned land, and 36 acres under lease. Most of the leased land is used for parking space.

One of our interesting buildings is the Hall of Giants, home of the Space Products Division, at Riverside. This structure, completed in 1964, is seven stories in height, but with a single floor. The height is necessary to accommodate the large machines and the products we make there.

More detailed descriptions of our facilities are contained in other articles in this issue of Rohr Magazine. Many of the machines we now use were undreamed of 25 years ago. Such machines as those operated by numerical, or tape, control; large forming presses; autoclaves, hydroclaves, filament winding machines, all have become commonplace in this rapidly changing industry.

But none of us imagined, a quarter century ago, when we looked over that first small building, that in a few years the aircraft industry would be so completely transformed. Because the management of Rohr Corporation has kept pace, even a bit ahead, of the industry's needs, however, we have achieved our position as the nation's leading aircraft subcontractor. □

Rohr-Winder, Georgia

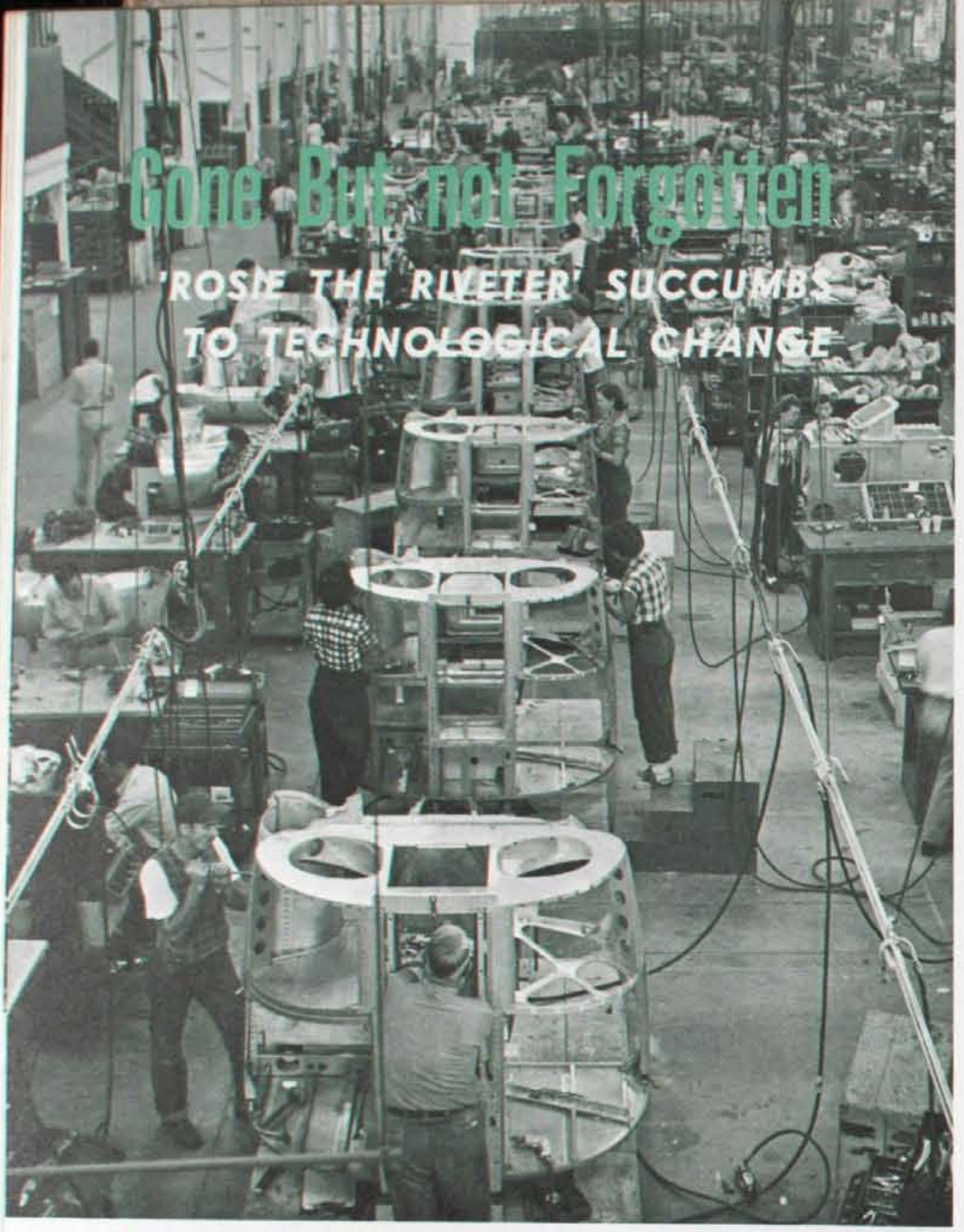
Rohr-Riverside, California

Rohr-Auburn, Washington

Rohr-Fullerton, California

Gone But not Forgotten

'ROSIE THE RIVETER' SUCCUMBS TO TECHNOLOGICAL CHANGE



Sheer manpower—and womanpower—were applied to reach production quotas during the critical wartime build-up. Saddle shoes, blue jeans and "page boy" hairstyles mark the era along with the B-24 bomber assembly on the line.

By J. L. Hobel
Vice President-Industrial Relations

WHEN President Roosevelt in 1940 called for the production of 60,000 military airplanes a year, the figure caused many a veteran in the industry to gasp. Hadn't they stepped up military production from 437 aircraft in 1934 to 6,028 in 1940? Wasn't the President being unrealistic in demanding another ten-fold increase? Where would the engineers, the mechanics, the craftsmen come from? Airplanes couldn't be produced on an assembly line, as in the automobile and other industries; they had to be made by hand.

But with war clouds darkening, and finally the attack on Pearl Harbor, the industry dropped its questions and went to work. In 1941, it produced 19,445 military aircraft, in 1942 the figure went up to 47,675, and the year after reached 85,433, far beyond the President's figure, but still short of the industry's capacity, for the next year the count moved up to 95,272. Bombers, fighters, reconnaissance airplanes, and transports rolled from the nation's plants in steady streams.

Where had the people who manned the factories come from? Who would have thought they could be recruited and trained so quickly?

They came from everywhere. From the farms, the little shops, the stores, the offices. They caught on quickly and became drop hammer operators, assemblers, dispatchers, and tool makers. They became technicians and soon were talking glibly of heat exchangers and boosters. They filled the highways from the rural middle west, traveling in any type of conveyance they could find, carefully conserving precious, rationed gasoline.

The supply of men ran out because millions were in the armed services, and still more factory workers were needed. The women then moved in and took places in the plants and, after a brief training period learned to sink rivets and assemble small parts. Rosie the Riveter became a collective name for the industry's heroines, and with each rivet they drove went a prayer for the safety of a son, a husband, a father or a sweetheart who would pilot the planes, or serve the nation on land or sea.

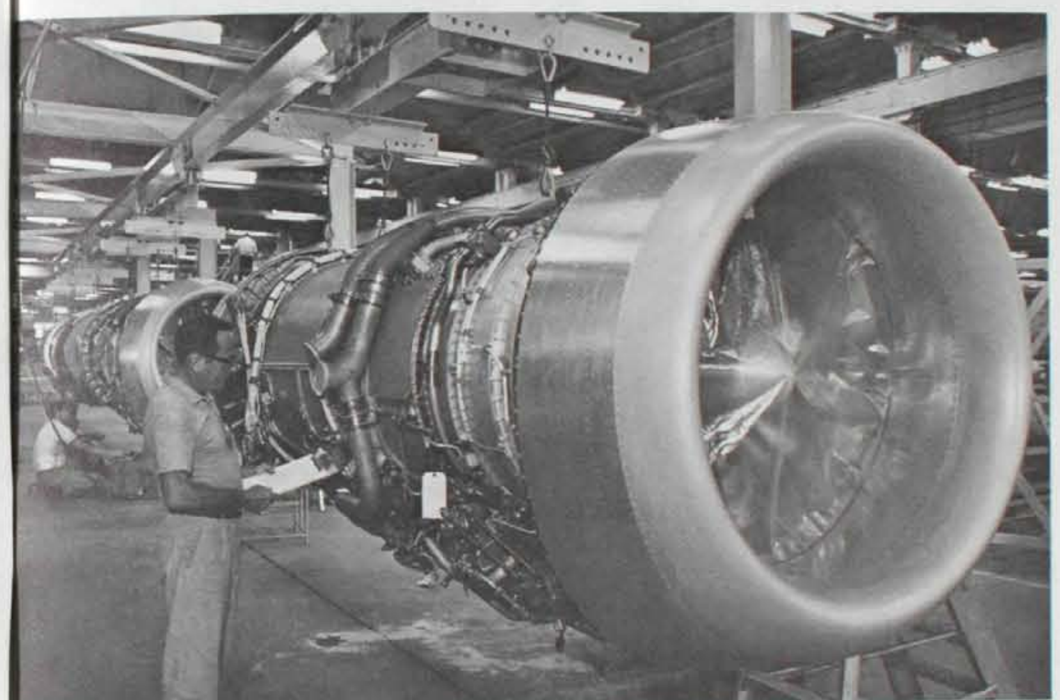
It was a period when production was the single objective of plant managers and workers alike. Quotas were set, and passed. And the airplanes rolled out and filled the skies, to the consternation of our enemies who again had guessed wrong; who had believed that the Americans were too soft, too complacent, too proud to fight.

At last the war ended and aircraft production dropped toward the vanishing point. The year after the war ended, in 1946, only 1,417 military airplanes were turned out, compared with 46,865 the previous year. Workers were laid off by thousands, whole sections of plants were closed, and only two companies in the industry—Rohr was one of them—continued to show a profit.

Many of the war time workers went back to their farms, stores, offices, and shops, but the increased orders for civilian aircraft to take the place of obsolete and worn-out units, many of which had been taken over by the military, enabled the major companies to retain the best of their trained and experienced employees. This also enabled the industry, of which Rohr had become an important unit, to rebuild their personnel around the nucleus they had retained.

Progress in the development of civilian aircraft was rapid. New designs, the development of new metals, new manufacturing technology combined to change the type of qualifications sought in recruiting employees. The number of unskilled men required in various shop areas declined, and continues at a declining ratio to the total. A steady search for talented personnel now marks the recruiting efforts of Rohr's Industrial Relations teams. It no longer is enough that a man can handle a drill gun or smash out parts on a drop hammer; he must have some knowledge of material stresses, creep, metal fatigue, and the oven temperatures required when hot-forming parts.

In brief, the young man with only a desire to work—admirable as that may be—but with no special training, cannot hope to go far in the aerospace industry, if he can get into it at all. Nor is it enough, if he succeeds in getting on the payroll, to be content with the meager knowledge that enabled him to get a mediocre job. He must keep abreast of new methods and materials. Rohr, along with most other companies in the industry, offers training courses and opportunties for employees. To the extent that these courses are studied and mastered, to that degree does the new employee advance.



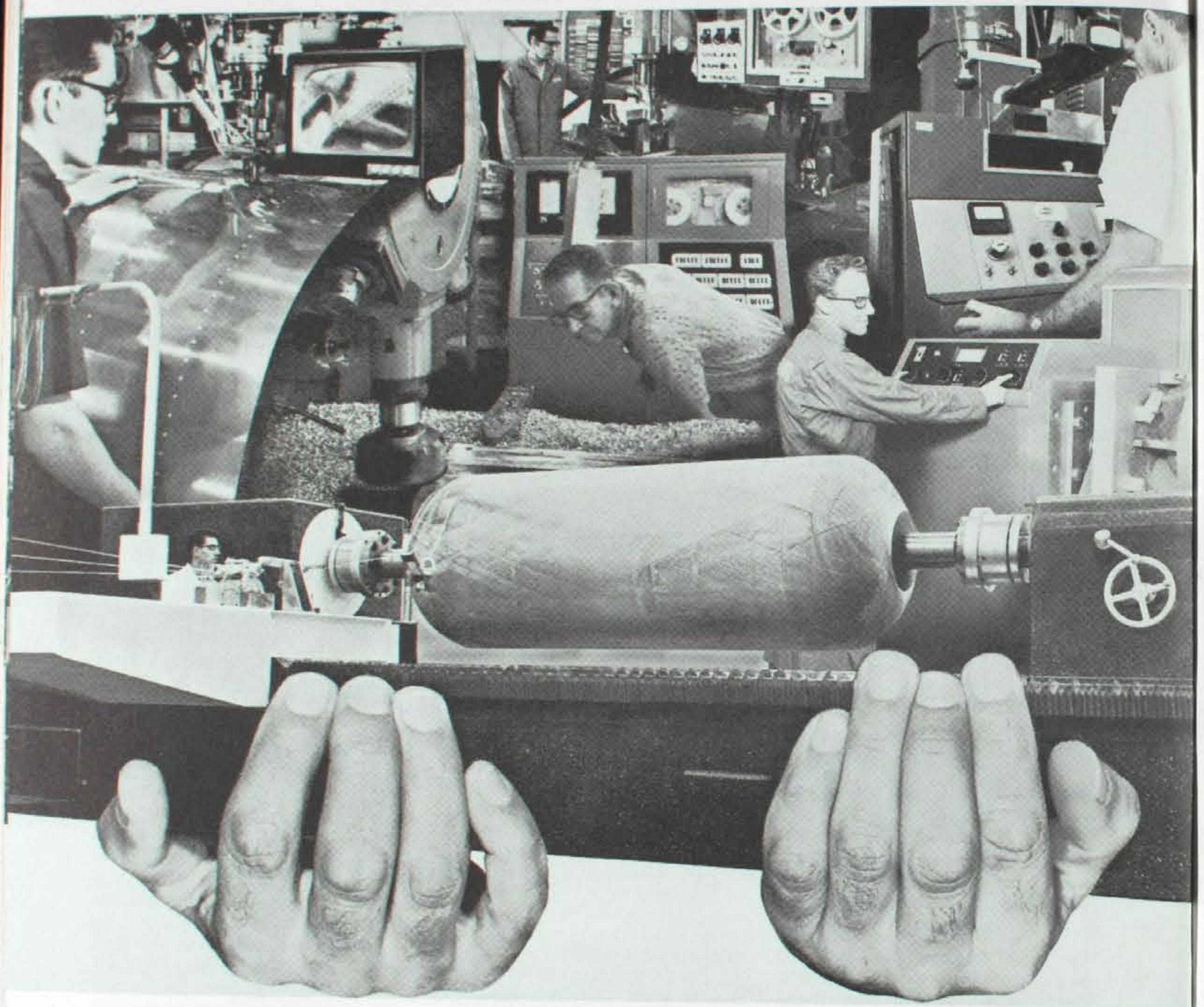
Today's power plant assemblies move down the line on monorails. Modern production methods, as on these Douglas DC-9 pods, demand fewer workmen and a higher level of technology.

The mastery of skills undreamed of 20 or 25 years ago are today's commonplace requirements in the aircraft and aerospace industry, and a high school diploma is about the minimum educational requirement enabling a young man to get a job. College or trade school training is a must in many areas. It is not enough that the applicant had training a few years ago but has not kept it up; he must continue to study and learn.

As an example, the spotwelder of today must have a good working knowledge of materials and processes. The laboratory technician must have either the education or training in, for instance, the use of cobalt as an inspection tool. A top tool designer, in addition to knowing the manufacturing processes in detail, is required to perform the stress analyses of his designs, and the engineer we seek will have a broad knowledge of the engineering disciplines in general and a specialty, such as dynamics, acoustics, or in fuel technology for the supersonic airplane. Today's milling machine operator, as another example, is expected to know feeds and speeds, gear ratios, and the approved methods for milling titanium, magnesium, and full-hard stainless steel — the so-called esoteric materials of even ten years ago.

Where will Rohr find these trained men? From the colleges and universities, from the vocational or trade schools, and by continuing to lend its top technical personnel to these schools to instruct in modern manufacturing processes and techniques.

So, while the days of Rosie the Riveter and the boy from the farm, with no previous training, are gone, the opportunities for reward and advancement in the aerospace industry still are here in even greater numbers than during those hectic war years. But they're not here for the high school "drop out," the lad who doesn't prepare himself. His kind is doomed to a life of mediocre jobs, if he is able to get one at all, because this is the age of skill and an eagerness to learn. This is an exciting, challenging, rapidly progressing industry — for those who can progress with it. □



New Technology In Materiel

ELECTRONICS REFINE PURCHASING OPERATIONS

By C. R. CAMPBELL
Director of Materiel

IN LINE with the ever advancing "state of the art" predominant throughout all aspects of the Aerospace Industry, the Rohr Materiel Department is applying a continuous effort on many fronts to increase the quality and efficiency of our materials scheduling, procurement and handling techniques.

Some of the more significant programs in work at this time are as follows:

Value Analysis — This may be defined as an organized approach to the objective appraisal of each element of design, procurement, installation and use of a product in order to achieve only the *necessary* parts function and reliability at *minimal* cost. An average yearly savings of $250,000 has been achieved through the use of improved manufacturing methods, facilities utilization, economic material substitutions, secondary source establishment, etc.

Computer Application — During the past year, a full-scale effort was initiated relative to the application of data processing to all functions in Material. Objectives of this program were to eliminate as much of the routine clerical effort and analysis as possible and to provide action information selectively, mechanically performing laborious problem search effort previously performed manually. Programs in various stages of development and implementation include:

Mechanically Scheduled Requirements — The establishment of production parts/materials listings by mechanically computing bills of material in relation to production schedule in such a manner as to provide "exact-need" material requirements, thus reducing inventory investment and clerical effort previously required to schedule parts and material. An annual inventory investment savings in excess of $500,000 will be realized from this program alone.

Cost Lot Allocation—A program which mechanizes a complex and tedious accounting function relative to the allocation of material issues to the proper work order, thereby reducing considerable clerical effort.

Recap and Order Program — A program which utilizes previously established magnetic tape records relative to requirements, inventory and on-order position to mechanically compute material status and generate purchase requisitions as required.

Purchase Order Preparation and Status—A program which mechanically produces purchase orders subsequent to award by buyer and simultaneously provides for punched card processing of receiving data.

In addition to the above, the program mechanically provides previous procurement and quotation history, scans open purchase orders and notifies purchasing of vendor delinquencies and generates many of the internal and external reports currently being manually prepared, such as Small Business Administration and Depressed Labor Area reports.

Corporate Annual Agreements—Considerable emphasis has been placed upon the benefits to be derived from a program to evaluate repetitively ordered materials for negotiation of annual procurement contracts with vendors. Price advantages are achieved due to the negotiating lever provided by a one-year volume of requirements and our overhead costs are reduced as a result of the minimal paperwork required to process requests for delivery against such orders.

To support this program, an IBM 1001 Data-Phone has been installed, providing us with the ability to transmit requests for delivery to our vendors, via punched-card media.

In addition to the above, programs relative to price analysis, price targeting, vendor liaison activities and improved materials handling techniques, are also in work in an effort to achieve procurement benefits wherever they may exist. In the coming year we will continue along this vein in order to maintain our position of support to this company's high reputation for quality and performance. □

Punched cards go into the reader for rapid transmission of information via the Dataphone link direct to the vendor.

24 YEARS OF SALES, EARNINGS, AND DIVIDENDS

FISCAL YEAR	GROSS SALES	NET EARNINGS	FEDERAL TAXES	CASH DIVIDENDS
1941	$ 1,493,488	$ 295,471	$ 256,885	$ 22,500
1942	6,665,913	429,867	700,926	326,250
1943	39,099,742	883,826	3,073,886	435,000
1944	70,658,893	1,825,703	3,443,483	435,000
1945	53,081,803	1,066,837	3,289,889	435,000
1946	6,069,100	390,043	521,748	——*
1947	7,163,483	372,563	214,221	——*
1948	7,828,581	503,571	281,000	——*
1949	24,674,488	1,233,709	742,000	——*
1950	27,869,112	1,455,155	909,000	84,323
1951	26,233,548	968,108	1,442,000	454,707
1952	41,322,184	1,151,811	2,600,000	600,000
1953	63,005,624	1,533,285	3,573,000	600,000
1954	101,604,448	3,510,811	5,175,000	750,000
1955	82,407,804	3,269,009	3,535,000	990,000
1956	90,027,159	3,144,634	3,500,000	1,260,000
1957	115,765,922	3,727,737	4,000,000	1,260,058
1958	147,538,056	4,022,474	3,930,000	1,310,881
1959	191,703,998	2,586,300	2,509,154	1,649,454
1960	193,249,182	(2,604,375)	(2,476,720)	1,854,405
1961	168,170,217	5,350,678	5,824,712	1,899,878
1962	151,010,265	4,975,500	5,402,994	1,979,737
1963	104,164,095	2,033,287	1,745,861	1,993,731
1964	128,537,039	2,615,632	2,832,235	1,996,975
1965 (9 mo.)†	116,822,906	3,293,782	3,207,967	1,504,766
	$1,966,167,050	$48,035,418	$60,234,241	$21,842,665

* *Rohr became a subsidiary of international Detrola Corporation (Newport Steel Corporation) split off to again become independent entity in 1950.*

† *Rohr's fiscal year ends July 31. At press time for this issue, latest available figures were for the 9-months ended April 30.*

The Financial Record

25 YEARS OF PROFITABILITY

IN ITS first 24 years and nine months Rohr Corporation's net earnings were $48,035,418, on sales of $1,966,167,050. It paid $60,234,241 in federal income taxes, and $52,800,000 in state, local and payroll taxes. In the same period shareholders received $21,842,665 in cash dividends, one 100% and two 50% stock splits, and two 4% stock dividends.

