

CREATIVE ENGINEERING FOR THE SPACE AGE

*Pesco*

A DIVISION OF THE BORG-WARNER CORPORATION

aerospace  
equipment





MAIN PLANT . . . BEDFORD, OHIO

Better products through creative research and engineering  
PESCO PRODUCTS DIVISION • BORG - WARNER CORPORATION  
24700 North Miles Rd. Bedford, Ohio (44014)

aerospace  
equipment



# CONTENTS

## THE SCOPE OF PESCO

History . . . . .	2
Corporate Heritage . . . . .	4
Management . . . . .	6
Organization . . . . .	7
Geographical Significance . . . . .	8
Borg-Warner Research . . . . .	10
Pesco Products. . . . .	12

## THE PHYSICAL FACILITIES OF PESCO

Manufacturing . . . . .	18
Test Facilities . . . . .	22
Clean-Environment Facilities . . . . .	23

## THE CAPABILITIES OF PESCO

Quality Control . . . . .	27
Reliability . . . . .	30
Training and Service . . . . .	31
Provisioning . . . . .	32
Technical Publications . . . . .	32



**A member  
of the  
AIRCRAFT/  
AEROSPACE  
TEAM  
since 1933**

Pesco Products Division of the Borg-Warner Corporation is a leading supplier of fluid handling components and systems for all types of aircraft, missiles, and ground support equipment.

Pesco's many product lines include high-reliability fuel and fuel booster pumps, hydraulic pumps and power supply systems, electric and hydraulic motors, cryogenic fluid handling systems, including cryogenic motors and pumping systems, axial-flow fans, thermoelectric coolers, and electronic cooling packages.

Organized in 1933 as the Pump Engineering Service Corporation, Pesco began as a modest manufacturer of vacuum pumps and fuel and hydraulic pumps. Now entering its fourth decade, Pesco has produced more than one million pumps and hundreds of thousands of other hydraulic and electrical components.

Pesco is known for the variety of dependable components it has developed for the aircraft and aerospace industries. One of the company's first products was the Model 194 vacuum pump, which is still finding wide application on aircraft instrumentation.

Vacuum pumps were only the beginning. In 1935, Pesco introduced its fuel and hydraulic pumps. When the famed "China Clipper" took to the air in 1939, it was supported by installations of Pesco fuel, hydraulic, and vacuum pumps. After this first venture into commercial aircraft components, Pesco sought to apply its technical knowledge and specialized manufacturing skills to still more products. In 1943, for instance, the company built its first engine-driven centrifugal fuel pump for the Hughes Aircraft Company.

Pesco supplied advanced systems and components to the nation's fighting planes during World War II. Pesco's patented "pressure loading" feature first appeared in pumps installed on the famed P-51 Mustang. Completely submerged fuel booster pumps were used on the P-39 and B-24. Pilots of Douglas F-4s wore flight suits surrounded by an envelope of cooling air circulated by Pesco pumps.

In 1944, Pesco began producing its own electric motors, since commercially-available motors did not meet Pesco's exacting requirements for performance and reliability. The first models were used to drive an emergency hydraulic pump. Shortly after this, Pesco developed an electric motor-driven fuel vane pump to pressurize gasoline cabin heaters on bombers.

Commercial aircraft adopted many of Pesco's wartime-developed products for new passenger comfort and operating dependability. The Lockheed Constellation, for example, used Pesco fuel and hydraulic pumps. In 1945 and 1946, two-stage compressors for cabin pressurization made their appearance.

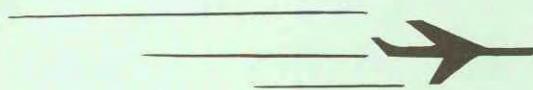
With the rapid changeover to jet-powered military aircraft during the first postwar years, Pesco applied its vast engineering experience and product knowledge to this important new field. In 1945, the company developed for the F-80 a two-stage unloading pump which was later adopted by the Swedish Air Force. In 1946, Pesco delivered the nation's first turbine-driven afterburner pump. Weighing 9 pounds and delivering 25 horsepower, it was the forerunner of afterburner pumps used today.

Pesco has demonstrated a unique ability to

convert anticipated requirements into dependable devices with sustained performance capabilities. This is affirmed by the fact that Pesco pumps and equipment are installed on virtually all of today's major aircraft, and by Pesco's continuing record of association with "milestone" flight vehicles.

Pesco has also kept pace with the expanding needs of national defense and man's far-reaching probes into space. When the United States modified the German V-2 rocket as its first major operational vehicle of the missile age, a Pesco motor-driven hydraulic pump was specified. Today, Pesco pumps and power equipment are being used on all versions of the Polaris, the Pershing, the Minuteman, and other missiles.

Airframe, engine, missile and space vehicle manufacturers depend upon Pesco's extensive technical knowledge and practical manufacturing experience to translate new performance and reliability requirements into precision components and systems with advanced capabilities for powering or guiding flight.



# MANAGEMENT

The strength of Pesco Products Division lies in the competence of its management team. Each member contributes specialized knowledge and experience to the operation of the business. Individual skill and judgment are backed by corporate direction and consultation on matters of finance, capital investment, subsidiary activity, and operating policy.

Each of the individuals charged with divisional responsibility has a broad background of experience in his particular area of activity. Thus, he contributes to the successful operation of the division not only as a member of the management team, but as a practitioner in his specialized field of interest, as well.



D. R. SPOTZ  
*President*



T. R. THOREN  
*Vice President Engineering*



R. F. FREESE  
*Vice President-Treasurer*



W. J. WHITEHOUSE  
*Director Manufacturing*



M. W. NESBITT  
*Vice President Sales*



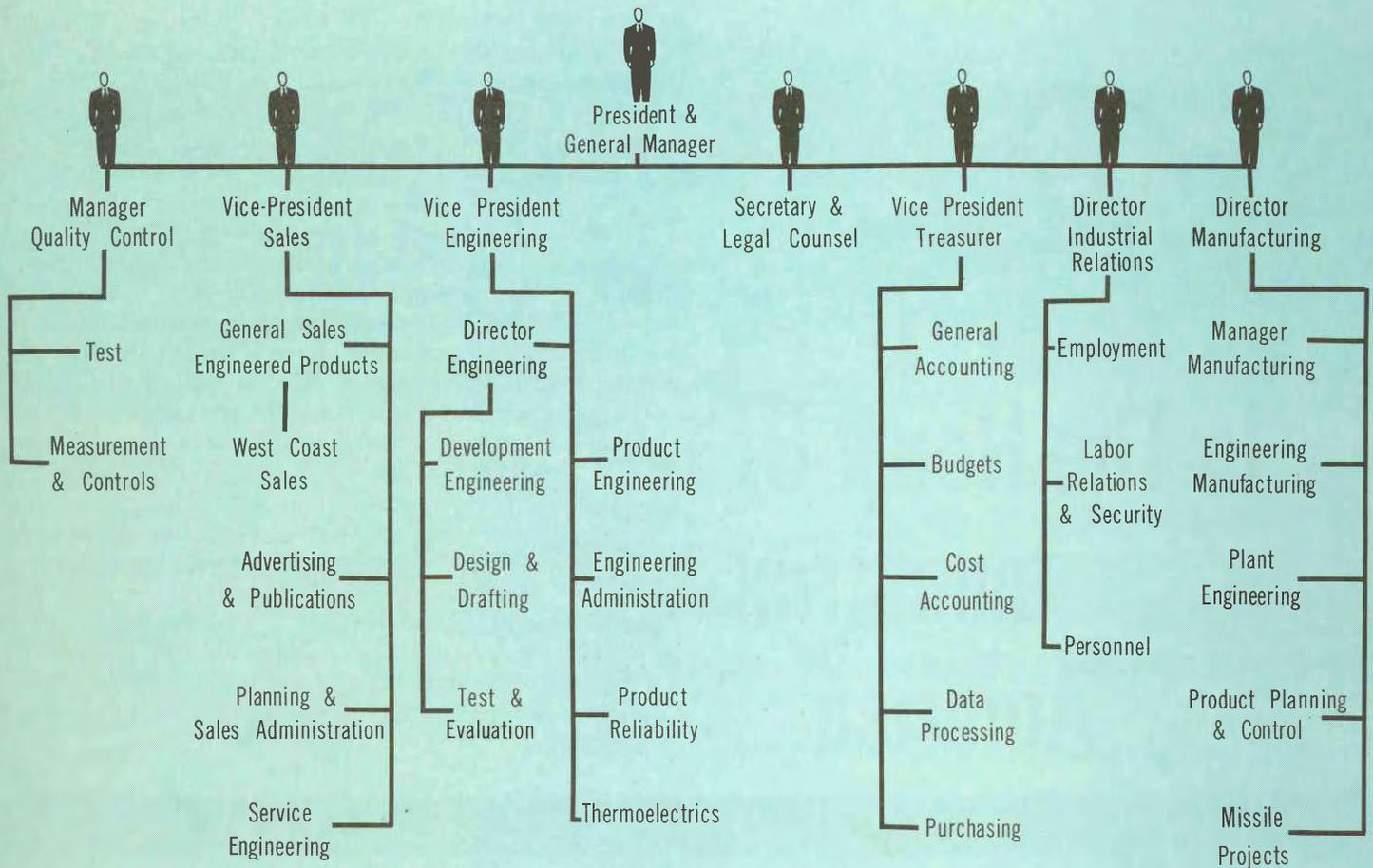
R. O. EVANS  
*Secretary & Legal Counsel*



O. A. STELL  
*Director Industrial Relations*



J. D. SELONG  
*Manager Quality Control*



# ORGANIZATION

As a division of Borg-Warner Corporation, Pesco operates as an independent activity with full responsibility for all phases of business including marketing, engineering, manufacturing, and finance.