The final quarter of the 25th fiscal year ends July 31, and figures for the fourth quarter were not available when this issue of the Magazine went to press.

The adjoining table gives a year-by-year record of the sales, net earnings, federal taxes, and cash

BY W. I. MATHEWS
Vice President-Finance

dividends.

In addition, the Company has paid, during the same period, a total of $908,840,982 in wages and salaries. The payroll now is approximately $5,000,000 a month.

Cash dividends have been paid every year except four (1946 through 1949) when the Company was a subsidiary of International Detrola Corporation (later Newport Steel Corporation). It has earned a profit every year except in 1961, when tooling and pre-production costs on a new transport program exceeded estimates and caused a loss of $2,604,375.

Despite the loss, however, the Company continued dividends of 25 cents a share per quarter, and the following year net earnings bounced back to $5,350,678, highest in corporate history.

FRED H. ROHR
Chairman of the Board and Chief Executive Officer

B. F. RAYNES
President and General Manager

I. M. LADDON
Director

B. P. LESTER
Director

GUY M. HARRINGTON
Treasurer

The Board of Directors

JUDGEMENT AT THE TOP

FRED H. ROHR

CHAIRMAN OF THE BOARD AND CHIEF EXECUTIVE OFFICER, founded the Company in August, 1940, after 15 years in executive positions with Boeing, in Seattle, Solar, and Ryan companies in San Diego. Born in Hoboken, N. J., he moved with his parents to San Francisco, where he attended school. After serving in the Navy in World War I, he joined his father in the sheet metal business at Fresno, and later formed his own sheet metal works in San Diego. He is a Director of the Security-First National Bank of Los Angeles, belongs to numerous technical organizations, and is active in civic and cultural activities in San Diego. He and his wife, Shirley, live at 555 San Fernando St. They have a son, Frederick Jr., a Vice President of the Company, and a daughter, Mrs. Keith Hollenbeck. His hobbies are golf and deep sea fishing.

B. F. RAYNES

PRESIDENT AND GENERAL MANAGER, joined the Company in October, 1940, as chief inspector. He moved up through positions as tooling superintendent, several management positions with International Detrola during the time Rohr was a subsidiary, and back at Rohr as chief tool engineer, vice president-manufacturing, senior vice president. In 1961 he was elected to the Board of Directors and in December, 1963, to his present position. He has held leading positions in many professional associations, including the Aerospace Industries Association, Society of Automotive Engineers and California Manufacturers Association, as well as in civic, political and social organizations. Born in Clinton, Indiana, he is a mechanical engineering graduate of Rose Polytechnic College. Mr. and Mrs. Raynes and their son and daughter live in a suburban area east of Chula Vista.

I. M. LADDON

DIRECTOR, joined Consolidated Aircraft (now Convair) in 1927, after 10 years as chief of Design Branch, McCook Field. Designed famous PBY Catalina, the B-24, and other Consolidated airplanes. Became vice president and director of Convair in 1935, and from 1941 to 1948 was executive vice president. He is a graduate of McGill University, Montreal, in 1915, received a Doctor's degree in 1957. He also is a director of General Dynamics, Servel, First National Bank of San Diego, Langley Corporation. He has two sons and a daughter, and lives in San Diego.

B. P. LESTER

DIRECTOR, senior partner of Lester, Ryons & Co., investment bankers, first became a director of Rohr Corporation in 1942, and in 1944 was elected Vice President and Chief Financial Officer. He resigned in 1945 when Rohr became a subsidiary of International Detrola Corporation (later Newport Steel), but again became a director in 1950, after Rohr again became an independent corporation. He is a member of the New York Stock Exchange, and the Pacific Coast Exchange. He has two sons, and lives with his wife in Pasadena, Calif. He is a director of several corporations.

GUY M. HARRINGTON

TREASURER, Member of the Board of Directors, joined Rohr on Oct. 1, 1940 as an accountant. He advanced from accountant to controller to treasurer and member of the Board of Directors. Harrington is treasurer and a director of the San Diego County Association for Retarded Children, and an active member of the tax committee of the California Manufacturers Association. For many years a competitive small boat sailor, Harrington now devotes most of his spare time to golf. □

F. E. McCREERY

A. F. KITCHIN

W. I. MATHEWS

S. W. SHEPARD

Veterans Give Stability on 'Mahogany Row'

J. L. HOBEL

K. W. GOEBEL

F. H. ROHR, JR.

C. E. CANTWELL

F. E. McCREERY, *Senior Vice President, received his Bachelor of Science Degree in Mechanical Engineering from the California Institute of Technology. He worked as design and project engineer at Ryan Aeronautical Company, then joined Rohr in August, 1940, as Assistant Chief Engineer. He moved up to his present position in December, 1964, after serving the company as Executive Chief Engineer, Vice President of Engineering, and Vice President of Manufacturing. He is an officer in the Society of Automotive Engineers, and is General Chairman of the 1965 National Aeronautic and Space Manufacturing Meeting. In the Aerospace Industries Association he serves on the Executive Committee of the Manufacturing Committee, and as Liaison Representative of the Manufacturing Committee, Liaison with Quality Control Committee. He is also a member of the American Institute of Aeronautics. He is active in the Boy Scouts of America. The McCreerys have three sons, ages 8, 9, and 10.*

A. F. KITCHIN, *Vice President-Administration, is a native of San Diego County. He studied at University of California, Los Angeles, Balboa University, and University of California Extension courses. After serving in the Navy four years, he was employed by the San Diego County Water Company, the Lake Henshaw Resort, and Nuttall-Styris Company, a San Diego wholesale hardware firm. He joined Rohr in December 1940, as a buyer in the Purchasing Department, advancing to Production Coordinator, Assistant Production Manager, Production Manager, and in 1953 was elected Vice President. Golf, fishing and Hi Fi are his hobbies. He and Mrs. Kitchin have two daughters in college, and a son attends junior high school.*

W. I. MATHEWS, *Vice President, Finance, came to Rohr with a background in accounting and banking. He received his B.A. degree in Business at the University of California at Los Angeles, and obtained his Certified Public Accounting Certificate in 1949. After six years at the Security First National Bank in Los Angeles, he became Senior Auditor for the John F. Forbes Company. In 1952 he joined Rohr as Accounting Manager at the Riverside plant, where he remained until 1959, when he was returned to Chula Vista as Controller for the Corporation, and was elected Vice President in 1963. Mr. and Mrs. Mathews and their family of six children reside in Chula Vista. He is a member of the governing body of his local church, and a member of the National Association of accountants. Working with amateur radio equipment is his hobby.*

S. W. SHEPARD, *Vice President, Corporate Secretary, and Legal Counsel, was born in Canada and received his B.A. and Law degrees from the University of Arizona. He was in private practice from 1938 to 1942. In September, 1942, he entered the Planning Division of Rohr, and moved quickly to supervisor of Allocations. Within a year he was a Department Head, then became Staff Counsel and Corporate Secretary. In 1963 he was elected Vice President, while retaining his work as Secretary and General Counsel. Mr. and Mrs. Shepard's first son is a Chemist for Southwest Radiological Laboratory, in Las Vegas, while the second son studies Mechanical Engineering at the University of Arizona. Mr. Shepard is a member of the Health Planning Commission of San Diego, the United Community Services, and the Budget Committee of the San Diego Taxpayers Association. He is a member of the California and Arizona State Bar Associations.*

J. C. THOMPSON

C. L. LIGHT

R. D. HALL

H. R. CLEMENTS

J. L. HOBEL, *Vice President, Industrial Relations, joined Rohr in 1940 as a clerk in the Controller's Office, but was soon promoted to Secretary to the Controller, then Office Manager, Labor Relations Manager, Director of Personnel and Industrial Relations Manager, and Vice President in 1963. He has served on school boards and chambers of commerce, and was Councilman and then Mayor of Chula Vista from 1950 to 1954. He originated supervised Halloween programs for children, and the Rohr Halloween Carnival. He also has participated in local and state welfare councils, and as chairman of San Diego's Committee for Employment of the Handicapped. He is a golfer, loves to travel, and work in his carpentry shop. Three children and nine grandchildren provide Mr. and Mrs. Hobel with even more interests.*

K. W. GOEBEL, *Vice President, Engineering, was born and educated in San Diego. While attending San Diego State College, he worked at Solar Aircraft Company as draftsman, Design Engineer, and Eastern Engineering Representative. After war-time service in the Navy, he became Senior Designer at Ryan Aeronautical Company. He joined Rohr in 1949, where he moved up from Project Engineer, to Design Engineering Manager, Engineering Manager, and Chief Engineer. He was elected to his present position in 1963. He has served on the San Diego Industry Education Council, the Board of the San Diego Science Fair, and is a member of the San Diego Yacht Club and the Point Loma Civic Association.*

J. C. THOMPSON, *Manager, Auburn Plant, a native Californian, became a Tidewater Oil Company salesman upon completion of his education. He joined Rohr in 1942 as a mechanic in the B-24 Engine Line, was promoted to Assistant Foreman, Foreman, and Assistant Factory Superintendent. In 1956 he was selected to open the Auburn, Washington, assembly plant. Mr. and Mrs. Thompson have one son, age 19, presently in Junior College. Mr. Thompson is first Vice President of the Auburn Chamber of Commerce and will be President in 1966-67. He was President of Auburn Kiwanis Club in 1963, and was Board member for his county's Y.M.C.A. He is also board member for the Association of Washington Industries. For recreation, he golfs, (in the low eighties), swims, bowls, and plays tennis.*

F. H. ROHR, JR., *Vice President, obtained his A.B. degree in Engineering at San Diego State College in 1948, then did graduate work in the School of Business at the University of Southern California. He worked during the summers for Rohr while still in school, starting as a draftsman in 1940, and made the drawings for the original Rohr drop-hammers. In successive summers he worked in trim and drill and primary fabrication, then on the B-24 Motor line assembly. He was in the U.S. Air Force from November, 1942, to January, 1946, later became Staff Assistant, Patent Department Supervisor, Budgets and Forecasts Supervisor, Assistant to the Vice President, Assistant Vice President, and in 1963, Vice President. Mr. and Mrs. Rohr have four daughters. He has been a member of the Board of Directors of the Chula Vista Chamber of Commerce, and is a member of the Society of Automotive Engineers and of Aerospace Museum, Incorporated.*

C. E. CANTWELL, *Vice President, Manager Riverside Plant, joined Rohr in 1958, after a long connection with the aircraft industry. He served as Plant Manager of the Ford Motor Company's Aircraft Engine Division in Chicago, and Chief Test Engineer at Ford's Dearborn plant. He was affiliated with the Federal Aviation Administration for four years, and served during the war as an officer assigned to the Navy Bureau of Aeronautics. He started at Rohr as Assembly Superintendent, was promoted to Assembly Manager in 1960 and to Plant Engineering Manager in 1962. In 1963 he became Plant Manager at Riverside. He was elected Vice President in December, 1963. He is a member of the board of directors for the Riverside Chamber of Commerce and United Fund, and is on the District Council for Junior Achievement. The Cantwell's son, in the Army, is stationed in Germany but will return this year. They have two daughters, 9 and 12. Mr. Cantwell's hobby is golf.*

C. L. LIGHT, *Manager, Winder Plant, served in the Navy and at Ryan Aeronautical Company before joining Rohr in June, 1942, as an inspector. Since moving to Winder, Georgia, he has been active in community affairs, is a member of the Georgia State Chamber of Commerce Council on Business and Industry, Chairman of the county Industrial Development Authority, member of the Airport Authority, and Vice-chairman of the Winder City Planning Commission. He served as Chairman of the Barrow County Heart Fund and worked on the Re-development Administration. The local Jaycees voted him Outstanding Boss of the year in 1964. He is a member of the Elks Club, and enjoys hunting, golf and reading. Two step-sons live at home with Mr. and Mrs. Light, while a daughter resides in New York.*

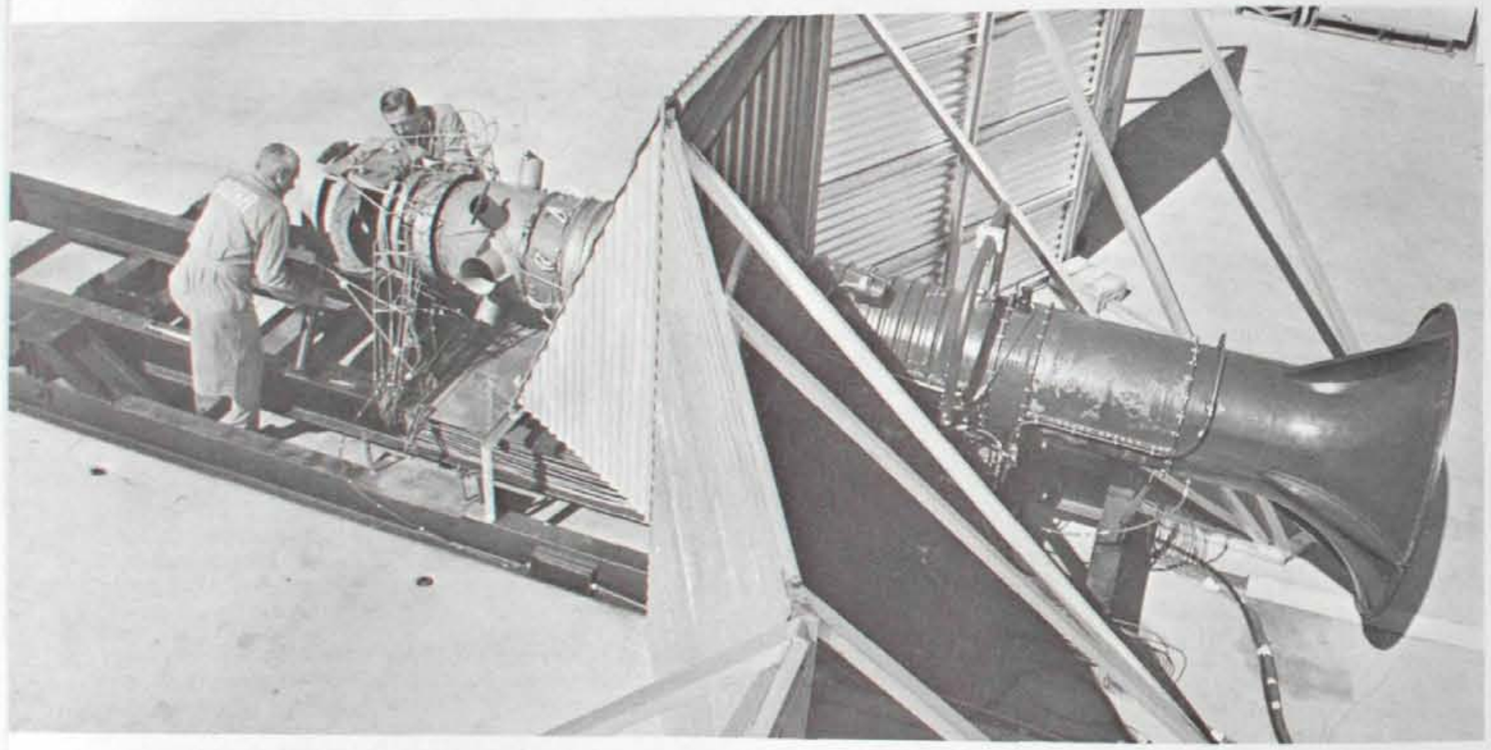
R. D. HALL, *Engineering Manager, Antenna Division, has been active in the development of the Antenna Field at Rohr and in his previous positions at American Bridge Corporation and Blaw-Knox Corporation in Pittsburgh, where he was responsible for design engineering, field coordination, and supervision during erection of antennas. He joined Rohr as Antenna Engineering Manager in 1960, when the Company first entered the Antenna structures field, became head of the Antenna Division when it was formed in 1963. He studied at the University of Maryland, University of California at Berkeley, and Carnegie Institute of Technology. He enjoys golf and swimming. The Halls' children are 18 and 9, both daughters.*

H. R. CLEMENTS, *Manager, Space Systems Division, had a varied career in the aircraft industry before joining Rohr in 1961. At Cessna Aircraft Company he became Chief of Aerodynamics of the Military Division, then Chief Technical Engineer. At the Wichita Division of the Boeing Airplane Company he worked on Advanced Design. At Rohr he has been Development Project Engineer, Chief of Technical Staff, and Engineering Manager for Development, before assuming his present position. He participates in a local flying club, sails, swims, and collects jazz records for the Hi Fi unit he assembled himself, as well as raising his six children, who range from 5 months to 10 years in age. He belongs to professional and honorary societies, has published various articles and given several presentations before professional conferences.*

'Short Order' Engineering

SCIENTIFIC DISCIPLINES CHANGE BUT PHILOSOPHY REMAINS GEARED TO CUSTOMER

By K. W. Goebel
Vice President-Engineering



A Propulsion Components Test Facility designed and built at the Chula Vista Plant, around a modern turbojet engine, makes possible a variety of "hot end" environmental studies.

ALTHOUGH Rohr aerospace engineering efforts have made substantial technological strides and have broadened into many diverse scientific disciplines, they are tied just as closely as ever in the past to the task of meeting known or anticipated customer requirements.

In the 25 years of Rohr's history as a subcontract supplier of structural components, the company's engineering and research efforts have grown with the mushrooming technology of the industry as a whole. Increasing engineering capability in the product design area has accompanied the growth in the scope of manufacturing capabilities. Many current and forthcoming programs involve engineering responsibility.

A majority of our production programs today involve Rohr engineers working closely with customer engineering to produce sophisticated products designed to take advantage of ever advancing manufacturing techniques. The demand for such service is currently greater than ever before.

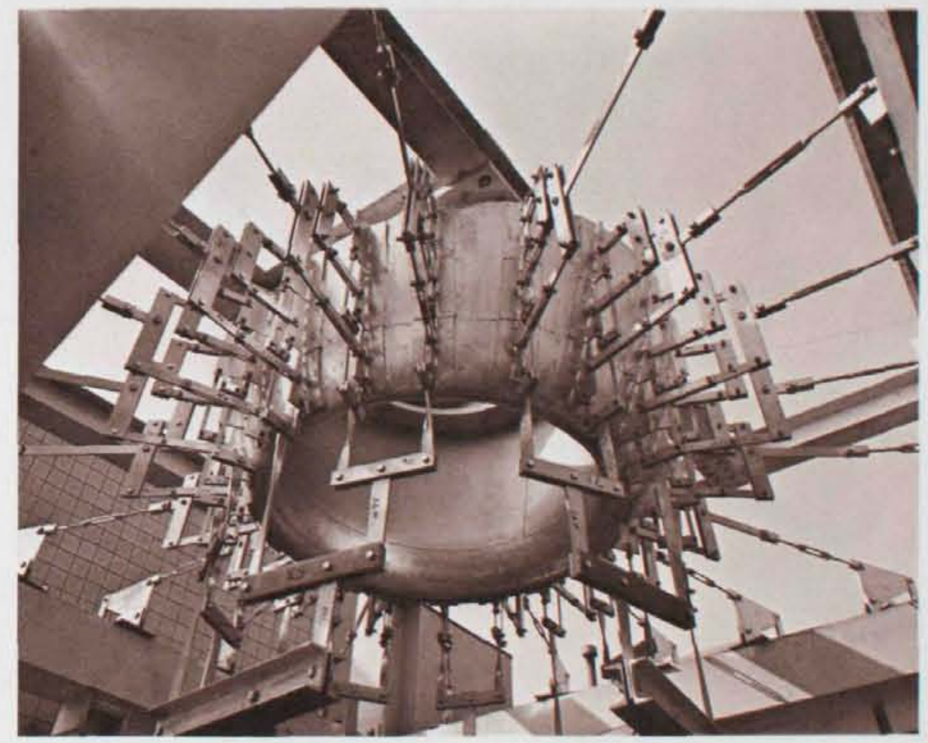
Rohr engineering is working with customers on several new aircraft not yet off the drawing boards, such as the American supersonic transport and the Air Force Heavy Logistics Transport, among others. The company's advanced engineering capabilities enhance Rohr's competitive position on such programs.

Self-generated, company financed research and development efforts have resulted in design innovations and, in some cases, proprietary designs on such aircraft components as thrust reversers, brazed and bonded honeycomb structures, welded structures and complete power packages and pods.

In the main, however, research work has contributed to the scope of customer research—supplementing that research in the particular areas of Rohr specialization.

Thus, despite the company's traditional role as a subcontractor, it is no longer possible to confine reearch efforts as closely as in years past. The company's specialization in the manufacture of propulsion components, which has advanced from the piston engine through the propjets, turbojets, turbofans and rockets has confronted Rohr research with an array of new problems involved in the progress to supersonic aircraft applications.

Installation of a propulsion components test facility during the past year illustrated such new research requirements. Rohr engineering faced a whole new field of propulsion components test applications.



Elaborate test setup on a DC-9 cowling.

Some of the recent and current programs illustrate the nature and variety of studies required to maintain a competitive position in this rapidly advancing field.