Pesco's management is organized horizontally through the staff level and vertically within individual departments. Overall operations are directed by the division president, with each key management function assigned

to an executive with broad experience in the area of his particular responsibility. A specific breakdown of these various elements of the management structure is indicated by the organization chart above.

The financial statement of Pesco Products Division is a part of the Borg-Warner Corporation annual report, a copy of which is available on request.

# Pesco

## In The Heart Of Industrial America...

## Draws The Top Workers From A Skilled Labor Pool

The main plant of Pesco Products Division is located on a 30-acre site in Bedford Heights, Ohio, a south-eastern suburb of Cleveland.

The plant is ideally located with respect to transportation for raw materials and finished products as well as for personal travel. There are five major railroads, 150 truck lines and 11 airlines serving Cleveland. The St. Lawrence Seaway provides a gateway to ocean shipping, and the Ohio Turnpike and the Federal interstate highway system serve the area.

A rail spur is located near the property and numerous truck lines have terminals located within minutes of the plant. Major highways link the facility with both the Cleveland and Akron municipal airports. The plant can be quickly reached from a nearby interchange of the Ohio Turnpike.

Included in the main plant are 302,000 square feet of production area plus ample space for development and test laboratories, warehousing, and service facilities. Modern offices within the plant house administrative and engineering personnel.

Proximity to suppliers of raw materials and manufacturers of components and semi-finished products is another significant advantage of Pesco's Cleveland location.

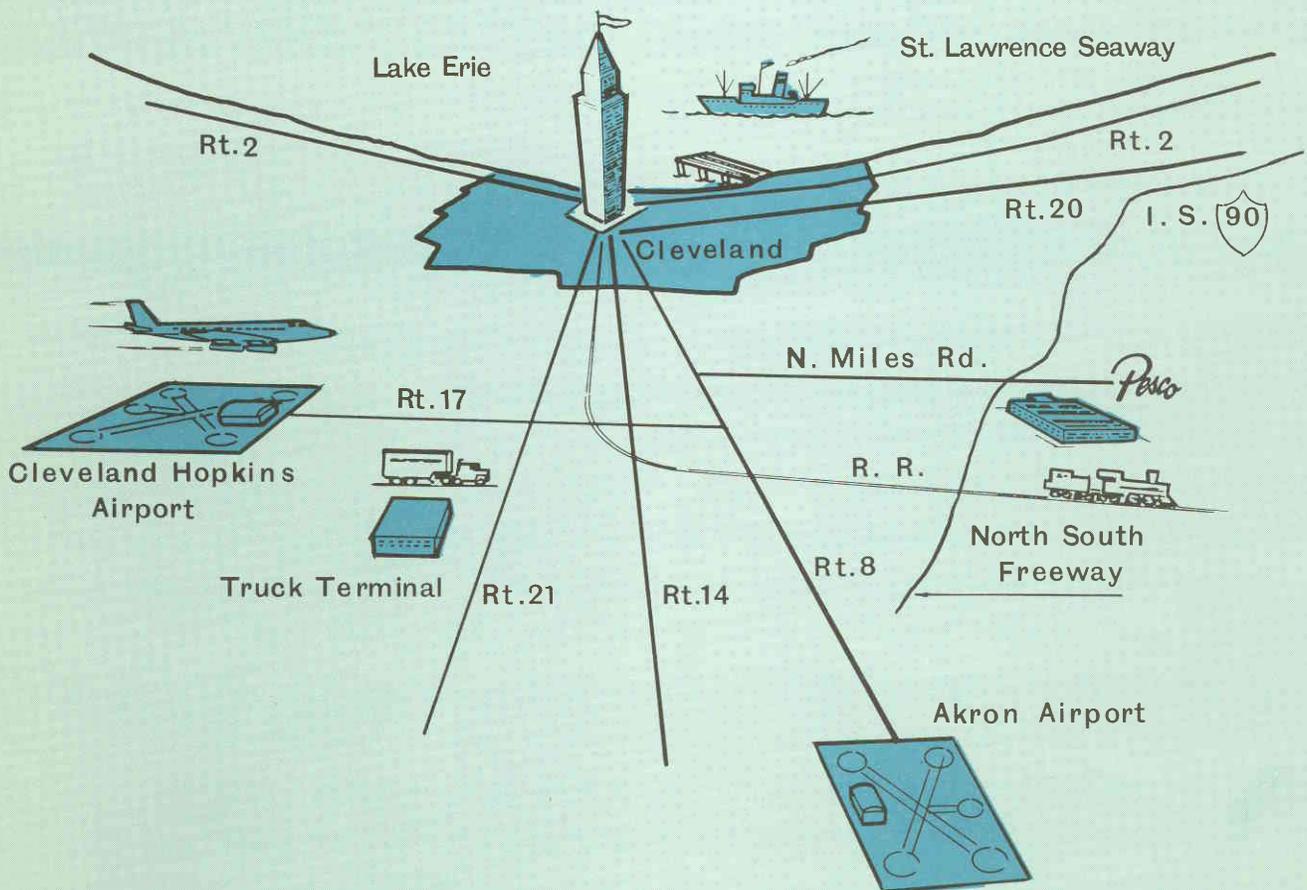
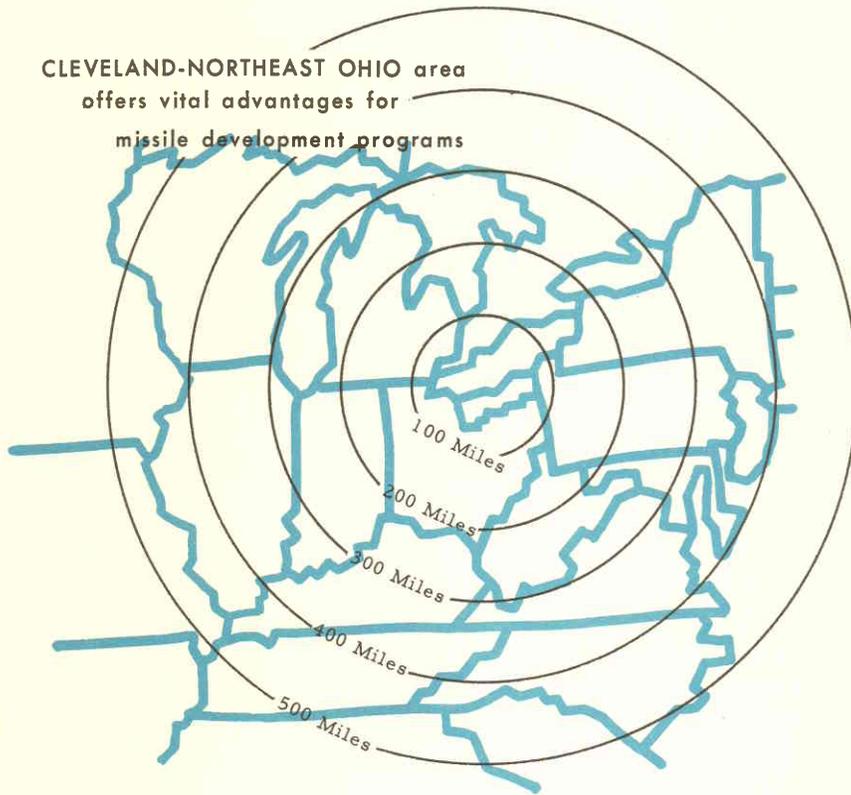
Three-quarters of the nation's production facilities and half its population are located within a 500 mile radius of Cleveland. In the greater Cleveland area alone are 3500 manufacturing firms employing 325,000 people. A location in this area offers many advantages to an aircraft/missile-oriented company such as Pesco. The area provides one of the country's largest skilled labor pools. Included in this tremendous potential are 35,000 people employed directly in the production of aircraft and missile components.