Recent studies have involved evaluation of high temperature bearings and lubricants to determine suitability for use at the "hot end" of propulsion units. Another recent program called for testing of jet engine vectoring systems and still another involved the flow characteristics of thrust reversal equipment attached to the ejector nozzles of supersonic aircraft.

Studies of structures for supersonic applications have been a major requirement, since the company intends to participate substantially in forthcoming SST programs. Among the studies have been applications of titanium alloys in structures for supersonic aircraft and the use of electron beam welding in the manufacture of such structures.

Another timely research effort involves preliminary design and testing of thrust reversal systems for high-by-pass-ratio, long range engines for transport type aircraft. Since thrust generated by the fan is several times that of the tailpipe, reversing only the tailpipe air as in many present systems will not suffice for these engines.

Advancing requirements in propulsion components has resulted in demands upon Rohr engineering for increasing depth in the area of aero-thermodynamics, and sonic structural fatigue, high temperature structural materials, and others. In order to meet such demands, the company has developed — and recruited — personnel in specialized technologies. This increase in technical talent, plus the supplementation of research and test facilities, has produced a new level of capability equal to the new problems. This means a generally greater scope of ability to handle the total engineering package on the components Rohr builds.

For regardless of the technology involved, Rohr's primary objective is to meet the needs of the customer, whether the program calls for manufacture to customer design, structural design, or complete package projects involving research, systems selection and other technical services. □

'Short Order' Engineering

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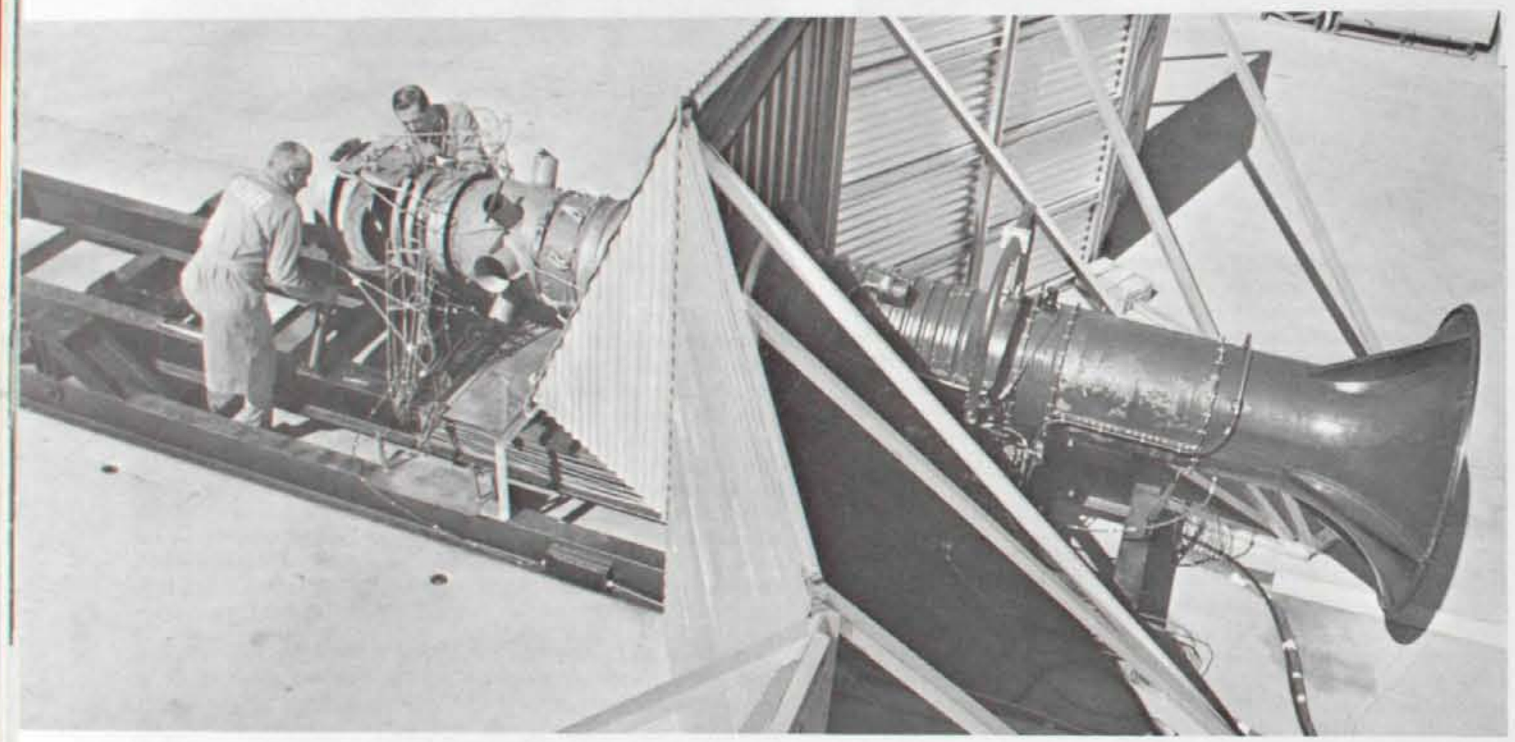
Vice President-Engineering



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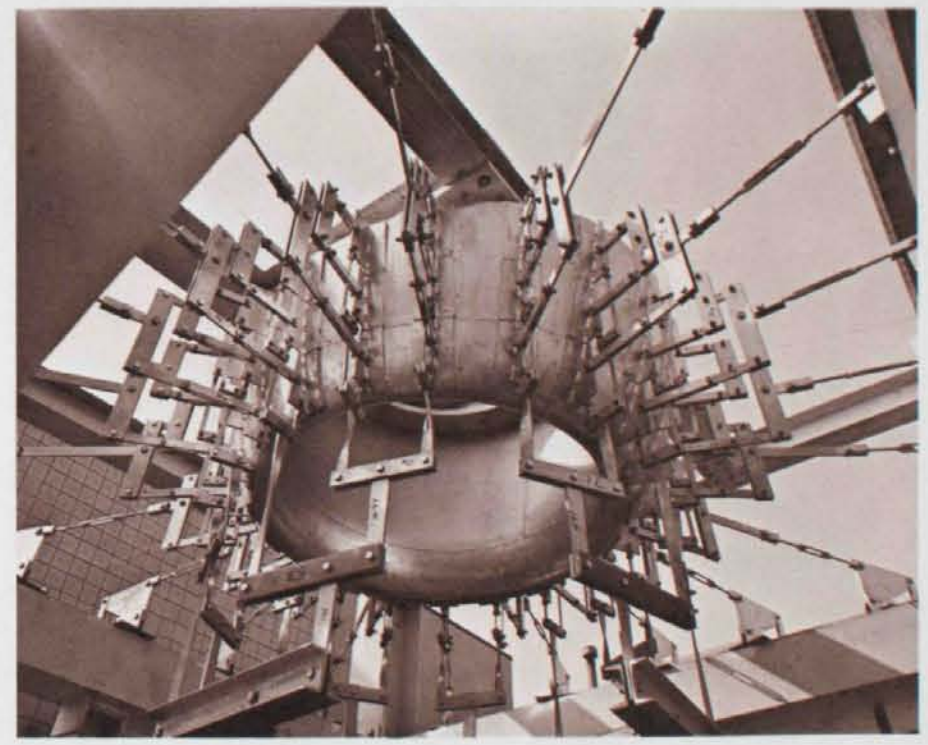

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The Critical Eye

QUALITY CONTROL TECHNIQUES KEEP PACE WITH CHANGING TECHNOLOGY

By I. Dagan
Director of Quality Control

WITH rapidly increasing trends towards automatic manufacturing methods, spearheaded by technical advancements in numerical manufacturing procedures and equipment, it is necessary for Quality Assurance to plan procedures and programs compatible with the manufacturing techniques.

Close coordination with the manufacturing program is being maintained to assure that the Quality Assurance program is developed properly to supplement the advances in manufacturing techniques, and to verify that a continuing high quality level is maintained. The modernization of Quality Assurance techniques applies to the fabrication of tooling as well as production components.

A recent and highly successful venture in this area involved the inspection of panels constructed to form the reflecting surface of a large antenna. All tools required to produce these panels were manufactured on numerical, tape-controlled machines, and the panel surfaces were required to maintain a high degree of accuracy relative to the theoretical curvature required for efficient antenna operations.

In order to verify this accuracy the panels were positioned on a numerically controlled machine in the same manner that they would later be installed on the antenna. The machine was then moved numerically to predetermined positions on the panels and measurements were taken and recorded automatically through a print-out system. This printed data was then analyzed to determine the actual accuracy of the antenna reflecting surfaces. In addition to obtaining the accurate measurements necessary, the data provided by the print-out system supplied automatic documentation of product acceptability.

A Zero Defects program has been established to obtain the participation of all levels of plant activity in producing quality products in order to enhance our competitive position in the industry. This program is pointed toward motivating people to perform properly the first time, and to develop pride and satisfaction in that accomplishment. The program takes the positive approach of recognizing exceptional performance with the intent of continuously improving craftsmanship.

In order to determine the results of this program throughout the factory, existing levels of quality were established and improvement is measured relative to those levels. This measurement is displayed in the various areas in the form of trend charts intended to advertise and recognize improved quality.

X-ray inspection techniques have been developed to a high level to make possible thorough inspection of such components as this large stainless steel honeycomb sandwich panel.

In order to insure the high quality expected in our extensive manufacture of brazed honeycomb structures, nondestructive testing techniques such as In-motion Radiography, Ultrasonic Inspection, and Thermographic Inspection are utilized, as follows:

In-motion Radiography: X-ray units designed in such a manner that the x-ray head moves over the part, creating a radiograph that clearly defines all the internal characteristics of the part being examined.

Ultrasonic Inspection: Method by which sound or energy is introduced into a part, and the reflected energy is measured. Dissimilarities within the structure are noted on an oscilloscope, or can be reproduced on a chart for evaluation.

Thermographic Inspection: Part coated with a special material which, when heated to a controlled temperature, will clearly portray the braze pattern.

Many types of electronic equipment are in daily use for checking of material thickness, organic and metal coatings, as well as for the examination of material for internal discontinuities and composition. An innovation followed by Quality Assurance is the use of portable dictating equipment for the recording of defects on major assemblies, which has resulted in reduced inspection costs. □

A Changing Scene In Manufacturing

By E. A. WHITE
General Superintendent of Production

DESPITE the growing complexity and technological advances of the aerospace industry, Rohr Corporation's success today — as throughout its history — is based upon the company's ability to build what the customer requires, on time and at a competitive price.

Within this basic philosophy, there is a constant and continuing effort to advance the "state of the art" in manufacturing areas. Typical of this effort is the increasing emphasis on conveyorized assembly and sub-assembly. Monorail engine lines are the rule now on all of the major programs involving propjet, turbojet and turbofan pod assembly.

The continued importance of conveyorized sub-assembly is based upon significant cost reduction and improved work flow. Experience with a variety of systems through the years has led to refinement of the conveyor systems. The philosophy of locating an employe at a work station with work flowing to him in "kit" form still exists. However, innovations such as automatic riveting equipment have increased efficiency on long-run sub-assembly operations.

Sequence of build has been re-emphasized, as well as scheduling required parts, tools and planning into the conveyor line. Positioning of operations to be performed by the worker has enabled realization of 15 to 20 percent reduction in man hours on suitable operations.

Further increases in efficiency may be expected through introduction of numerically controlled assembly machines into "on-line" operations. Such a machine, a numerically controlled automatic riveter, is under development and has shown a high degree of reliability—both in its riveting operation and in its ability to make its own control tapes for future operations.

This six-axis machine is designed primarily for the numerically controlled riveting of skins to structure on complex, compound-contoured cowl panels and is one of Rohr's first steps into the company's new "auto-production" philosophy.

Conveyorized handling also has been introduced into the detail fabrication of parts. A recently installed in-line flow conveyor system has resulted in a more expeditious and continuous flow of parts within the Trim and Drill Department. Patterned after the sub-assembly conveyor system, this new system has produced substantial savings in material handling, internal transportation and space utilization. Improvements in housekeeping, efficiency and cost are noteworthy.

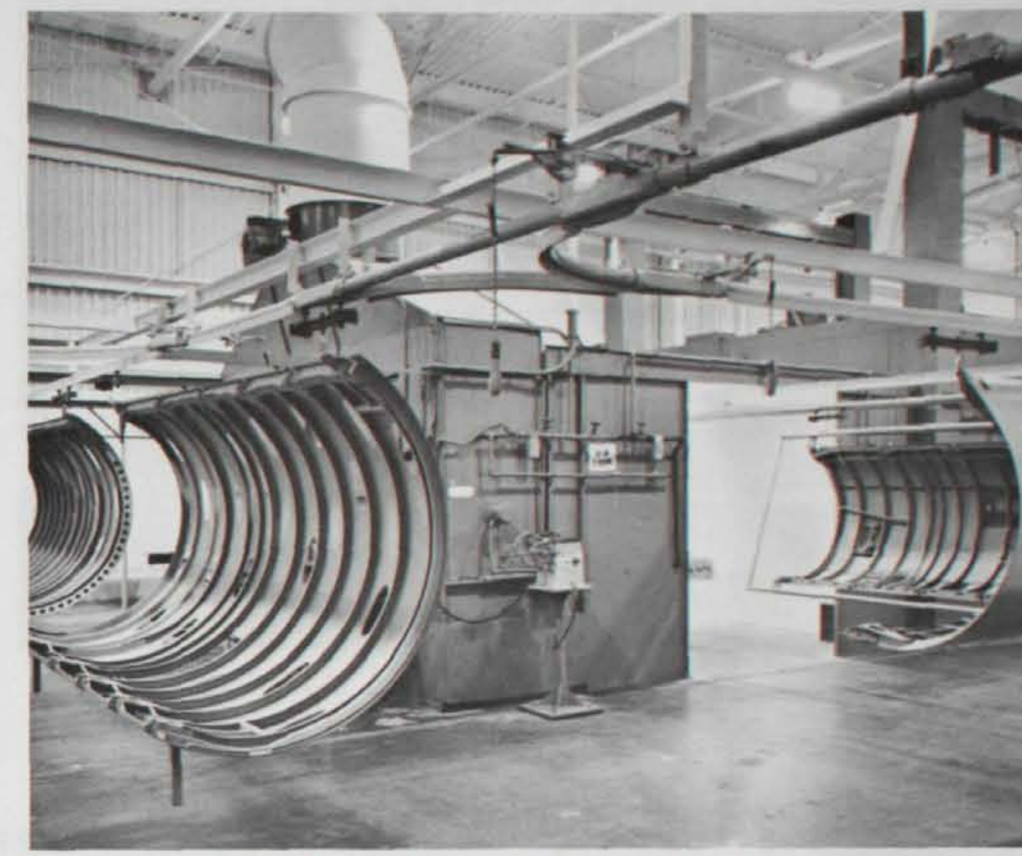
A mechanized planning system scheduled to go into operation later this year will be utilized in conjunction with the computer facilities for ordering quantities of parts to support scheduled needs. Considered a highly advanced system, it will assure compatibility of tools, parts, material and, in most instances, will guarantee methods of manufacture prior to trial. Installation of this mechanized planning system is expected to reduce costs of planning by some 30 percent.

In another significant step toward meeting anticipated demands of the industry with automated production techniques, the company has studied and determined the feasibility of numerically controlled welding machines. Basic design concepts were determined and it is anticipated that this concept of automatic, numerically controlled welding will play an important part in the rapidly advancing horizons of the aerospace industry.

Advances have been made in the welding of exotic type metals in atmospheric controlled chambers, while introduction of electron beam welding facilities also has enhanced manufacturing capabilities.

New equipment, both numerically controlled and conventional, and a steadily advancing technology keep the company's machine shop operations up with, and frequently ahead of, the demands of the industry. Machining titanium, columbium, beryllium, Hastelloy, maraging steel, Inconel, Rene'41 and even tungsten has become daily routine, and all of these are materials either unheard of or considered impossible a few years ago. □

Details moving through extensive roller conveyor system minimize material handling.



Boeing 727 nacelle panels move from work station to work station, in and out of bonding ovens, on overhead monorail system.

Close-up of parts "kits" on Trim and Drill Department roller conveyor system.

Largest bonded assemblies in the aircraft industry, the C-141 cargo doors enter the 15' x 35' autoclave for bonding on special-built tooling at the Rohr Space Products Division plant in Riverside.

BY H. C. EMERSON
Manufacturing Engineering and Tooling Manager

Tooling Techniques Set the Pace

NUMERICAL CONTROL, CONVEYORS, NEW PHILOSOPHIES MEAN COST REDUCTION

ROHR has made many substantial technological advances in Tooling and manufacturing Engineering within recent years in order to keep pace with developments in the aerospace industry.

In the field of engineering research, the application of new materials to honeycomb configurations has resulted in developing techniques for brazing high temperature Rene '41 and Haynes 25 honeycomb for use in missiles. Development of test data and improved design techniques has made possible production of the first steel honeycomb jet engine exhaust nozzles, used on the Lockheed C-141 aircraft.

Additional studies in the use of an in-flight thrust reversers have provided valuable experience.

Presently in development are new methods for high temperature resistant adhesive bonding of magnesium, aluminum, stainless steel, titanium and fiberglass to achieve greater strength with less weight at elevated temperatures, in aircraft and missiles.

Three 8' diameter by 22' long and one 15' diameter by 35' long autoclaves with automatic recording and programming controls are now in use. Bonding pressures can be infinitely varied to a maximum of 250 pounds per square inch. An additional 15' x 35' autoclave is being added to our facility and is expected to be in operation by early 1966.

We are presently manufacturing approximately 500 different metal bonded assemblies varying in size and complexity from small two part assemblies to large bonded assemblies, comprised of hundreds of detail parts.

Successful bonding of the 9' x 28' cargo doors for the C-141 has made Rohr producer of the largest compound contoured bonded honeycomb assembly yet manufactured.

Other research in bonding beryllium and titanium, the use of resistance heated adhesives, and development of methods for producing large bonded honeycomb structures has resulted in enhancing both Rohr's bonding capabilities reputation, and has been instrumental in obtaining production contracts on aircraft, helicopters, missiles, and space vehicles.

Electrical discharge machining employs the erosion principle for precision material removal, and is successfully used in the machining of honeycomb core.

Essentially, EDM uses an intermittent high frequency spark to remove material, submerged in a non-conductive or dielectric fluid.

The primary advantages of electrical discharge machining of the honeycomb core lie in the following areas: the electrode, or cutting tool does not touch the work piece, hence, there is no danger of crushing or other damage to the core, metal removal is greater than for more conventional methods, and the configuration of the finished product is limited only by the ability to fabricate an electrode.

The precision and tracking accuracy of Rohr antennas have been improved by the development of a coating system which inhibits deflections due to temperature and corrosion variations.

Several programs for developing design data and manufacturing techniques, nondestructive test methods utilizing ultrasonic test techniques, and research results of welding heavy-gauge steel plate by submerged arc, metallic arc, electroslag, and metallic inert gas processes provide the information and techniques necessary to produce large rocket nozzle shells.

Mechanized planning, a system developed for writing planning into symbolics, then processing through a computer and high speed printer into a work sheet which can be used by production, practically eliminates the planning time spent writing routine and repetitious material. The system also provides for rapidly obtaining past information from planning such as engineering part numbers, etc. Mechanized planning is also used in connection with the computer system in speeding the ordering of parts. Quantities of parts can be ordered compatible with the scheduling system.

Rohr's ability to design and build tooling has required that we constantly keep abreast of new technology and in many cases develop our own techniques.

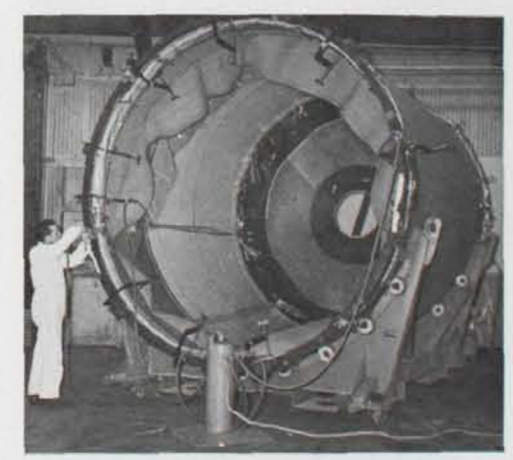
The development of plastics and ceramics has brought changes in several ways. The use of this material has replaced metals in many applications, resulting in more accurate contours, savings in costs and weight, and a substantial simplification of tool fabrication. Rohr's ability to manufacture tooling constructed from ceramics allows the production of honeycomb braze panels in almost any configuration. The use of ceramics in brazing fixtures has resulted in weight reduction of production assemblies through use of stainless steel honeycomb panels. The latest advance is the use of urethane plastics in forming tools.

Stretch dies for forming detail parts are now being built in tooling departments utilizing numerical control techniques which will in many cases eliminate the need for master models, reference patterns, and other tools.