In all, there are more than 310 types of production activity accounting for the manufacture of more than 2000 separate product classifications.

The public schools of the area are highly rated and provide a substantial nucleus of high school graduates qualified to fill job vacancies. Many excellent trade schools permit Pesco to choose well-trained young people who are adequately prepared for a career in precision manufacturing.

Two top-ranking engineering colleges, two universities, and four colleges of liberal arts provide many of the professional and administrative people who work at Pesco.

CLEVELAND-NORTHEAST OHIO area  
 offers vital advantages for  
 missile development programs





Borg-Warner Research Center

# Borg-Warner Research Center

Extending Pesco's engineering development facilities is Borg-Warner's Roy C. Ingersoll Research Center at Des Plaines, Illinois, a pioneer in advanced design concepts and basic product development.

This multi-million dollar facility is staffed with more than 150 well-qualified scientists, engineers, and technicians, and is equipped with precision instrumentation to translate theory into mechanics, ideas into hardware.

Functionally, the Borg-Warner Research Center operates within clearly-defined research parameters to fulfill the technical requirements of the various Borg-Warner divisions.

Activity at the Research Center includes basic work in the chemical, mechanical, physical, electronic, electrical and metallurgical sciences. Materials research and analysis are also prime functions.

From these efforts come many significant contributions to America's aerospace technology.