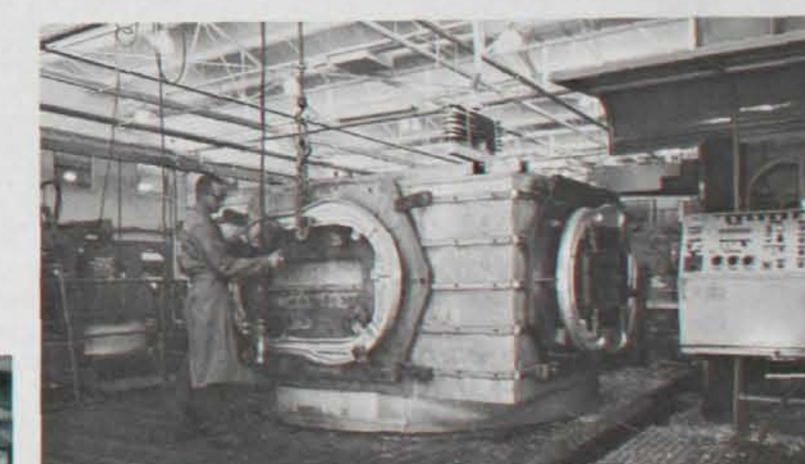
Standard tools are being developed for use on production machined parts which will reduce the requirement for special tools in individual parts.

The utilization of steel rule dies in the production of large blank parts has resulted in substantial savings over former methods of scribing, drilling, trimming and burring.

A new type punch, which is adaptable to our present tooling, has deleted the necessity for using drills

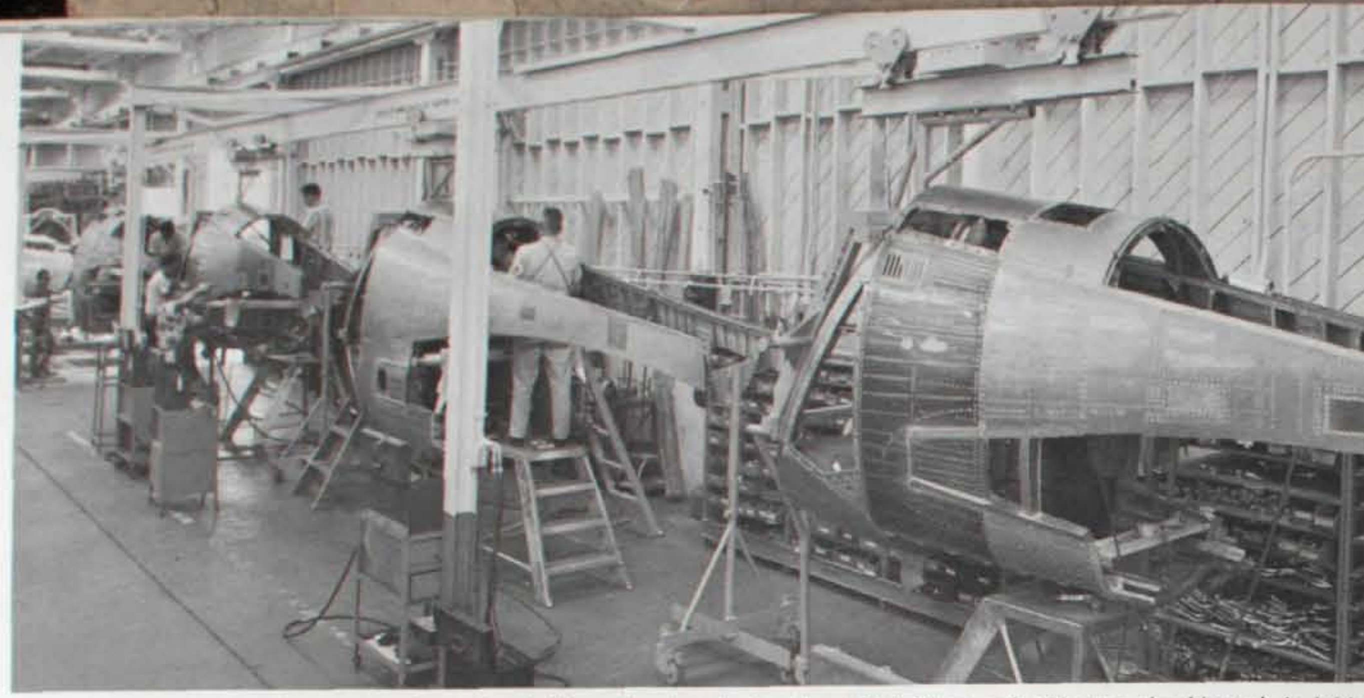


Locating tools for use in bagging an insulation segment for United Technology Center's 120-inch rocket motor case. The case is completely insulated in the propellant area.



The pentagon turret, located on a rotary table and capable of holding five large size tools, reduces down-time in connection with a numerically controlled milling machine, by allowing the operator to simultaneously load or unload parts during the milling operation without having to move the spindle to park position.

The use of electrical discharge machining in cutting stainless steel honeycomb core prevents crushing or damaging the delicate .001" to .004" thick cell walls while maintaining the necessary close tolerances.



Adaption of the monorail system to the engine build-up line for the Lockheed P3A Orion early this year should result in initial savings for the fiscal year of 2½ times the amount spent on initial installation costs.

in many of our detail parts. The hardness of the newer exotic steels makes the punch method more economical to use than the older drilling methods necessitating considerable re-sharpening of the drills.

We have expanded our horn routers to five machines, resulting in accurate trimming without using hand routers or router bucks.

Machining with carbide cutting tools has replaced high speed cutting tools in the majority of applications and has made possible the use of heat resistant high strength materials where required in tooling. Tracing equipment is now used on lathes and planer to machine contoured and complex configurations that previously were impossible.

Explosive forming through chemical or electrical energy release has made complex shapes practical to produce. Machining of these dies through numerical control process has reduced the handwork involved.

In welding, the latest methods have been adopted, including the use of a plasmarc cutting machine for aluminum and cres materials, while new optical tooling for accurate assembly of large tooling details has been employed. Precision measuring equipment such as gage blocks, optical comparators, large granite surface tables, bore gauges, and optical equipment are in common use.

Both crank and hydraulic presses are located in the die shop for tryout and development purposes. Other larger presses, and drop hammers, in use in the manufacturing area, have been utilized in the manufacture of thousands of aircraft parts.

A monorail system is employed in the form block department to service the routers.

The use of the monorail concept in the engine build-up line in the manufacturing area, provides better accessibility for installations, reduces congestion and eliminates the need to move mobile holding fixtures. With previous experience in the use of the system on the pure jet type engines of the C-141, DC-9, KC-135, 707, and 720B, Rohr recently implemented monorail facilities to include the P3A turbo-prop engine. Stabilizing outriggers were developed to overcome the new problem in stability required in this different type of engine.

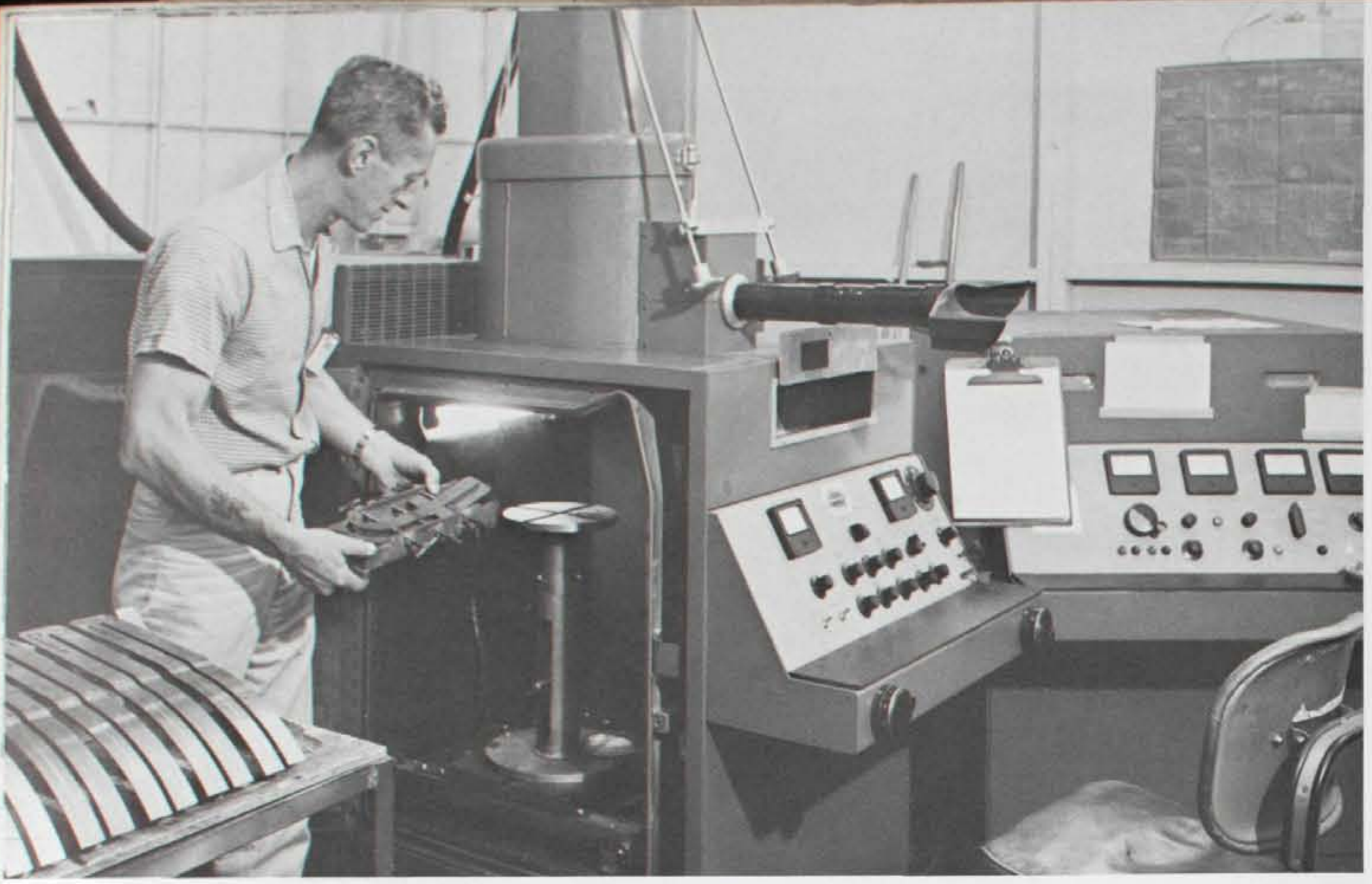
Other advances come from the use of numerical control machining for contour templates, which has increased the accuracy of model fabrication.

Four jig boring machines, vertical and horizontal, are in use which can hold two ten-thousandths accuracy. These have greatly increased our workload capacity, which operating from numerical data supplied by customers or compiled by our own programming group.

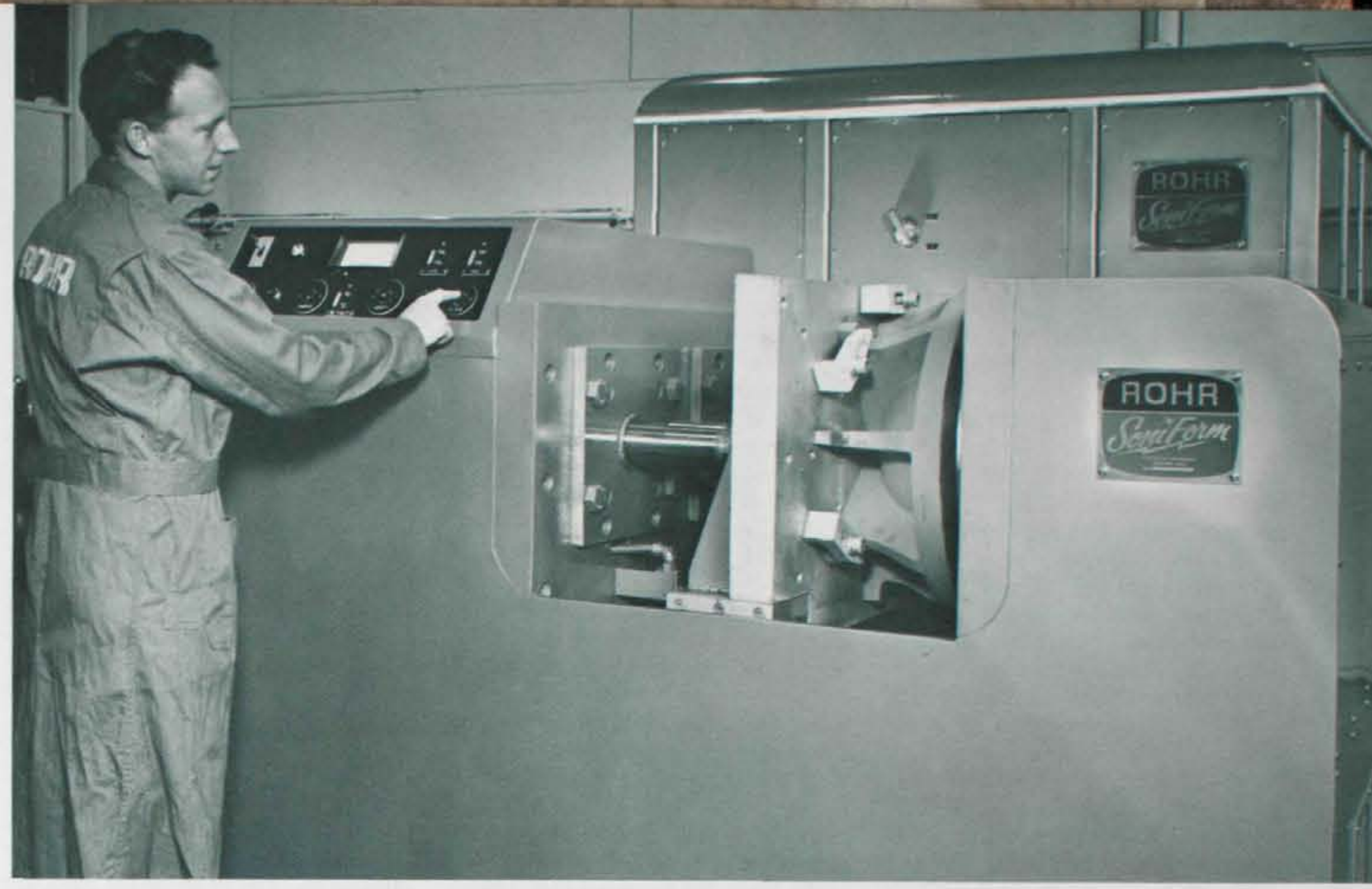
Numerical control machining has also proven useful for form blocks. It has resulted in more accurate and economical stretch dies to produce detail parts.

Rohr personnel developed programs to define mathematically and machine by N/C the header templates and longitudinal bars for all master tooling containing airplane contours as well as for many complex parts, difficult or impossible to machine by the older method.

The extended use of mathematically defined surfaces and the technical ability to manipulate such surfaces has contributed to a new manufacturing philosophy. The design of the product is no longer limited to conventional lines, points and circles, but now can utilize the use of conics, paraboloids, and mathematically defined surfaces. The production facility employs numerical control equipment to produce the desired part configuration without the requirement for highly skilled production personnel. However, quality assurance was the one factor which was not computerized or automated. Usages of the numerical control system in the area of quality assurance are now being developed. Present usage includes a "sweep-template" method on the 30′ antenna. □



Electron beam welding titanium track fittings. Manufacturing Research efforts have recently enlarged the capabilities of this and other electron beam equipment.



The Soni-Form, electrical discharge forming machine, is an outgrowth of Manufacturing Research efforts in the high energy forming area.

No Ivory Towers

'SHOP' PROBLEMS LEAD TO STATE OF ART PROGRESS

MANUFACTURING Research operations at Rohr are tied directly to the processes and problems of the "shop." Since research by its nature, however, tends sometimes to lead rather than follow, Rohr Manufacturing Research frequently reaches beyond immediate problems into accomplishments that constitute general advancements in the aerospace industry.

A major accomplishment of this type has been the development of the Soni-Form, a highly efficient electrical discharge forming machine. This machine, one of which has been sold, was the culmination of extensive research aimed at refining high energy forming processes to improve speed and eliminate or minimize environment problems. The machines are now in regular use in the Rohr-Chula Vista plant and have

BY H. M. RUSH
Chief of Manufacturing Research

attracted interest throughout the country.

Improvements in electric discharge forming were further advanced by such research programs as the use of magnetic coils for pulsed field forming and the development of mechanical sequencing systems for the Soni-Form machines.

With an eye to increasing water shortage problems around the world, studies have been made on the use of electrical discharge as a means of destroying bacteria in water — thus making waste water re-usable. Tests to date indicate essentially complete destruction of bacteria by this method.

Considerable attention has been given recently to forming problems involving unusual materials and configurations.

The unique development of one piece tapered tube of Hastelloy X now used in the DC-9 pneumatic system is another example of explosive forming technique constituting a major contribution to the state of the art. This tube previously had been made as a half stamping requiring five detail parts and much welding. Its fatigue life was short and was considered a major flight safety problem. Research conducted by Manufacturing Research resulted in a one piece detail having one longitudinal weld. The resultant assembly passed all engineering requirements and is now in flight use — and is being adapted for use on other new aircraft.

Contributions also have been made through development of forming techniques thin gauge corrugated panels of Rene' 41 for a supersonic transport application and in the forming of a sintered woven wire mesh material.

Intense research effort also led to development of effective welding techniques for this difficult mesh material.

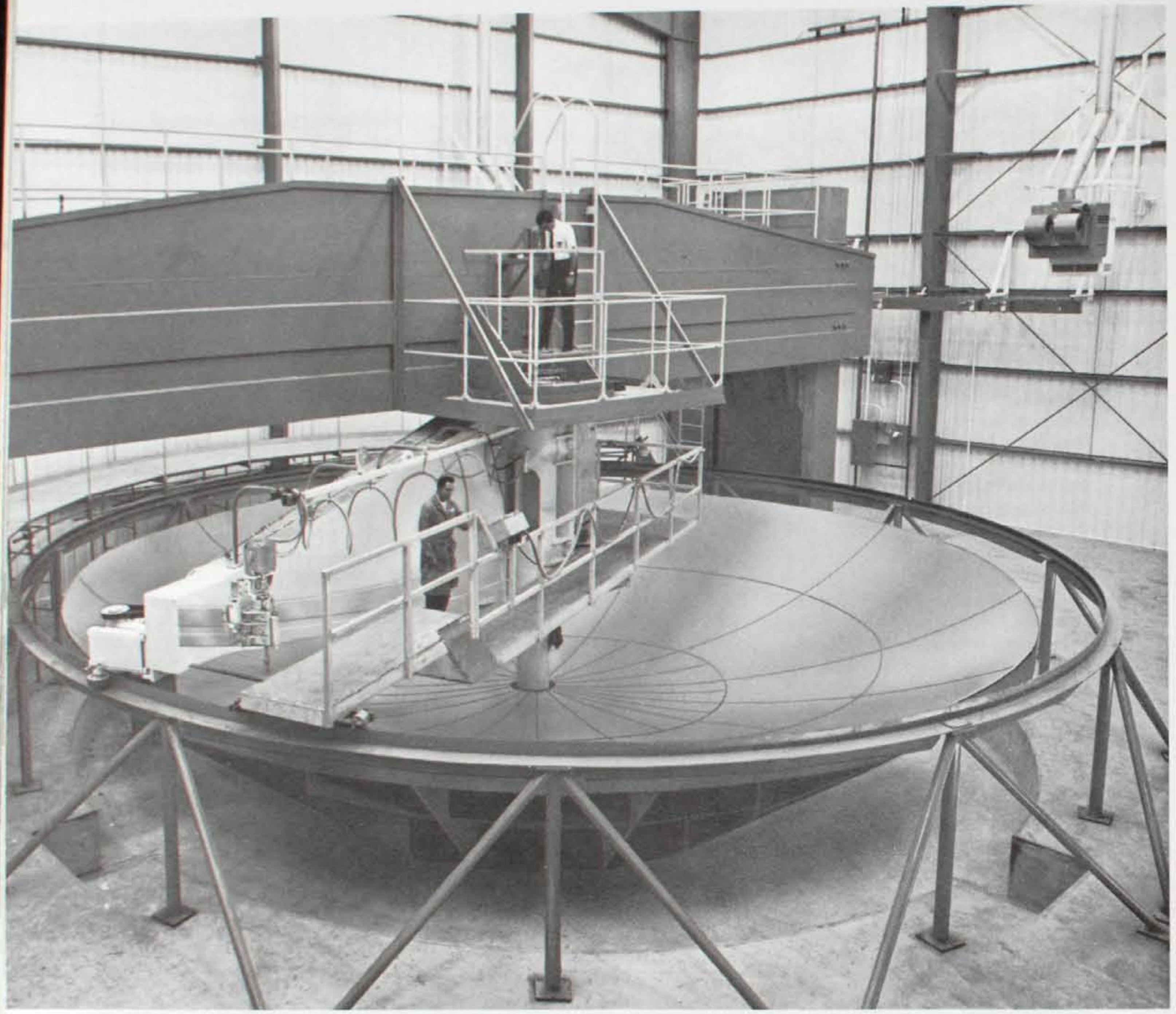
Research efforts also have enlarged the capability of the company's electron beam welding equipment. Under one sales order, special assemblies of tantalum and niobium were electron beam welded, illustrating the ability of this process to weld dissimilar refractory metals. The welds were sound and passed extensive gas spectrometer leak tests.