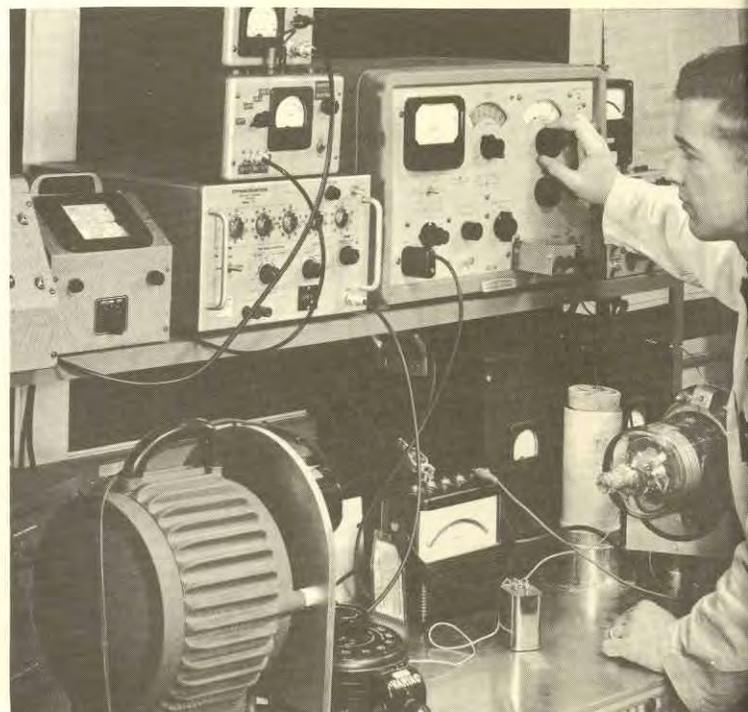
Thermal and electrical analyzing equipment.



Thermoelectric testing apparatus.



Research Center analog computer.



Laboratory instrumentation in a typical set-up.

# Pesco Engineering Capability

Exceptional liaison among engineering groups has been a traditional characteristic of the Pesco operation, and a significant influence in the company's manufacturing concept.

Close communication and personal contact insure complete integration of the design and development functions—and carry over into the production phase, as well.

Pesco attacks complex problems with group thinking. For example, a metallurgist, a mechanical designer, a hydraulic engineer, a thermodynamics expert, and a project manager may combine to form a synthetic all-around proficiency; and the cumulative knowledge of this proficiency is available to the person assigned primary responsibility for the project.

Historically, this concept has proved to be of tangible value to Pesco customers. It has stimulated design ingenuity, minimized development time, increased product reliability, and stabilized the transition from engineering to production.

The integrated engineering function at Pesco is administered by a vice president, with a Director of Engineering assisting in a staff capacity and exercising line supervision over Design & Drafting, Development Engineering, and Test & Evaluation.

Basically, products originate in Pesco's Development Engineering Department, with the company's Chief Engineer as immediate supervisor. Available for day-to-day contact and participation are groups specializing

in dynamic devices, positive displacement pumps, cryogenics, and electric motors.

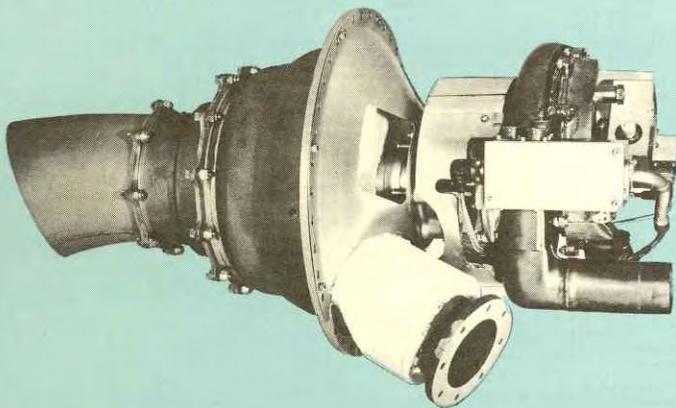
Supporting—and sharing responsibility with—the Development Engineering Department are the Test & Evaluation and the Design & Drafting Sections. The former provides significant laboratory services in metallurgy and chemicals, fuels and pneumatics, hydraulics, and electricity. Incorporated in the latter function are specialists in standards and specifications.

The Development Engineering group and its associated departments are staffed for complete capability from design concept to pilot model, and exercise total control over prototype production.

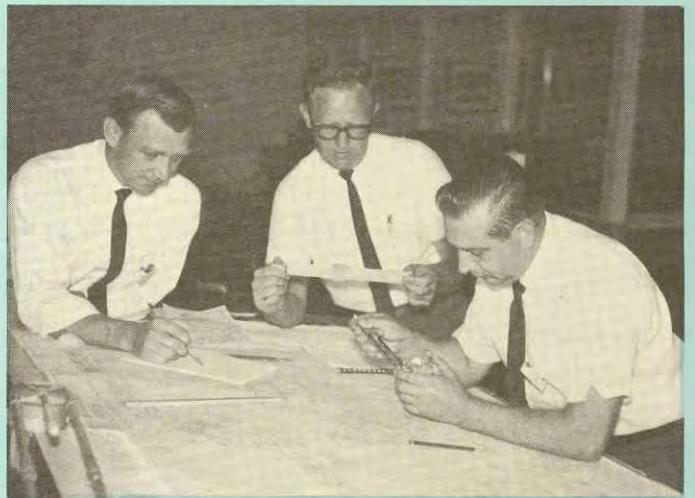
Once manufacturing has begun, cognizance and responsibility shift to Pesco's Product Engineering group. Duties of this organization consist of design changes to reflect new application requirements, and liaison with customers is a vital function contributing to production efficiency and customer satisfaction.