Substantial progress has been made in efforts to adapt electron beam welding for use outside the presently required vacuum chamber. Such a system would remove present size limitations imposed by the chamber and would allow electron beam welding on the assembly line. A "walking seal" device has shown promising results.

Techniques also were developed for the submerged arc welding of thick section maraging steel and Inconel 718. In both cases little practical information on weldability was available and research programs were necessary.

In the brazing field, the major contribution has been development of the Rohr Standard Retort (cold box) for use in vacuum brazing of honeycomb panels. Through procedures and parameters developed through research, cost reductions and quality improvements were achieved on both aircraft and rocket motor panels.

Investigation also led to successful brazing of Rene' 41 honeycomb panels and to development of techniques for brazing copper cooling fins to stainless steel radiator condenser tubes for Atomics International.



Numerical Lofting SPECIALIZATION SPEEDS PROGRAMMING FUNCTION

By N. O. OLESTEN
Chief of Numerical Control

A BOTTLENECK in the numerical control programming phase of fabricating tools and parts on numerical control equipment has been the process of transforming an engineering drawing to numerical data.

In the past, this task has fallen to the part programmer who, above all, must be knowledgeable about machining techniques and other machine shop practices. Thus, the special abilities required to transform a drawing into a mathematical definition of surfaces to be machined are necessarily secondary skills of a part programmer.

Often, the complexity of a tool or part requires a specialist, such as a loft engineer, to correctly define the surfaces forming it. Also, less complex parts could certainly be more efficiently defined by these specialists.

To realize the gains to be made through specialization, a procedure in which the engineering department will define their drawings numerically has been established. Under this system, loft engineers receive preliminary drawings from the designers, as they have in the past, for the purpose of making full scale undimensional drawings for use by tooling, fabrication, and assembly departments. Instead of making a graphic drawing, the loft engineer now writes a program to define the surfaces of the parts on the drawing. Further, he writes the statements necessary to operate a numerically controlled drafting machine which will produce the drawing to be used by the manufacturing departments.

During the definition phase of the loft engineer's task, the surface definitions have been preserved on magnetic tape. This tape is a master part definition—an extension of the master dimensions concept which is widely used today in the airframe industry. The numerical layout (NULO) is identical in appearances to the ordinary undimensional drawing. However, it is now only a graphic representation of the master part definition.

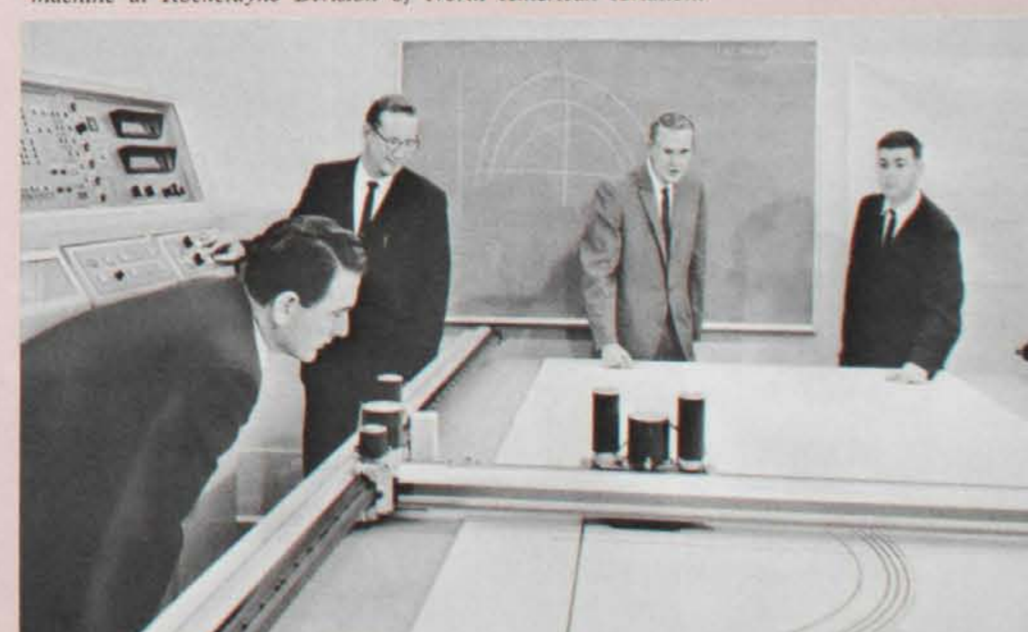
A part programmer now has the definition of the surfaces immediately available to him. He does not have to interpret a drawing, with the chance of misinterpretation, nor consult with a loft engineer for assistance in defining surfaces through methods with which he is unfamiliar. In short, the part programmer can concentrate on his specialty-generating control media for numerical control machine tools.

APTIII has been chosen as the programming language for this work because it is sophisticated and available. APT was written for machining operations however, and is not ideally suited for programming drawings. To adapt APT for this purpose, several supplementary routines are being prepared. Special routines to write, read and update the master part definition tape, to automatically define hole patterns, to calculate flange angles, and to develop form block contours are among these.

As described to this point, the NULO procedure depends on having engineering data in numerical form. Often, undimensioned drawings are received from our customers. These drawings must be transformed to numerical data as in the past. The procedure differs in that a specialist will do it, and he will be aided by an output device on the drafting machine. With this device, a drawing may be placed on the drafting machine table and by means of a joy-stick control and closed circuit television, coordinate values may be "picked up" from the drawing and automatically punched into paper tape. The data on the paper tape may then be utilized by the loft engineer to create a mathematical definition of the drawing, and finally a NULO to replace the customer's drawing.

Eventually, a complete system, identical in purpose to the NULO procedure, will be used throughout the aerospace industry. Our current system will meet our needs until a programming language directed to drafting needs is available. □

Rohr's numerical lofting techniques were developed and tested through use of this machine at Rocketdyne Division of North American Aviation.



Electronic Age Management

NEW TECHNIQUES PROVIDE BETTER OPERATIONAL INFORMATION

By Harry Goodell
Administrative Services Manager

The company's future competitive position depends, to a great extent, on the progress that can be made in developing a management information system that will assure that the tools of production both in machines and manpower are used to their greatest potential.

It is toward this end that the Data Processing Department has undertaken a long range total system plan. This system, utilizes data collection units located in all manufacturing and materials handling areas of the Chula Vista and Riverside plants where data is first generated. It will feed a continuous flow of new information directly into the central computer memory bank in order that all levels of management and operating personnel, with the use of visual display devices or typewriters hooked directly to the computer, will have access to pertinent information in its simplest, most usable form.

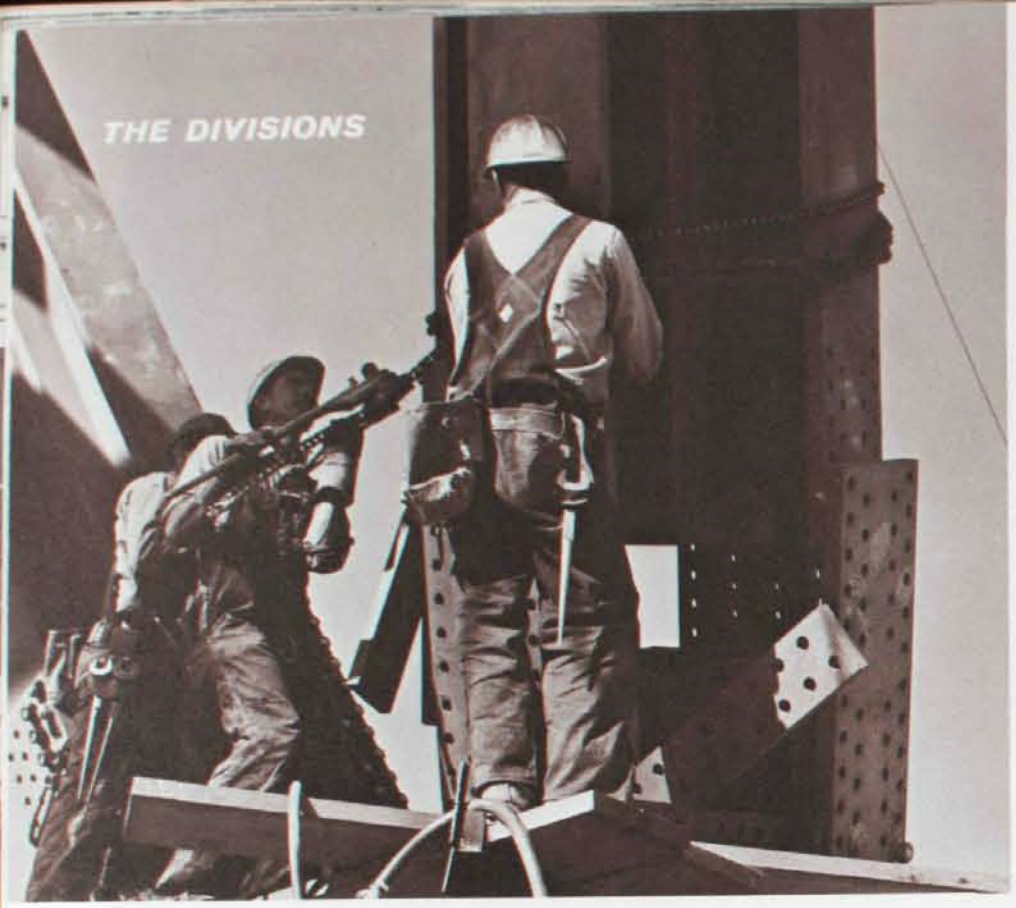
Management reports will be generated on an up-to-the-minute basis so that today's problems will be corrected today—not next week.

This system will expand mechanical data processing in the areas of engineering, manufacturing engineering, scheduling, materiel, and production and later, in quality and financial controls so that the computer, with its access to over one-half billion characters of on-line memory, will be able to coordinate a major portion of the information generated and required in these departments.

For example, as information about new or changed parts is collected from our customer's drawings and fed into the computer, the parts list along with other pertinent information required will become immediately available to the manufacturing engineers who determine how the part is to be manufactured. With the entry of the part construction information, a computer program will go to work to fit the manufacture of the part into the production schedule in accordance with the date the part is required. Material requirement data is then produced as a direct result of the part schedule. If the computer finds that the material is not in stock and not on order, it will be able to write a purchase order requisition which will be given to the Purchasing Department for their action.

The development of a realtime system such as Rohr envisions is extremely complex and will require a great deal of coordination with the departments involved. Most major companies are pursuing a similar course, though, to date, no one company has accomplished the entire task.

With the implementation of such a system at Rohr the benefits should result in increased management control and a shortening of the manufacturing cycle in order that we may improve our competitive position in a rapidly changing business environment. □



Steelworkers place heavy girders high on the structure of the 210-foot diameter tracking antenna being built by Rohr for NASA at the Goldstone Deep Space Station in the Mojave Desert.

Scale model of the "210," which will stand as high as a 21-story building.

Microwave relay (horn) antennas being shipped from the Chula Vista plant. Rohr builds these antennas under a contract from Western Electric Company.

Precision 85-foot steerable antenna built by Rohr for NASA and installed at Rosman, North Carolina.

A 30-foot diameter Az El antenna constructed by Rohr and erected at the Goldstone Deep Space Station.

Antenna Division

By R. D. Hall
Manager—Antenna Division

APPROXIMATELY four years ago Rohr entered the antenna structures field as one part of a corporate diversification program. Our decision was based upon the firm belief that a genuine marriage of aircraft and steel technologies, both in the design and fabrication areas, would be beneficial to the product.

Until that time, a majority of antenna structures had been built by steel fabricators and it had begun to appear that the requirements for accuracy were outstripping the "bridge-building" approach. To be sure, several aircraft firms had tried their hand at the antenna business but their efforts applied exclusively to aircraft technologies with little regard for the inherent structural steel aspects of the product.

As the first step in our program, Rohr management recruited a team of experienced antenna engineers. This nucleus was supplemented with talent from the aircraft side of the house—particularly in the areas of aerodynamics, optical tooling, computer analysis and dynamics. Concurrently, we began to analyze our steel fabricating needs. Following analytically detailed studies, we decided to create our own steel fabricating capability.

Our aim was to become competitive with the steel companies by installing a facility specifically designed for the production of antennas. Additionally, an in-house steel capability would allow us to infuse the results of our R & D efforts, our knowledge of optical tooling, our advanced metal forming techniques, and our welding technology into the project—while at the same time applying a quality level higher than most steel companies regularly attain.

We have come a long way in the past four years. Initially, our small group was sustained with a single contract for a 60-foot diameter aluminum bonded reflector. During this period we studied new fabrication techniques for welded rather than bolted structures; developed coating systems to replace the traditional galvanized finish of steel antennas; designed, developed and tested high accuracy surface panels; developed computer programs to streamline our engineering effort; and adapted proven optical tooling methods to the needs of field aligning antenna axes within seconds of arc and setting thousands of square feet of antenna surface to within a few thousandths of an inch of the true curve.

Within a year we had obtained contracts for six 85-foot diameter precision antennas and a 30-foot diameter Az-El.

We consider ourselves antenna structures experts. We do not design or produce the radio frequency or electronic equipment generally associated with the term "antenna." Our contribution is the steel and aluminum structure. The Antenna Division is organized along extremely flexible lines, in that we will *design, fabricate,* or *erect,* either separately or as a package. We perform a number of engineering studies for the systems primes in the antenna business and for numerous government agencies. Due to the interdependence between a large steerable antenna structure and its drive and servo system, Rohr stands ready today to accept full responsibility for these elements of the system. Our engineering staff includes experts in both of these fields and as a service to our customers we are prepared to furnish all antenna hardware including reflectors, mounts, drives, servo systems and foundations.

The division takes pride in being ready to design and build any space frame structure required by the communications industry. To date these have included: precision steerable antennas used to track, communicate and command space probes; tropospheric scatter antennas used for communications between ground stations; microwave antennas and horns used for "line-of-sight" transmissions; radar antennas, both ground mounted and shipboard; steerable antennas for satellite communications; and finally, equatorially mounted radio telescopes for radio astronomy.

A few highlights of our more interesting antennas are given below:

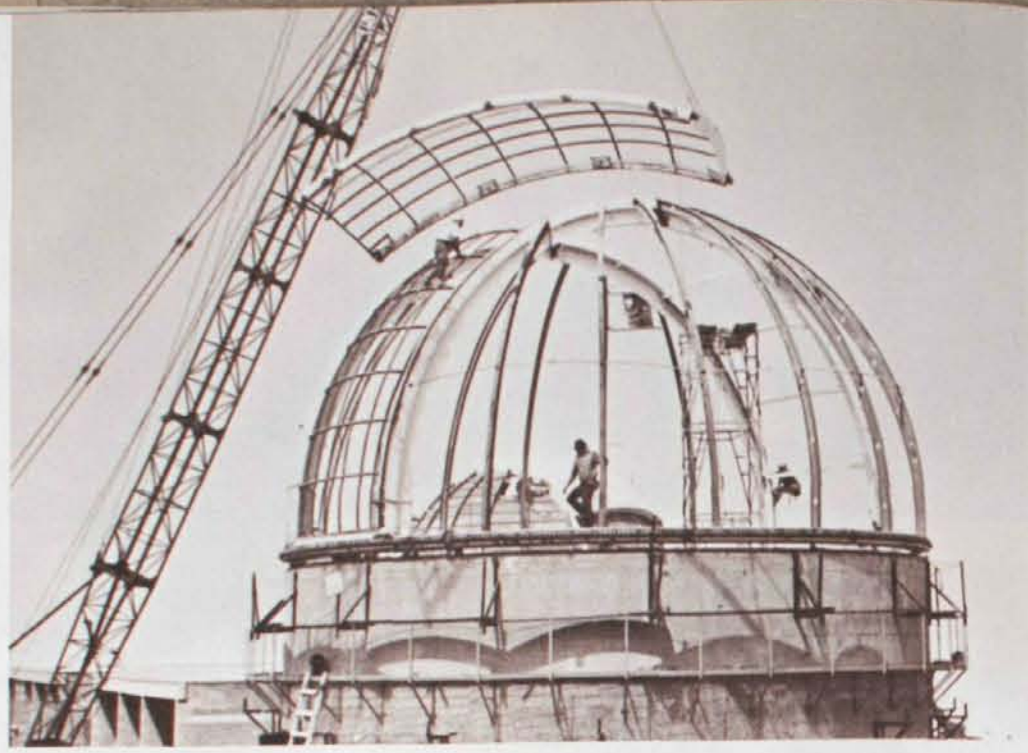
A 15 foot millimeter wave telescope was installed about a year and a half ago at the Aerospace Corporation in El Segundo, California. We are convinced that this is the most accurate antenna ever purchased. The surface was machined to an accuracy of .0018 inch rms and the antenna has a proven pointing accuracy of 7 seconds of arc rms. For comparison — a dime subtends an angle of one second at a distance of four miles.

Three thirty-foot tracking antennas have been built for the Jet Propulsion Laboratory—one used for measurements on Venus and the other two in conjunction with NASA's Apollo program.

We currently have in production a 36-foot diameter millimeter wave telescope which will be installed at Kitt Peak, Arizona, for the National Radio Astronomy Observatory. It will have surface accuracies comparable to the 15-foot telescope and even more accurate pointing capabilities. To manufacture this reflector to such exacting tolerances, we designed and installed the largest and most precise radial arm milling machine in the world.

One of our 85-foot antennas in California received the television signals of the Japanese Olympics which were relayed by the Syncom Satellite.

Skeleton structure of an 85-foot Rohr-built antenna outlined against the clear skies of the Grand Bahamas.



One of two 45-foot diameter tracking astrodomes built by Rohr for use with large optical telescopes atop Mt. Haleakala in Hawaii.

High precision millimeter wave radio-telescope built by Rohr for Aerospace Corporation and seen in operation atop one of the Aerospace buildings at El Segundo, Calif.

Our 85-foot radio telescope which was installed at the Naval Research Laboratories, Maryland Point Observatory, is operating successfully at a 2 cm wavelength with an aperture efficiency of 40 per cent—a real advance in the state of the art.

A classified 150-foot diameter tracking antenna we built for a government agency is the cheapest dollar per square foot antenna available.

The colossus of United States antennas is the 210-foot diameter tracking antenna which was designed and fabricated by Rohr over the past two years and is currently undergoing final assembly at the Jet Propulsion Laboratory's Goldstone Tracking Station near Barstow, California. It stands as tall as a 21 story building and has 86 per cent of an acre of reflecting surface area. Its rotating mass of approximately five million pounds floats on an oil film only 5 to 8 thousandths of an inch thick. This antenna will be used to track spacecraft to the vicinity of Mars and Venus and will be able to receive signals from radio sources billions of light years away.

Our primary field of interest, of course, is to maintain a position of leadership in the antenna industry. Unfortunately, this industry has a history of feast or famine, so to fill in a few of the valleys we have undertaken several interesting projects to diversify ourselves. We have supplied the University of Michigan with two 45-foot diameter tracking astrodomes to protect their large optical telescopes and tracking cameras from the environment atop 10,000 foot Mt. Haleakala in the State of Hawaii and we are currently fabricating a 95-foot diameter dome for our 36-foot antenna which will be erected at the Kitt Peak Arizona Observatory of the National Science Foundation.

To bolster the corporation's interest in oceanography we are fabricating several research buoys — one for General Dynamics — a 40-foot diameter deep ocean weather station capable of telemetering information on weather and sea conditions back to land — the other a deep submergible buoy for Woods Hole Oceanographic Institution to be used in conjunction with the Polaris program. We are currently starting fabrication for an aluminum hulled high speed 65-foot boat and hope to participate in the Mohole program. Our highest flying effort to date has been a radar calibration sphere which has been orbited by M.I.T. as one portion of their Lincoln Satellite.

Our capabilities and achievements in the field of precision construction presently range from the ocean depths to terrestrial environment to the edges of outer space, and we expect to fully exploit the future markets in these areas. □

BY G. F. GUERIN
Manager, Architectural Division

Architectural Division

AFTER three years of experimental work in a small pilot plant, the Company last year created the Architectural Division and acquired a manufacturing facility at Fullerton, California.

Limited production got under way in the new facility several months ago, and included residential houses for erection at Borrego Springs Park, Eagle Mountain (near Indio), Victorville, and other communities in Southern California, and at Las Vegas, Nevada.