Pesco's orientation toward engineering is apparent throughout the production sequence. In the Purchasing Department engineering buyers are alert to engineering essentials, and engineering schedulers in production control assure optimum coordination among operations.

The capability and technical imagination of Pesco engineering are best evidenced by the products which appear on the pages that follow. Some have advanced the state of the art. All have achieved specific objectives—efficiently and dependably.



Pesco liquid hydrogen pump with turbine drive.



# PESCO PRODUCTS

On these pages are listed some of the basic products and systems developed and currently manufactured by Pesco Products Division.

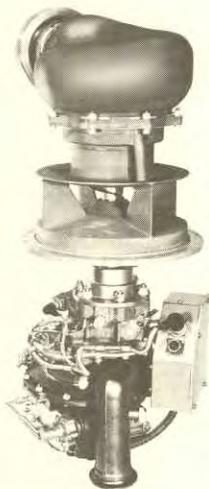
Although the concepts they represent are becoming conventional through acceptance and use, design characteristics invite modification of the items to meet individual application requirements. Many of the products, in fact, have been developed specifically as elements of a fully-integrated system or power package.

And through its advanced research program, Pesco has developed important, often highly-sophisticated,

concepts from theory into the realm of practicability even before the products have been in field demand. This program, too, has provided preliminary information on feasibility and cost, and has been a definite factor in reducing project lead time.

Current production programs for these components illustrate the broad range of development and manufacturing capabilities at Pesco. Every product has been designed and produced by Pesco's own team of management, engineering, and production specialists.

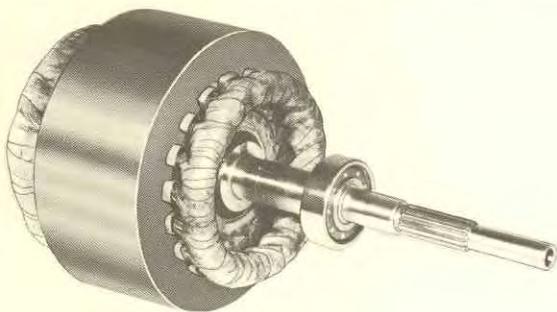
## CRYOGENIC SYSTEM COMPONENTS



### *Cryogenic Pumps*

Single- and multi-stage centrifugal pumps for handling cryogenic fuels and oxidizers have been developed by Pesco. Designed for horizontal or vertical installation, either submerged or externally mounted, the pumps provide instantaneous starting or stopping, even after 24-hour soaking in cryogenic fluid.

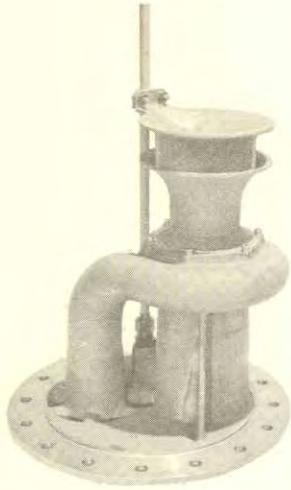
Facilities for testing cryogenic pumps to 25,000 rpm at 1000-foot head, 500 gpm flow, and at temperatures below  $-400^{\circ}\text{F}$  are available in Pesco's cryogenic laboratory.



### *Cryogenic AC and DC Electric Motors*

A high horsepower-to-weight ratio is the outstanding characteristic of Pesco AC electric motors designed for submerged operation in cryogenic fluids. Six sizes of three-phase, 400-cycle, 200-volt cryogenic motors are available, ranging from 0.2 hp at 11,500 rpm to 50.0 hp at 23,000 rpm.

Submersible DC cryogenic motors running in liquid nitrogen resolve the problem of low starting torque at cryogenic temperatures encountered with AC motors.



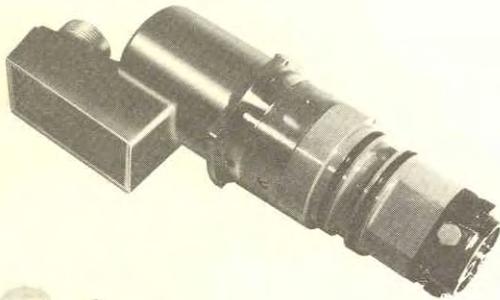
### *Cryogenic Chilldown Pumps*

Single-stage, volute type centrifugal pumps for pre-operation chilldown of cryogenic liquid systems have been developed and produced by Pesco Products Division. Incorporating a centrifugal impeller and an axial flow inducer for improved vapor handling ability and suction performance, Pesco chilldown pumps are built to eliminate problems of lubrication, wear, and extra weight by having both impeller and inducer mounted directly on the electric motor drive shaft. Hydraulic axial loads from the pump impeller on the bearings are hydraulically balanced so that bearing operation, even under conditions of low lubricity of cryogenic fluids, is reliable during extended periods of high speed operation.