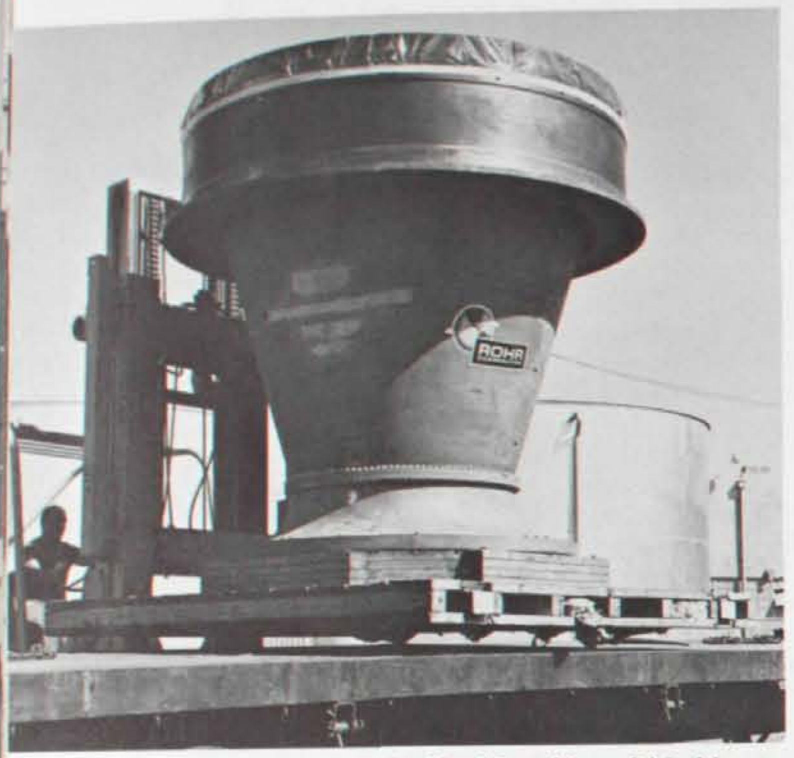
The houses consist of a steel frame, walls of polystyrene that are faced on the exterior with asbestos cement, and on the interior with a variety of finishes — wallboard, vinyl, plywood, to name a few. Completely finished in the factory, the component parts of the house are then erected on the building site. The result is an attractive, durable structure — a wide variety of designs is available. They require a minimum of maintenance, are impervious to termites and dry rot. They have proved popular with builders and customers.

However, numerous problems have been encountered, chief of which has been the difficulty in competing, cost wise, with conventional construction, due to the inherent high quality of the Rohr house.

The Division is continuing production of those houses for which contracts have been signed, after which for a time the plant, with limited personnel, will be devoted largely to further research.

By this policy we will reduce the heavy write-offs of production costs that have affected Company earnings for the last two years. □

Rohr home erected in San Diego by a builder-dealer as a display model drew large and interested crowds to open house events.



Rohr-refurbished nozzle for Lockheed Propulsion solid fuel booster ready for delivery at the Space Products Division.

Loading huge Thiokol nozzle in the "Pregnant Guppy," a Boeing transport rebuilt for such use by the Air Force.

Space Products Division

By H. R. CLEMENTS
Manager—Space Products Division

THE SHORT history of operations at the Rohr Space Products Division, is highlighted by many firsts in the area of development and manufacture of major components for large solid propellant rocket motors.

Since producing the nozzle for the first successfully fired 120-inch diameter solid propellant rocket motor early in 1962, Space Products Division manufactured rocket nozzles for the 156-inch (1.2 million pounds of thrust) motor and the world's largest (260″) nozzle which was fired for the full scheduled 62 seconds duration at over 3 million pounds of thrust on a 156-inch motor earlier this year.

This nozzle was 19 feet high, 14 feet in diameter at the exit cone, and weighed 20,000 pounds. The structural shell was formed of segments of 18 percent nickel maraging steel in the heaviest gauge yet formed and welded in the industry. The nozzle's tape wrapped ablative throat and liner sections consisted of carbon, graphite and silica fabric impregnated with phenolic resins. They were wrapped (on a mandrel) under precisely controlled tension, temperature, and pressure, then hydroclave cured at 350°F under a pressure of 1000 psi. The four-ton exit cone section alone, contained 21 miles of ablative tape.

The nozzles for the 260-inch solid rocket motor demonstration program also included the fabrication of two 65-inch test assemblies. These nozzles were all fired successfully.

During mid-1963, Rohr fabricated a successfully fired nozzle extension for the F-1 liquid propellant engine. This consisted of an ablative tape wrapped liner, honeycomb sandwich structure with glass laminate facings and filament wound glass reinforcement.

Rohr, Space Products Division, is currently manufacturing the world's largest submerged, liquid injection, thrust vector control nozzle for a 156-inch (3 million pound thrust) motor. This nozzle embodies the latest technology in tape wrapped ablative throats and liners. Along with the tape wrapped ablative liner, the exit cone will utilize honeycomb and filament wound glass for reinforcement. The rubber insulation for the three segments of this motor is currently in production. Simultaneous to this task, Rohr is producing a 156-inch monolithic maraging steel case for a 1.3 million pound thrust booster.

On the Titan III-C Program, Rohr is providing rubber insulation for 10 foot cylindrical center sections and the aft closure for the 120-inch (1.2 million pound thrust) strap-on boosters. On this program, the insulation for the center pound section employs both the precured and cured in-place techniques. The aft closure insulation is fabricated in two stages to accommodate placement of a graphite nozzle mating ring, which is precisely positioned by the rubber material. In this case, the insulation is cured and bonded in place, simultaneously.

Reliability is assured by close control of manufacturing processes, including curing under high pressure in Rohr's 15-foot by 35-foot autoclave. In each instance, the assembly is subsequently cleaned, inspected and packaged for shipment to the customer.

In addition to the Titan III-C Program, Rohr provided the rubber insulation liner for the 156-inch, 1.2 million pound thrust motor successfully fired twice during 1964. For the first firing, Rohr provided the insulation in the three segmented cases, including the forward and aft closures. These cases were refurbished by Rohr for the second firing. Only 125 days separated the firings. These insulated components, along with the Rohr manufactured nozzle used in the second firing, were delivered on or ahead of schedule.

Rohr has built nozzles of varying sizes, and has provided insulation and other major components used in the firings of 20 large solid propellant rocket motors without a single failure.

The Space Products Division has an impressive capability in the area of reinforced plastics and filament winding. More recent areas of participation are: (1) deep submersible filament wound vehicles for underwater development programs; (2) fiberglass laminate radar windows; and (3) filament wound commercial applications in corrosive resistant structures and process equipment for industry.

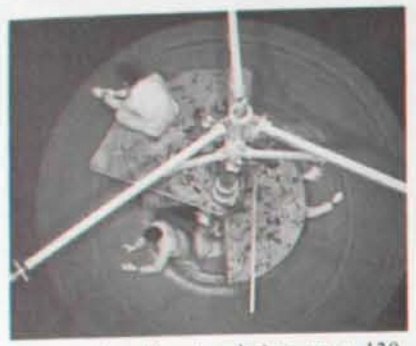
(1) A vehicle for sonar transducer calibration was recently placed in operation at the Navy, Point Loma facility. This unit is used to calibrate transducers to a depth of 2,000 feet. All operations have been completely successful.

(2) The Horn Antenna Window, manufactured for Western Electric, is a large, flat, fiber-

Ablative tape being wrapped to form the non-metallic liner for a Thiokol 156-inch rocket motor nozzle.

Welding 18 per cent nickel maraging steel shell for 156-inch nozzle entry cone.

Removing non-metallic ablative liner from the mandrel on which it was wrapped and cured. This nozzle was used in the successful firing of Thiokol's 156-inch, three million pound thrust solid fuel motor.



Lay-up of rubber insulation on a 120-inch solid fuel rocket motor end closure for United Technology Center.

Giant 156-inch motor case entering the autoclave at Rohr Space Products Division for curing and bonding of the rubber insulation.

glass laminate, the edges and corners of which are locally reinforced to facilitate load transfer and rapid mounting under severe "field conditions." Its purpose is to protect the very accurately-formed paraboloid reflector (antenna) from the environment, while permitting maximum transmission of undistorted electromagnetic radiation to and from the antenna surface. The window is fabricated with weather-resistant polyester resin and multiple layers of fiberglass cloth to a very close thickness tolerance with virtually no voids or air pockets which would tend to alter the dielectric characteristics of the window.

(3) The Division is presently developing filament wound process tanks for handling and storage of corrosive fluids. The first tanks for underground installation will go into service about August 1. These units are designed to store corrosive waste materials for reclamation or safe disposal.

The Space Products Division excels in the areas of applied research, development and application of advanced materials and processes in the successful solution of customer design and engineering problems. Two recent examples include the development of a proprietary process for obtaining a controlled fiber orientation within complex ablative configurations required for inlet applications on submerged nozzles; and the adaptation to a production environment of a new ablative material and process (Snap Cure) capable of wrapping a cured component without the use of a pressure vessel. Both efforts were concluded by furnishing actual hardware for test firing.

New and unique applications of the Space Products Division facilities have been demonstrated in the application of the 175-inch diameter by 356-inch deep hydroclave to test deep submergible vessels at simulated ocean depths. This facility offers pressures to 1000 psi and temperatures to 500°F. □

Motor cases for the United Technology Center's 120-inch solid fuel Titan III-C strap-on boosters being insulated at the Rohr Space Products Division.

Orbiting Target

ROHR-BUILT SPHERE SERVES TO CALIBRATE ANTENNA SYSTEMS

A series of extremely accurate and highly polished aluminum spheres being manufactured at Rohr-Chula Vista is being put into orbit around the earth to provide targets for the calibration of some of the country's most powerful radar and radio systems.

The first of these 44½-inch spheres rode into orbit on May 6 as a "bonus payload" on a Titan III-A flight test at Cape Kennedy. It was injected into orbit to serve as a test target to check the strength of radar signals from the ground.

Designed by Massachusetts Institute of Technology's Lincoln Laboratory under the sponsorship of the Advanced Research Projects Agency of the Department of Defense the satellite sphere was one of two scientific satellites carried into orbit on that same shot. The second was an experimental communications satellite called the LES-2. The satellites were injected into orbit after the third burn of the Titan transtage had placed it in a circular orbit at an altitude of 1500 miles. The LES-2 separated first and was placed into a new orbit by its own small injection rocket. Then the 75-pound polished metal sphere was ejected by a spring from a cylindrical container built into the Titan payload truss. The sphere moved away from the burned out Titan at the rate of three feet per second and into its own orbit.

Lincoln Laboratory's Mill Stone Hill radar at Westford, Massachusetts detected and tracked the sphere and reported fully satisfactory results. In addition to its primary mission in the calibration of radar and radio systems, the satellite sphere will be used in experiments to measure the influence of weather and atmospheric conditions on satellite radio relay communications.

The calibration sphere is designed to yield a variety of useful information, with applications seen in calibrating radar systems for reentry studies, space communications and radar astronomy. It may also help obtain additional information about the shape of the earth's gravitational field, according to the Lincoln Laboratory.

The useful life of the sphere in orbit is estimated at up to five years, due to an anticipated decline in efficiency resulting from surface degradation caused by collision with micro-meteorites.

As injected into orbit the aluminum sphere was as nearly perfect in shape as modern manufacturing technology could make it. Spinformed hemispheres of .160 inch aluminum were joined mechanically to a back-up ring and then machined on a tracer type vertical lathe. Sphere tolerance requirements are extremely critical as were surface finish specifications. Inside surfaces of the spheres are anodized black for better heat distribution and the exteriors buffed and polished.

Accuracy of shape is required to produce steady radar echoes of uniform strength. The Lincoln Laboratory explained that other objects in orbit are non-spherical and thus produce scintillating echoes fluctuating widely in strength.

The initial order to Rohr called for five of the spheres, with an indication of further requirements. □

The highly polished surface will reflect signals with sufficient accuracy to allow calibration of radar and radio systems.

Precise welding was required to join two hemispheres into a perfect sphere.

Grumman Announces Turbofan Gulfstream

ROHR RECEIVES CONTRACT ON PODS, THRUST REVERSERS

Grumman's Gulfstream II design incorporates aft-mounted pods and other features associated with most recent, high performance jet transports.

ANNOUNCEMENT of a contract from the Grumman Aircraft Engineering Corporation will put Rohr-built pods and thrust reversers on still another of the country's advanced, high performance transport aircraft—this one a turbofan powered executive airplane.

Grumman has awarded Rohr a contract, which should total in excess of $15,000,000 through the course of the program, for the design and manufacture of turbofan engine pods and thrust reversers for the New York company's new Gulfstream II.

Grumman announced production plans early in May on this turbofan-engine successor to the popular propjet Gulfstream I. Rohr is manufacturing a variety of components for the Gulfstream I at the Company's Winder, Georgia, plant and in addition is producing major assemblies for the Grumman E2A.

Assembly operations and mating of the pod and thrust reverser components with the engines will take place at the Winder, Georgia, plant and from there the completed power plants will be shipped to Grumman's plant at Bethpage, Long Island, New York. Design, tool manufacture and parts fabrication will be accomplished at Rohr's main plant in Chula Vista, California.

Award of this contract with the Winder, Georgia, plant of Rohr represents a new major contract for production of aircraft components.

This new Gulfstream II is designed as the world's fastest corporate transport and will operate in the transonic speed range — 585 miles an hour. It will be certificated for a maximum altitude capability of 43,000 feet and will have a range of 2640 nautical miles at 40,000 feet with ten passengers, baggage and a three-man crew. Maximum range at 40,000-foot cruise altitude, with 30-minute fuel reserve, will be 3010 nautical miles.

The aircraft will be 80 feet long, with a wingspread of approximately 69 feet and a wing sweep of 25 degrees. The circular fuselage will offer possibilities for many different accommodation arrangements — from a walk-around cabin arranged in "living room" fashion to an airline type arrangement that will handle up to 24 passengers. The pressurization system will provide sea-level cabin conditions up to 22,000 feet and an 8,000-foot cabin at 43,000 feet. The aft mounting of the power plants will result in very low cabin sound levels.

Power will be supplied by two Rolls-Royce "Spey" turbofan engines, each developing 11,400 pounds thrust. Engine pods will be mounted on either side of the aft fuselage well above wing level and Rohr-designed Thrust Reversers will insure short field landing capability.

The T-type empennage features a swept vertical fin with a swept horizontal tail mounted atop the fin, well above the jet exhaust.

Range, operational versatility and short-field capabilities will give Gulfstream II operators a wide variety of options in corporate travel, according to Grumman. Long-range multi-stop flights may be scheduled or many short hops may be accomplished without refueling.

Selection of Rohr's Georgia facility as a subcontractor on this new Grumman airplane means participation by the Company in virtually every new transport aircraft program now under way in this country. In its traditional role as a subcontractor to the aerospace industry, Rohr has manufactured more than 70,000 pods and power packages through the 25 years of the Company's history. Rohr-built pods are in service on most of the multi-engine commercial and military aircraft now flying. □

Thundering Success for Titan III-C

FOUR-STAGE VEHICLE PERFORMS PERFECTLY IN FIRST FIRING

THE NEWEST, most powerful rocket ever fired, the mighty Titan III-C, scored a thundering success, June 18, on its maiden test flight at Cape Kennedy, Florida.

The giant, four-stage launch vehicle, bearing insulation segments installed by Rohr in the strap-on booster engines, roared aloft in perfect flight on its initial flight test, carrying a 10½-ton dummy payload. It was the first time that the III-C configuration, with its strap-on solid rocket motors, and liquid-propelled core, had been launched.

Blazing into action and spewing twin jets of flame 400 to 500 feet long, the 127 ft. high vehicle (that's as tall as a 12-story building) developed 2½-million pounds of thrust from its UTC boosters, rose, and disappeared into the Florida skies.

Its first-stage engines took over approximately 120 seconds after the launch. Small jets alongside parted the spent booster engine cases from the main vehicle, 28 miles above the earth.

At 67 miles the second stage engines cut in to give additional boost to the payload.

A third transtage, at 102 miles, blazed into action sending dummy payload into orbit 115 miles above the earth, at 17,500 mph.

The successfully fired vehicle is a product of the Air Force Research and Development Program 624A, conceived by the Space Systems Division of the Air Force Systems Command and developed by United Technology Center and other major aerospace firms as a standard space launch system for a variety of manned and unmanned booster systems.

Rohr has been a major subcontractor to United Technology Center, division of United Aircraft Corp., Sunnyvale, contractor to SSD on the booster-stage.

Rohr's Space Products Division of Riverside, provided the Rohr-built liner portion on the system's booster engines.

The Space Products Division has provided synthetic rubber insulation in the motor case segments and aft closures throughout the program. Thus far, the division has insulated 80 of the 10-ft. diameter motor case segments and 11 of the end closures.

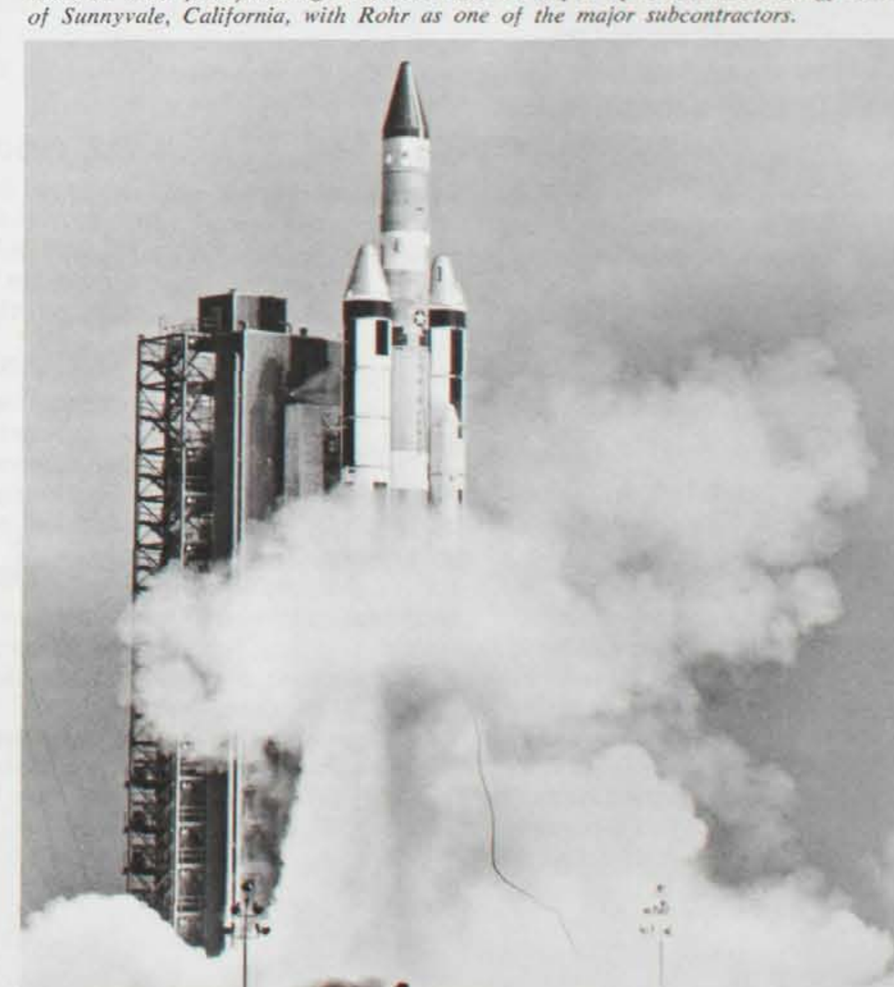
Each of the end closures contain some 2000 pounds of molded rubber. One thousand pounds of synthetic rubber insulation goes into each of the motor case segments. Both prefabricated sections and molded-in-place components are used.

After the insulation material is placed, the components are cured and bonded in a 15 by 35 foot autoclave, one of the largest autoclaves in the industry, and located at the Riverside plant.

Five of the motor case segments are used in each of the 90-foot tall booster motors. Motor case segments and end closures insulated by Rohr are used in the two solid propellant, "strap-on" rockets which constitute the booster stage of the Titan III-C vehicle.

In addition to the insulation work carried out by Rohr's Space Products Division at Riverside, aluminum intertank structure for the Titan III-C are produced at the main Chula Vista plant. □

Successful first firing of the Titan III-C, the most powerful rocket ever fired. The 120-inch solid fuel first stage boosters were developed by United Technology Center of Sunnyvale, California, with Rohr as one of the major subcontractors.



Aircraft Order Boosts Backlog

ROHR CORPORATION has received from Douglas Aircraft Company a contract for the manufacture of jet engine pods for models 62 and 63 of the advanced version of the DC-8. The contract, over the next three or four years, is expected to total approximately $35,000,000, including spares.

Not all of the total amount of the contract is included in the Company backlog, which now stands at $221,800,000. Most orders on long run contracts, although for a specified number of ship sets, are received in increments. It is Company policy to include in the backlog only amounts represented by work orders.

The advanced version of the DC-8 will include a three foot addition into each wing tip, a restyled interior, and new, slimmer pods for the four turbofan engines. It will carry up to 251 passengers, and first deliveries of model 62 will be in the Spring of 1967.

The DC-8 contract, plus the contract for jet pods for the *Grumman Gulfstream* (described in more detail on another page) places Rohr on all the major multi-engine aircraft programs now in production, both military and civilian.

In addition, the Company is negotiating several other contracts, both in aircraft and aerospace, continuing the policy of diversification both as to customers and products.

The tabulation at the bottom of the page shows the wide range of manufacturing activities.

DIVERSIFICATION OF CUSTOMERS AND PRODUCTS

AIRCRAFT CUSTOMERS

The Boeing Company
Douglas Aircraft Company
Lockheed-Georgia Company
Lockheed-California Company
Grumman Aircraft Engineering Corp.

SPACE PRODUCTS DIVISION

Thiokol Chemical Corp.
Lockheed Propulsion Company
United Technology Center

ANTENNA DIVISION

Western Electric Company
Jet Propulsion Laboratory
Gilfillan
Bristol Iron & Steel
Westinghouse Electric Corp.
Raytheon
National Radio Astronomy Observatory
Massachusetts Institute of Technology
Imodco, U.S.A.
Reeves Instrument Co.
Naval Research Laboratory

CUSTOMERS

Aerojet General Corp.
Chrysler Corp.
Curtiss-Wright Corp.
DeHaviland Aircraft of Canada
Eastman Kodak Co.
NASA, Langley Research Center
NASA, MSFC, Huntsville
Rocketdyne (Div. of North American)

AIRCRAFT PRODUCTS

Jet engine pods, fuselage sections, stabilizers, elevators, thrust reversers, struts, ailerons, landing gear pods and doors, cargo petal doors, wing-to-body fairings, flight and ground spoilers, wing joint fittings.

SPACE PRODUCTS DIVISION PRODUCTS

Submerged liquid injection and vector control nozzle for 156-inch filament wound solid booster motor, insulation for case for 3-million pound thrust nozzle, insulation of aft closure and center sections.

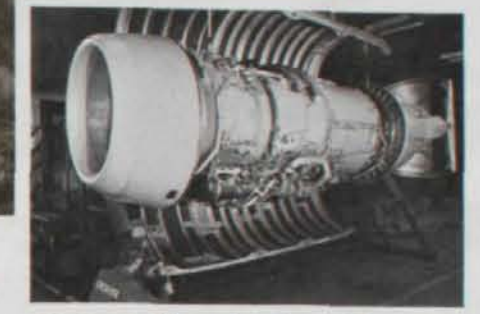
ANTENNA DIVISION PRODUCTS

Microwave relay horn antennas, 210-foot tracking antennas, shipboard antennas, radar antennas, 30, 60, and 85-foot tracking antennas, radio telescopes, radar calibration spheres.

MISCELLANEOUS PRODUCTS

Oxidizer pump manifold, engine and base heat shield (Saturn V), service panels vector nozzle for J65 engine, honeycomb core, invar honeycomb rings, digimatic service, sheet metal cone, brazed honeycomb assemblies, bonded bulkhead, F-1 skirt Saturn V engine, intertank structures.

Douglas Aircraft Company's newest model, the twinjet DC-9, has been ordered by 17 airlines for a total of 142 announced sales and leases, 19 sold with purchasing airlines not identified and 122 on option.



Engine build-up for the DC-9.

Douglas Aircraft Company

MISSILE, space and aviation projects of the Douglas Aircraft Company combine to place the Southern California-based firm in the forefront of the nation's aerospace companies.

Founded by Donald W. Douglas in 1921, the company has expanded its initial role of commercial aircraft builder into a wide range of associated fields.

Douglas is chairman of the board, and Donald W. Douglas, Jr., president of the company. Currently the firm's backlog of business is more than $1.4 billion and consists of commercial aviation, defense, atomic energy and space contracts.

A sizeable portion of this backlog includes orders for the Douglas DC-9, the world's newest commercial short-to-medium-range jetliner in production. The twinjet DC-9 is undergoing an intensive flight test program preliminary to entering commercial service next year.

With sales of the reliable DC-8 four-engine commercial jet transport continuing to climb, Douglas has announced three "stretched" versions of this airliner capable of carrying as many as 251 passengers. Designated as the Series 60, these new models of the DC-8 are enlarged by extending the fuselage.

In the space field, Douglas is a major contractor in the National Aeronautics and Space Administration's Saturn-Apollo program. The company is producing the C-IVB, an upper stage for different versions of the huge Saturn launch vehicle.

The S-IVB, a larger and more powerful vehicle than the earlier Douglas-built S-IV, will be the top stage of the Saturn IB, assigned to boost manned Apollo spacecraft into earth orbit, and for the giant Saturn V which will propel the three-man Apollo toward the moon.

Since the company entered the missile business in 1941 with the development of an experimental guided bomb, more than 45,000 missiles and rockets have been built by Douglas.

Among these is the famed Thor rocket—the nation's most reliable space booster—which Douglas produces as prime contractor to the Air Force.

The Douglas Thrust Augmented Delta (TAD) was used to place the Early Bird television satellite into synchronous orbit. Like the thrust augmented Thor, TAD is equipped with strap-on solid motors which supplement the lift-off thrust of the basic liquid propellant system.

Latest addition to the long list of military aircraft built by Douglas during its 43-year history is the TA-4E advanced jet trainer. The TA-4E is a modification of the A-4E Skyhawk attack bomber, newest of the A-4 series which has served the Navy and Marine Corps with maximum efficiency for nearly a decade.

Major contributions by Douglas to the nation's missile arsenal are the Zeus missile and the Nike Hercules Army anti-aircraft defense weapon. Douglas is associate contractor to Western Electric in both these programs.

Douglas employs some 50,000 persons at locations from California to Cape Kennedy, Florida. Corporate and Missile and Space Systems headquarters are located in Santa Monica, and the Aircraft Group is situated in Long Beach.

The Douglas Space Systems Center, Huntington Beach, Calif., is one of the world's most technically advanced space research and assembly facilities.

Additionally, Douglas is now building an Advanced Research Laboratory on the Huntington Beach site which is scheduled to open early next year and be staffed with more than 40 of the nation's top basic science researchers.

Other Douglas facilities include a rocket engine static test installation in Sacramento; production facilities in Tulsa, Okla., and Charlotte, N.C., and the Aircomb Division, Cudahy, Calif., where high-strength, low-weight paper honeycomb structural core material is manufactured.

Newest company operation is at Hanford, Wash., where Douglas and the United Nuclear Company jointly will manage plutonium reactors and fuel fabrication facilities at the Atomic Energy Commission's plant. Douglas also is building a research laboratory there. □

Lockheed Aircraft Corporation

Lockheed's JetStar military-executive transport, with Rohr-built pods and thrust reversers.

A HALF CENTURY ago Allan and Malcolm Lockheed designed, built, and flew the first Lockheed plane, then manufactured a 10-passenger flying boat, two Navy seaplanes, and a sport biplane. In the late 1920s came the famous Vega monoplanes, a distinguished line of record-setting aircraft flown by famed pilots of that era.

In depression years the earlier Lockheed company went bankrupt. Robert E. Gross and a group of investors in 1932 purchased its assets, formed the present corporation, and built and marketed the successful Electra transport series.

With Europe near war in 1938, Lockheed won a huge order to build the rugged Hudson bomber to protect the vulnerable British Isles and ultimately delivered 3000 to Britain, the U.S., and allied nations. After Pearl Harbor its P-38 Lightning fighter hit a 15-a-day peak. Employment climbed above 94,000. From Lockheed factories poured more than 19,000 military planes.

As peace neared, Lockheed began building the F-80 Shooting Star, first U. S. operational jet fighter, forerunner of the T-33 and T-1A trainer and F-94 interceptor — a series totaling some 8400 planes. It started producing P-2 Neptune patrol bombers for the U. S. Navy and nine foreign nations — a record 17-year production of 1051 planes continuing through 1962. Another postwar program, Constellation transports, advanced global air travel to new heights of luxury, speed, and efficiency.

Diversification, growth, and new product lines have accelerated in recent years as Lockheed:

Began operating the large government aircraft factory in Marietta, now Lockheed-Georgia Company, to build bombers, the versatile C-130 Hercules family of troop-cargo transports now in U. S. and foreign military service, the C-141 StarLifter, and is competing for the C-5 military transport.

Formed a division, now Lockheed Missiles & Space Company, that builds the Polaris fleet ballistic missile and Agena space vehicles used for numerous military and civilian space missions. The new Poseidon fleet ballistic missile also is an LMSC program.

Introduced the 1500-mph F-104 Starfighter to U. S. and foreign service and became international system manager on a vast overseas program in which seven nations are manufacturing hundreds of these versatile aircraft under license.

Developed the P-3A Orion as the latest antisubmarine warfare plane.

Entered the helicopter field with its XH-51A rigidrotor vehicle.

Built the U-2 reconnaissance and high altitude research plane.

Established Lockheed Electronics Company and Lockheed Aircraft International to strengthen electronics and overseas programs.

Built the YF-12A interceptor, holder of nine world speed records.

Gained shipbuilding-heavy construction skills by acquiring Puget Sound Bridge & Dry Dock Company, now renamed Lockheed Shipbuilding and Construction Company.

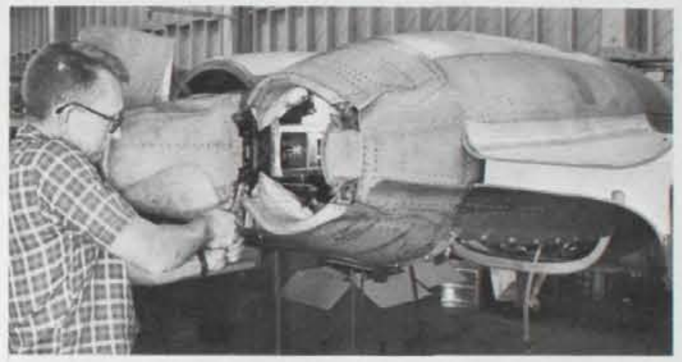
Entered the rocket motor-propellant field with Lockheed Propulsion Company, builder of the rocket escape systems for Mercury and Apollo, and developer of the first 156-inch-diameter solid propellant rocket motor in the national large booster rocket program.

Launched ocean systems and undersea research programs.

Lockheed facilities today cover more than 21 million square feet. □

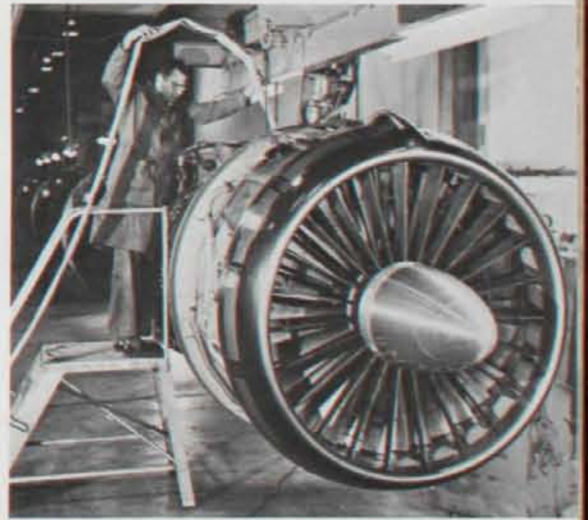
Lockheed C-141 StarLifter with Rohr-built pods, cargo doors and other components.

Lockheed's sub-hunting Orion, this time over a friendly U.S. submarine.



Installation of Rohr designed and built thrust reversers on JetStar pods.

P-3A Orion propjet power packs on the monorail engine line at Rohr-Chula Vista.



Functional test on compressor section of Lockheed C-141 assembly on Rohr-Winder engine line.

The Boeing Company

Latest of the Boeing jet transports to go into service is this short-to-medium range Trijet 727.

THE Boeing Company has pioneered new concepts in air transportation since its founding in 1916, and has been active in missile, space, and rocket development since 1946. Now the world's largest producer of multi-engine aircraft, Boeing is also active in the Minuteman Intercontinental Ballistic Missile, Saturn V, and Lunar Orbiter programs, commercial and military helicopters, and gas turbine engine production.

About 90,000 employees work in four Boeing divisions: Aero-Space and Turbine Divisions in Seattle, the Airplane Division in Renton, Washington, and Vertol Division in Morton, Pennsylvania. Boeing of Canada, Ltd., in Ontario and the Boeing International Corporation are subsidiaries.

Founded as Pacific Aero Products Company when William E. Boeing saw the prospects of American participation in World War I, it became the Boeing Airplane Company in 1917. Fifty Model C trainers from Boeing went into war service.

The first contract international air mail route, linking Seattle and Victoria, British Columbia, in 1920, used the Boeing B-1 flying boat, and when the United States government, under President Coolidge's economy program, stopped flying the mail in 1926, Boeing received the contract for carrying transcontinental airmail. Boeing Transport, Incorporated, was organized to build planes for the mail route. Model 40-A and B planes signaled the beginning of regular commercial passenger service over long distances and were the first to use voice radio communication with the ground.

Boeing offered company stock to the public in November, 1928, and shortly afterwards the United Aircraft and Transport Corporation was founded. The new company included Boeing Airplane Company, Pratt & Whitney, Chance Vought, Hamilton Propeller Company, Pacific Air Transport and Boeing Air Transport. In 1931 Boeing Air Transport joined National Air Transport, Pacific Air Transport, and Varney Air Lines to form United Air Lines.

Government hearings in 1933 and 1934 led to a law prohibiting air mail contractors from being associated with aviation manufacturers. United Air Lines took over air transport, United Aircraft Corporation was formed to control eastern manufacturing firms, and Boeing Airplane Company took over western manufacturing.

Boeing products marked several firsts in aircraft design. The 247, delivered in 1933, was the first all-metal, twin-engine transport, and could climb on one engine with a full load. The 299 and its successor, the B-17 Flying Fortress, were the first four-engine bombers. The B-17 became a major weapon in World War II, nearly 7,000 being built by Boeing alone.

The next bomber, the B-29, was the first pressurized heavy bomber produced in quantity, the first with a complete remote-controlled gun-firing system.

Boeing's B-47 six-engined Stratojet and spectacular eight-jet B-52 bombers form the principal striking force for the Strategic Air Command today. The B-52 set new speed and distance records, extended unrefueled range, and could be used to launch supersonic North American GAM-77 "Hound Dog" missiles.

More than 380 jet transports in the 707/720 series of commercial airliners have been delivered to 26 airlines since 1952. The 707 can fly New York-to-London schedules in less than seven hours, carrying up to 189 passengers. The 707, 707-120, 707-320, and 720 are all four-engine jet transports with 35-degree swept-back wings. The next model, the 727, which had its initial flight in February, 1963, is designed to operate on short-to-medium range routes, and is powered by three turbofan engines mounted at the rear of the fuselage. A still newer, and smaller, Boeing 737 is now in the design stages.

A new era started for Boeing in 1958 when Bomarc went into full-scale production and the company was awarded contracts on the Dyna-Soar and Minuteman programs, even though the Dyna-Soar contract was later cancelled. No longer was the production of airplanes the company's only major concern. In 1961, the company's name was changed to The Boeing Company.

The supersonic Bomarc missile is a United States Air Force area defense weapon designed to destroy enemy aircraft and airborne missiles before they come near target areas. Its takeoff is vertical, and it is guided from the ground by radio signals generated automatically by an electronic computer reading radar tracks of the invading enemy. Its own target seeker pinpoints the enemy and attacks.

The Turbine Division has pioneered the majority of small gas-turbine applications in the aircraft, marine, vehicular and industrial fields, while the Vertol Division, acquired as the Vertol Aircraft Corporation in 1960, manufactures helicopters and tilt-wing aircraft. The CH-46A Sea Knight deploys combat equipped troops to remote areas, and the CH-47A Chinook is the Army's standard medium-transport helicopter, with a capacity of 33 fully equipped troops.

Boeing formed its Scientific Research Laboratories in 1958 for pure research in gas dynamics, flight mechanics, plasma physics, geoastrophysics, advanced mathematics, and solid-state physics.

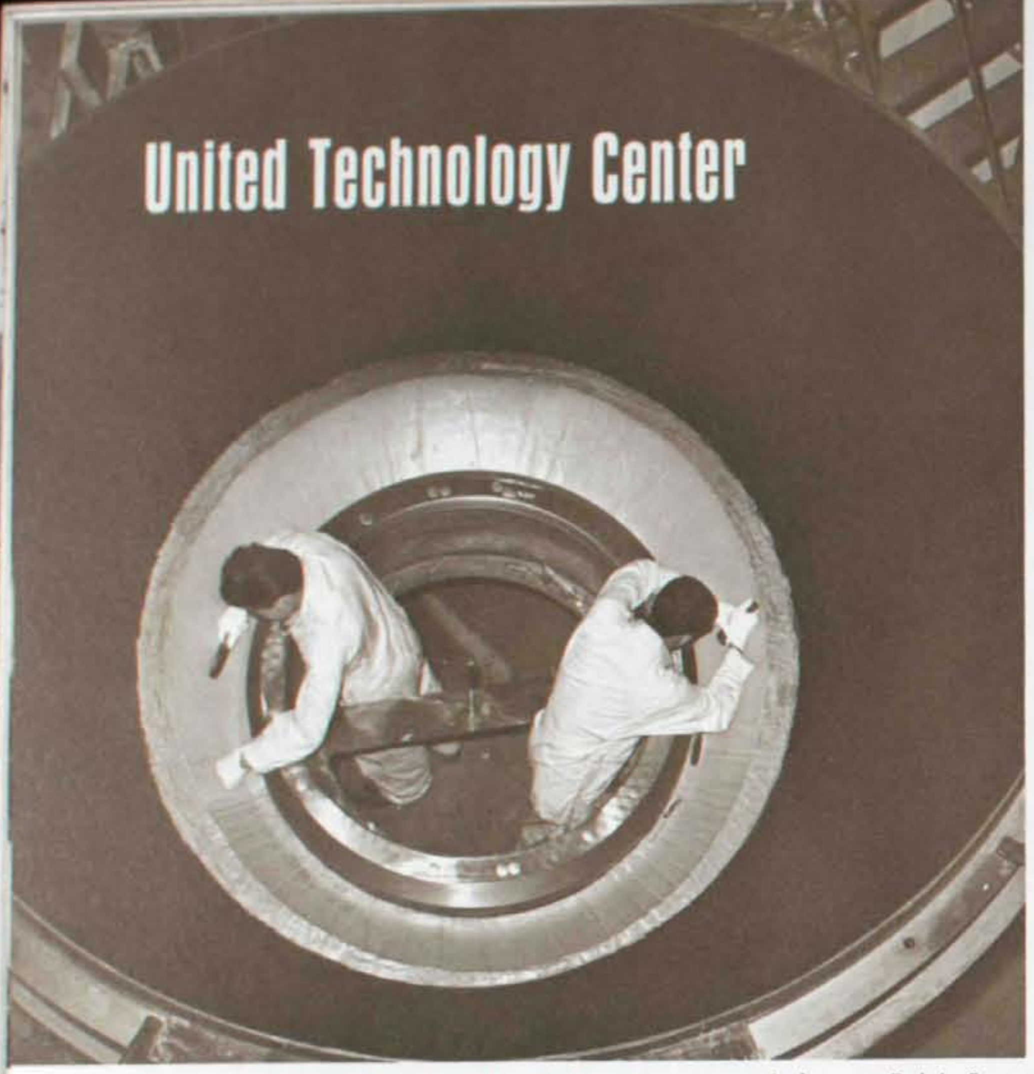
Lunar Orbiter spacecraft designed to fly within 28 miles of the moon and take sharp, detailed photographs are being built for the National Aeronautics and Space Administration. The company is the weapon system integrator for the Minuteman ICBM, the nation's major strategic missile force, with responsibility for assembly, test, launch control and ground support systems.

Boeing will produce the first stage of the three-stage launch vehicle Saturn V, which will boost the Apollo spacecraft. Boeing's booster will be so large that transportation by highway, rail, or air will be impossible. Barges will move the units to Cape Kennedy. □

The Boeing 707, first of the large jet transports, is in service in a variety of configurations throughout the world.

Power plant build-up for Boeing jet transports on the long monorail lines at Rohr's Auburn, Washington plant, only a few miles from Boeing Commercial Aircraft Division facility at Renton, Washington.

United Technology Center



Lay-up of rubber insulation on Titan III-C motor case end closure. Rohr's Space Products Division serves as a major subcontractor to UTC on the solid fuel first stage boosters for the Titan III-C.

UNITED Technology Center, a United Aircraft Corporation division, is engaged in research, development, and production of space propulsion systems ranging from small hybrid and space-storable, liquid-fuel rockets to huge multimillion-pound thrust, solid-propellant booster motors.

UTC's biggest single assignment is production and testing of the booster stage of the Air Force Titan III-C standard space launcher. Pairs of the five-segment, solid-propellant motors which UTC has developed and is producing give the Titan III-C a liftoff thrust of nearly 2½ million pounds. The 120-inch diameter motors weigh 250 tons and stand 85 feet tall, the largest solid-propellant motors yet committed for flight.

UTC's Titan III work is being carried out under Air Force contracts totaling about $175 million and continuing into 1967. The Titan III-C will be a work horse military space booster, capable of orbiting a variety of manned and unmanned payloads of up to 25,000 pounds.

In addition to its pioneering work with big solids, including the development of mechanical joints to hold segmented motors together and a thrust vector (steering) control system, UTC is actively pursuing a number of other major advanced propulsion programs.

Among these are the fabrication of glass filament-wound rocket cases up to 156 inches in diameter, development of hybrid rocket motors, formulation of more powerful rocket propellants, and development of improved thrust chambers and throttling techniques for outer-space liquid rockets.

These efforts are directed from the division's administrative, research, and engineering headquarters which occupies more than 300,000 square feet of floor space in Sunnyvale, Calif. UTC's Development, Production, and Test Center is at Coyote, Calif., 28 miles southeast of Sunnyvale, where an ambitious corporate-funded construction program has provided some of the largest and most modern facilities in the industry.