---

## HYDRAULIC PUMPS AND MOTORS

---

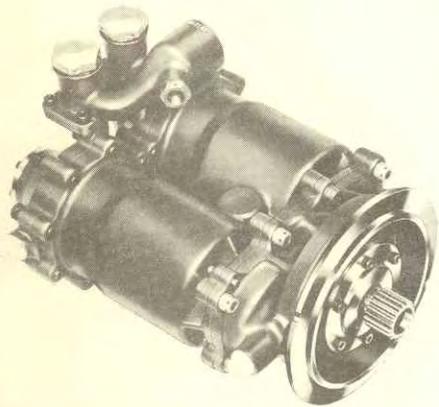


### *Variable Displacement Piston Pumps*

Pesco variable displacement pumps combine uniform flow rates with high volumetric and torque efficiencies. By reversal of hydraulic connections, these components serve as high-power-output hydraulic motors.

The units are available either with stationary or rotating cylinder barrels. Models with rotating barrels feature pistons of unique spherical design which eliminate piston-bore galling; prevent piston seizure under thermal shock, cylinder distortion or fluid contamination; and eliminate side-load wear, maintaining peak efficiency during unit life.

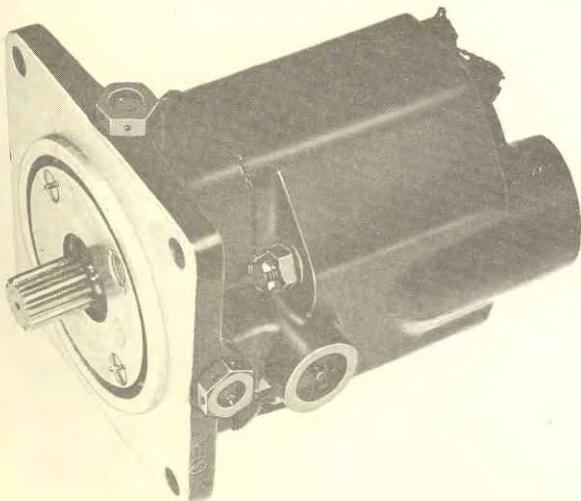
Pump or motor speeds range to 24,000 rpm, and operating temperatures as high as 700°F are permissible. A design advantage of Pesco units is their fast response to flow variations, which can be as low as 0.02 seconds from zero to full flow.



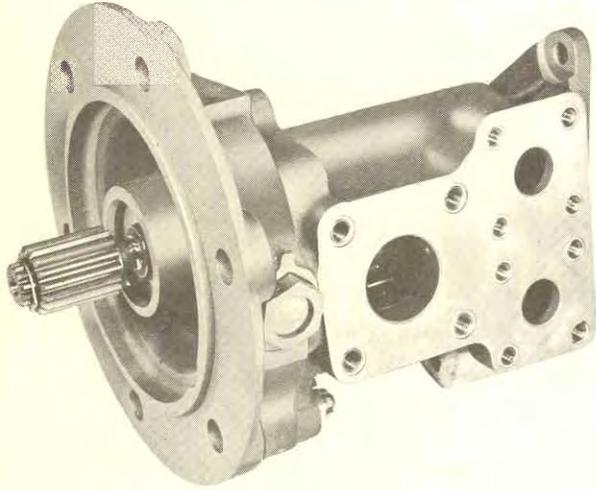
### *Positive Displacement Gear Pumps*

Pesco positive displacement hydraulic gear pumps assure uniform flow rates, sustained operating efficiency over extended periods, and high volumetric and torque efficiency.

Characteristics include suction capabilities for reliability up to 50,000 feet without pressurization, operating pressures in excess of 5000 psi, speeds to 24,000 rpm and flow ratings from 0.2 to 50 gpm.