UTC was established in 1958. Barnet R. Adelman is division president. □

Insulating motor case segments for the Titan III-C solid fuel boosters in the Rohr Space Products Division plant at Riverside.

The U.S. Air Force scored a complete success on June 18 when it fired the giant Titan III-C four-stage launch vehicle at Cape Kennedy. Rohr served as a subcontractor to United Technology Center on the two solid fuel "strap-on" boosters for this most powerful rocket yet developed.

Thiokol Chemical Corporation

IN 1927, a medical doctor, turned research chemist, was attempting to create antifreeze in his private laboratory. During the process he stumbled upon a material that proved to be the world's first synthetic rubber.

Dubbed Thiokol (from the Greek *thio*—sulfer and *kol*—glue) the foul smelling material exhibited tenacious bonding and sealing qualities and was impervious to most solvents and corrosive agents.

In 1929, Thiokol Chemical Corporation was formed as a pioneer developer of synthetic rubber and a supplier of chemicals for such items as sealants, binders, gasoline hoses, and printing press rollers.

A method of producing the synthetic rubber as a liquid polymer was developed in 1943. This was followed in 1946 by the discovery that the liquid polymer, combined with an oxidizer, produced a remarkably efficient solid propellant, ideal for use as a rocket fuel.

Thiokol elected to enter the rocket business. The firm's only operation at that time was the chemical plant in Trenton, New Jersey. A government contract for solid fuel research and development was obtained and a plant was established at Elkton, Maryland, in 1948. A year later a second solid fuel rocket motor plant was created at Huntsville, Alabama.

Since that time Thiokol Chemical Corporation has grown to 15 operating facilities and 24 offices staffed by more than 9500 employees. This is evidence that Thiokol has proved conclusively the value of solid propellant motors. The inventory of America's missile and space systems lists dozens propelled by Thiokol motors, including Falcon, Pershing, Nike-Hercules, Nike-Zeus, Sergeant, Genie, Bomarc, Mace, and Minuteman, as well as retro-rockets for the Mercury and Gemini programs.

The nation's largest and most powerful solid propellant space booster demonstration motors have been developed by Thiokol. The largest, measuring 100 feet in length, weighing 900,000 pounds and producing 3 million pounds of thrust, employed a Rohr nozzle.

During its growth, Thiokol expanded into the field of liquid-fueled rocket motors. The most famous of these, the XLR-99 engine, propels the X-15 rocket plane.

Even though rocket operations have over-shadowed its other activities, Thiokol's chemical operations are continually growing and expanding as are Thiokol's diversifications into glass-epoxy laminates, tracked vehicles, and electronic and ordnance devcies. □

The nation's largest and most powerful space booster demonstration motor, developed and test fired by Thiokol, generated three million pounds of thrust.

Final wrapping operations at Rohr's Space Products Division on the nozzle for Thiokol's huge motor.

Aerojet-General Corporation

AEROJET-GENERAL Corporation, a pioneer in rocket propulsion, has long since moved into broader technological areas of the aerospace world. Today, it is involved as a major participant in major missile and space programs such as Polaris, Titan, Minuteman, Gemini, Apollo, NERVA (nuclear rocket engine) and the Mark 46 Torpedo, as well as a wide spectrum of advanced programs.

The company was organized in Pasadena in March 1942, by the late Dr. Theodore von Karman and a group of associates from California Institute of Technology as the Aerojet Engineering Corporation. Its first interest was in the development and production of war-time JATO (take-off assist) rockets for military aircraft under an original Army Air Corps contract of $10,000. Today, the company's annual sales are in excess of a half billion dollars and it employs approximately 22,000 persons.

The General Tire & Rubber Company obtained a controlling interest in the company in 1944, and in 1953 the firm was reorganized under its present name of Aerojet-General Corporation. Principal officers are Dan A. Kimball, chairman of the board, and W. E. Zisch, president, both of whom have been associated with the company since its earliest years. Corporate headquarters is located at El Monte, California.

From 1943 to 1951, the company's principal operations were located in Azusa, California. In the latter year, development of the company's larger plant at Sacramento was begun. Today, Aerojet's major missile and space propulsion programs are conducted at Sacramento, where its separate Liquid Rocket Operations and Solid Rocket Operations divisions are located, as well as the largest rocket-testing complex in the Free World. It is at Sacramento that the powerful liquid rocket engines for the Titan missile and space booster series are made, as well as the solid rocket motors for Polaris and Minuteman. The company's REON Division (Rocket Engine Operations-Nuclear) also is at Sacramento.

The Rohr Space Products Division's numerically controlled filament winding machine has been used on a variety of pressure vessel projects for Aerojet-General Corporation.

At Von Karman Center in Azusa, the company's major projects are the Mark 46 Torpedo and the SNAP-8 program. Other divisions there are involved in such diverse fields as developing a water desalination technique based on reverse-osmosis and infra-red detection systems.

The company also operates a large plant at Downey, California, devoted to ultra-precision fabrication of missile components and ordnance items. In Dade County (near Miami), Florida, Aerojet is building super size solid rockets for the National Aeronautics and Space Administration. Its Atlantic Division, at Frederick, Maryland, specializes in automated sorting and delivery systems. Aerojet-General Shipyards in Jacksonville, Florida, and Aerojet-General Nucleonics in San Ramon, California, are responsible for the firm's activities in automated oceangoing research vessels and advanced nuclear techniques.

With total physical assets of more than $125,000,000 and a highly-experienced staff of scientists and technological specialists, Aerojet-General is one of the oldest companies in the aerospace field. While it continues as a leader in its specialized areas of rocket propulsion, nucleonics and space electronics, Aerojet has for several years been broadening the base of its operations through application of space-age techniques to such everyday problems as waste disposal studies, life sciences, water and air pollution, and promising commercial products. □

Construction proceeds steadily with the installation of radial rib back-up structure on the giant 210-foot tracking antenna, largest of its type in the free world, designed and being built by Rohr Corporation for the Jet Propulsion Laboratory.

Jet Propulsion Laboratory

THE JET Propulsion Laboratory, America's first government-sponsored research group devoted to the study of rockets, in 1936 started the basic research in rocketry and jet propulsion which was to culminate in the nation's present multi-faceted defense network and space exploration programs.

Now a research and development facility operated for the National Aeronautics and Space Administration by the California Institute of Technology, the Laboratory directs programs for the unmanned exploration of the moon, the planets, and inter-planetary space.

A small group of interested scientists and students gathered in 1936 to experiment with rocket engines, with the encouragement of Dr. Theodore von Karman, aerodynamicist and director of the Guggenheim Aeronautical Laboratory at GALCIT. Not until July 1, 1939, did the group receive financial assistance from the National Academy of Sciences to develop rockets to assist Army Air Corps planes at takeoff. The first units (JATO) were functional by August, 1941, and they cut in half the time and distance required for takeoff.

The need for new propellants led to the development of a liquid fuel rocket engine using the spontaneously igniting combination of red fuming nitric acid and aniline in 1942.

In January, 1944, Army Ordnance asked the Laboratory to begin research and development of long-range guided missiles. New propellants, better metals and remote control devices were required. With this stimulus, JPL's facilities and staff increased. A family of test vehicles grew up which used a solid fuel. JPL pioneered in telemetry, the transmission of instrument recordings via a radio link, when it became increasingly difficult to gather data from the high-flying rockets.

Eventually radio guidance methods were developed, and then inertial guidance systems which were invulnerable to countermeasures because they could automatically adjust to a predetermined flight path.

Solid fuels were improved by the substitution of a polysulphide manufactured by Thiokol, for asphalt. Thiokol has since grown to giant size in the missile business. The new fuel bore extreme temperatures well, burned with a lower chamber pressure, permitted lighter rocket casings, and could itself be used as an insulator. The "internal burning star" design, developed simultaneously in England and at JPL, maintained a steady burning rate, constant pressure, and constant thrust by keeping the inner surface area constant. In a 1947 report, JPL advocated the consideration of solid fuels for high performance, long range missiles.

During this program to reduce some of the inherent difficulties of solid fuel rockets, JPL engineers made important contributions to rocketry. To eliminate the mechanical support or "trap" that was used to hold the charge inside the rocket casing, a bonding material was inserted on the inner wall of the chamber. The molded charge was inserted into the rocket and secured by this material. The method was called case-bonding. The next step was to pour the rubber-base propellant directly into the rocket chamber. By inserting the star-shaped mandril into the casing while the propellant was in a liquid state, the "cast-in case-bonding" method was successfully developed.

JPL's contribution to solid fuel rockets was matched by research on liquid fuels, injectors, cooling systems, and precision valves.

The long-range rocket, Corporal E, was developed into a tactical weapon when international tensions increased in 1949. By April, 1954, it was released to the Army, as America's first operational surface-to-surface radio guided missile. Its more flexible successor, the Sergeant, developed in cooperation with Sperry Gyroscope, was a solid propellant inertially guided missile, America's first "second generation" missile.

A cluster of Sergeants was used in September, 1956, in the Jupiter C, and again in January, 1958, when the Jupiter was used to launch the U.S.'s first earth satellite, Explorer I, which discovered the Van Allen Radiation Belt. Explorer II failed, but Explorers III and IV, orbited in March and July, 1958, brought new information on cosmic ray intensities. *Continued Overleaf*

Grumman Aircraft Engineering

GRUMMAN AIRCRAFT Engineering Corporation, under the direction of Leroy Randle Grumman, as President from 1929 to 1946, and as Chairman of the Board of Directors of the Bethpage, Long Island company since 1946, has developed into an important producer of aircraft, space, and hydrofoil products — as well as into a major research facility.

Among its current projects are the Orbiting Astronomical Observatory, L.E.M. Lunar Excursion Module, Echo Canisters, HU-16 Albatross, S-20 Tracker, E-2A Hawkeye, A-6A Intruder, O-VI Mohawk, and Grumman Gulfstream.

Grumman temporarily abandoned the commercial aviation market at the outset of the Korean conflict, and has had military and space projects as its major contracts.

Research and development facilities have expanded with the addition of a $5 million Electronic Systems Center in 1961, used to ground test space and aircraft systems such as radio, radar, guidance, control, and power systems. The largest radio frequency Anecohic Chamber in the United States is housed here. A new research wing houses nuclear and physics laboratories, including a $200,000 Van der Graaf accelerator. The three million electron volt accelerator, complete with positive and negative ion capabilities, is used for pure nuclear research in addition to investigating such space craft contingencies as secondary state radiation properties in matter (space craft shielding) and the effect of Van Allen Belt electrons on solar cells.

Of its major aircraft in production, the Hawkeye represents a new generation of early warning and intercept control aircraft for the U.S. Navy. Like the WF-2 Tracer, its radome houses long-range detection equipment.

The Gulfstream marks Grumman's return to the commercial aviation market. It was first delivered in June, 1959, as a propjet designed specifically for executive operation. Plans for a more advanced turbofan powered model, the Gulfstream II, were announced in May, 1965. It is designed as the world's fastest corporate transport and will operate in the transonic speed range. □

The Gulfstream I marked the re-entry of the Grumman Aircraft Engineering Corporation into the commercial aircraft field. The Gulfstream has proved an extremely popular executive transport and Rohr builds components for it at Winder, Georgia.

On December 3, 1958, shortly after the creation of NASA, JPL was transferred from Army jurisdiction to the civilian agency. New experiments, including deep space probes, were planned. On December 6, 1958, Pioneer III, a conical fiberglass payload, was launched. It failed to escape the Earth's gravitational pull, but did discover a second radiation belt 10,000 miles above the Earth. The next Pioneer orbited the sun.

A space vehicle tracking facility was set up in the Mohave desert, where the Goldstone Antenna with its 85-foot-diameter receiving dish was built. Two new antennas were added by the end of 1964, and another, the 210-foot-antenna being built by Rohr is due to be completed by January, 1966. The Goldstone complex, together with four overseas stations, the Space Flight Operations Facility at JPL, and a ground communication system linking all locations make up NASA's Deep Space Network.

On August 4, 1960, JPL used the Goldstone antennas to conduct the first two-way transcontinental telephone conversation via the moon. Voice and continuous-wave transmission were sent from Goldstone to the Bell Telephone Laboratory's station at Holmdel, New Jersey.

A week later, with the launching of Project Echo, two-way conversations were held between JPL and BTL via a 100-foot-diameter radio reflective balloon. The Echo balloon, in an orbit around the earth at an altitude of 1000 miles, was visible to millions of people during its first fifteen days in sunlight.

On February 10, 1961, the Goldstone and Woomera dishes were used in sending a telephone message from the United States to Australia via the moon.

The Goldstone facility was used again on March 10, 1961, to bounce radar signals off the planet Venus. This experiment refined the Astronomical Unit (AU), the scale factor of the universe, to 92,956,000 miles plus or minus 1000 miles. Prior to this time, the AU was known only within an accuracy of 60,000 miles. In addition, the experiment produced data that indicated that Venus rotates about once every 225 days, which is the length of the Venusian year.

JPL currently directs a number of NASA's unmanned lunar and planetary projects. These include the Ranger and Surveyor series of spacecraft for lunar exploration and the Mariner and Voyager missions to the planets. □

North American Aviation

North American Aviation's 2000-mile-per-hour XB-70 Valkyrie has pushed the state of the art in aircraft design, construction techniques and materials to impressive new levels.

NORTH AMERICAN Aviation, Incorporated, in just 31 years of operation has grown from a single small plant with 75 employees and one contract to comprise seven divisions employing 103,000 workers, who produce major components of the nation's weapons and space systems.

Its concern has spread to aircraft, aerospace systems, oceanographic research, guidance and advanced electronic equipment, communications systems, rocket propulsion and nuclear energy, and its sales have exceeded one billion dollars in four of the past five years.

After six years as a holding corporation for investments in air transportation and manufacturing companies, North American was reorganized to produce aircraft in 1934. Its first Army Air Corps contract for 42 BT-9 trainers was the beginning; the company was to become the largest builder of military airplanes in the world.

Trainers and fighter planes for World War II were dominant in the company's first years.

The company's first space contract was a feasibility study for guided missiles, awarded in 1946, and was followed by an Air Force contract for the Navajo intercontinental weapon system. Expanded operations required division of the massive company into separate operating components in 1955. The company then consisted of two aircraft divisions and four new ones: Atomics International, Rocketdyne, Missile Development (now Space and Information Systems), and Autonetics. A seventh, the Science Center, was established later, in 1962.

Cancellation of the Navajo program in 1957 involved a loss of one-seventh of the company's backlog of business, but work continued on the XB-70 triplesonic plane and the X-15 research plane. Both have been responsible for technological advancements in every phase of airplane development.

Most of the nation's successful satellites and space probes have been launched into orbit by engines developed at the Rocketdyne Division, the leading producer of liquid-fueled rocket engines. The Rocketdyne engine powered the first American satellite, Explorer I.

The Autonetics Division produces inertial instruments and navigation systems, data processing equipment, radars, flight control, automatic checkout and armament control systems, and microelectronic circuitry. The USS Nautilus and USS Skate used Autonetics' autonavigation systems on their historic trips under the Polar ice cap.

The Space and Information Systems Division (S&ID) is the company's prime organization for research and development of manned and unmanned space exploration vehicles, anti-missile projects, and management of information systems. It is the prime contractor for Apollo, the three-man spacecraft for exploration of the moon, and for the second stage of the Saturn V launch vehicle that will carry the Apollo.

Atomics International Division will build SNAP (Systems for Nuclear Auxiliary Power) reactor systems, for generating electrical power for extended periods in space vehicles, at lunar bases, on the ground and under the sea.

Atomics International is also one of the nation's leading manufacturers of nuclear reactors for central power stations, medical, biological, and industrial research, and for education and training. The division is affiliated with companies in West Germany, France, Sweden, and England for the development and sale of power and research reactors.

Aircraft production continues at the Los Angeles and Columbus Divisions. The X-15, XB-70, and T-39 Sabreliner (a jet utility trainer) are built in Los Angeles.

The largest contract for the Columbus Division is for the supersonic RA5C Vigilante attack and reconnaissance weapon system, a multi-mission aircraft that can attack targets at Mach 2 speeds from high or low altitudes. Counter-insurgency aircraft are in process of development.

The Science Center is located in Conejo Valley, California. It consists of a nucleus of scientists and technicians dedicated to pure research and to broadening the scope of the corporation's technical activities. The Center's efforts are directed toward the fundamental sciences of physics, chemistry, metallurgy, and mathematics. These programs supplement activities in labs of other North American Divisions, which are directed toward advancing product technologies to meet specific developmental goals.

Lockheed Propulsion Company

FOR more than 12 years Lockheed Propulsion Company has been specializing in the research, development, and manufacture of solid propellant rockets for military and civilian space use. During this period, Lockheed has developed and successfully fired rocket motors ranging in size from a few inches long and a little over an inch in diameter to the Free World's first 156-inch-diameter solid rocket. Lockheed Propulsion Company has about 650 employees, many with advanced technical degrees. It occupies three separate sites: Redlands, Beaumont (inactive), and Potrero. It is a division of Lockheed Aircraft Corporation with the full support of that organization, and it has a history of success which has earned LPC a place in the forefront of its field.

In 1952 Grand Central Rocket Co. was founded, operating out of rented facilities in Pacoima, Calif., as the rocket division of Grand Central Aircraft. In June, 1954, the company moved its facilities and 60 employees to the present Redlands site, organized as a partnership, and later incorporated. In 1958, Tennessee Gas Transmission Co. acquired the majority interest in GCR and transferred its controlling interest to Petro-Tex Chemical Corp., jointly owned by Tennessee Gas and Food Machinery and Chemical Corp. Lockheed Aircraft Corporation purchased a half interest in GCR in early 1960 and assumed full ownership in mid-1961. Shortly after this, GCR became Lockheed Propulsion Company. Early in 1963 LPC became an operating division of the Lockheed Corporation to climax a decade of achievement and launch a new decade in an even stronger position in the aerospace industry.

Lockheed Propulsion Company is presently working on important research and development programs under various government contracts.

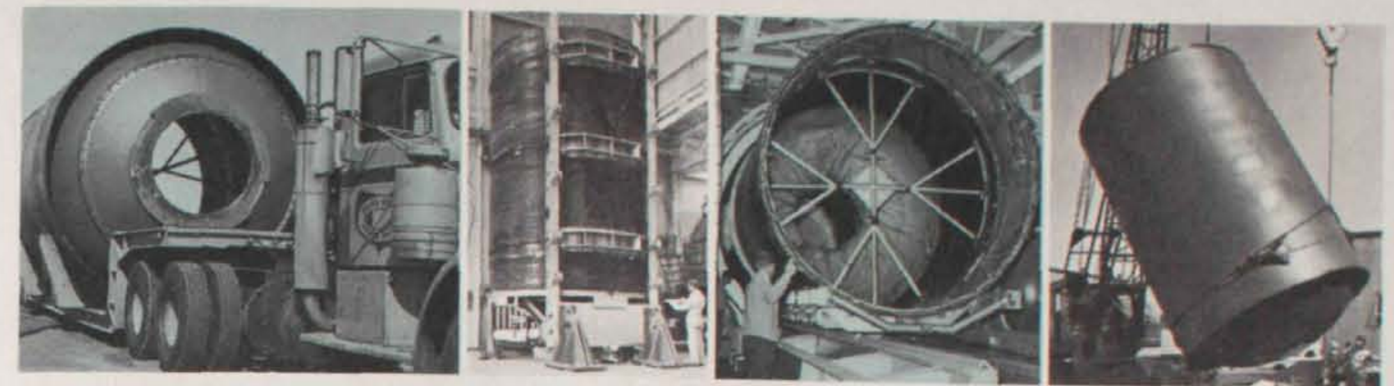
Under the executive management of the Air Force Space Systems Division, LPC designed, built and test fired two giant 156-inch-diameter segmented solid motors in 1964. These firings marked the first time motors of this size had been test fired. The tests were designed to demonstrate the feasibility of large booster motors and to demonstrate in full scale a jet tab system for thrust vector control. Today LPC is working on a second Air Force contract to build and test-fire two more of these giant 156-inch-diameter rockets, one of which will develop more than 3 million pounds of thrust.

In the field of thrust vector control, LPC built and tested the first large-scale thrust vector control system using hot gas bled from the combustion chamber of the motor itself.

In a program for the Navy, LPC is harnessing rocket technology to provide emergency ballast expulsion for nuclear submarines. In addition, the company is developing the propulsion system for the MAULER Army battlefield air defense guided missile. It is also developing a solid rocket motor for an advanced air-to-air missile for Hughes Aircraft. In the field of propellant research, LPC has developed an advanced high burn rate, low cost propellant that will provide for uniquely improved potential for large solid motor ballistic capabilities. Company funded research projects are continually investigating possible break-through areas and intensively accumulating data regarding fundamental science in the comparatively new fields of solid propellant and hybrid (combined solid-liquid propellant) rocket propulsion.

Lockheed Propulsion Company 156-inch solid fuel booster in successful test firing as a part of the U.S. Air Force large solid booster feasibility program.


Motor case section for 156-inch Lockheed Propulsion booster leaving Rohr Space Products Division at Riverside. Rohr installed rubber insulation in the steel case.


156" rocket engine case insulated by Rohr for Lockheed Propulsion Company in 12 days.