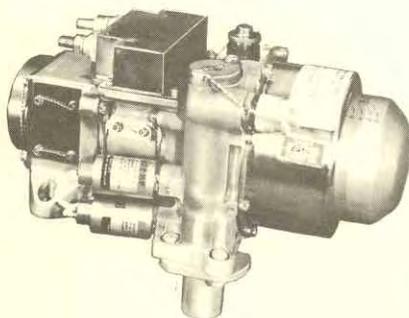
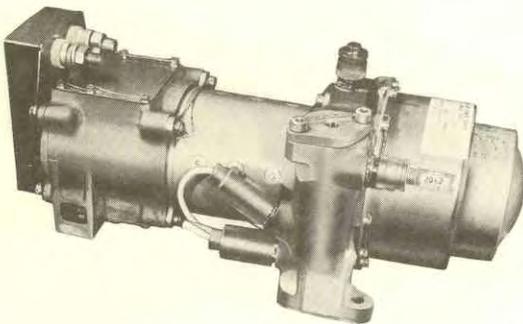
# PESCO PRODUCTS



## *Multi-Element Gear Pumps*

Pesco multi-element gear pumps are designed for fail-safe operation in airborne lubrication, scavenging, hydraulic-power and liquid-transfer systems. Any combination of these functions can be built into one housing designed to meet specified space, weight and drive requirements. Engineered to perform reliably up to 50,000 feet without pressurization, they operate in temperature ranges from  $-65^{\circ}$  to  $600^{\circ}$ F and have displacements of .004 to 3 cubic inches per revolution.

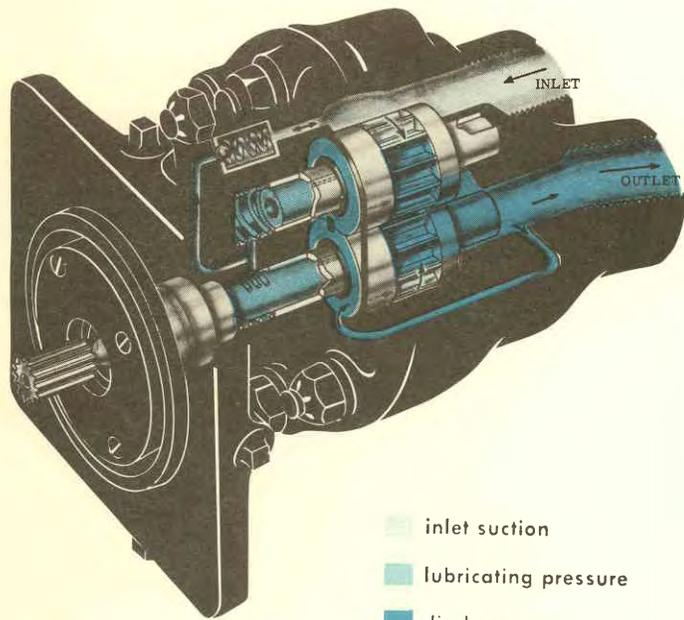
## INTEGRATED HYDRAULIC POWER PACKAGES



Pesco integrated hydraulic power packages are developed and manufactured to meet specific environmental and performance conditions. Units have been built to produce pressures in excess of 5000 psi, and flow rates up to 50 gpm.

A typical Pesco hydraulic power package consists of an appropriate drive—electric motor, hydraulic motor, or turbine—a Pesco variable displacement piston pump or a Pesco fixed displacement gear pump, a reservoir, and necessary filters, controls, valves, connectors, and other auxiliary equipment to meet the system specifications. All components are carefully selected and custom-engineered into a compact unit meeting the space and weight limitations, while assuring optimum system performance.

The drive used on a particular power package is selected on the basis of the type of power available, the duty cycle of the hydraulic power system, the output required, and weight-versus-horsepower considerations. For most missiles, small hydraulic pumps are driven by DC motors. Depending upon the application, an aircraft power package may employ a turbine drive, a hydraulic motor, or an electric motor as the system prime mover.



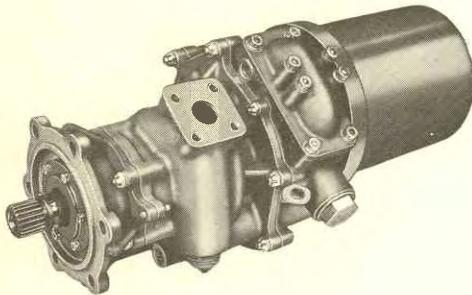
- inlet suction
- lubricating pressure
- discharge pressure

## PRESSURE LOADING...

*the heart of every Pesco gear pump*

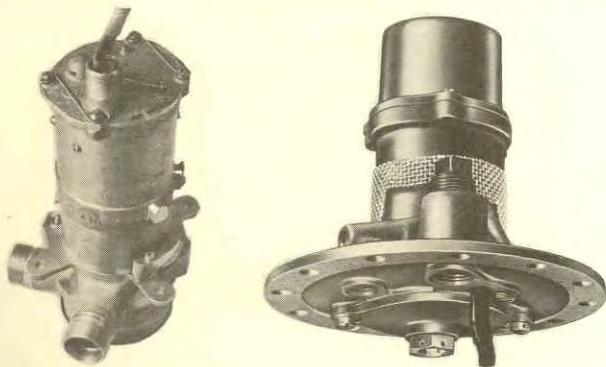
Pressure loading is a unique principle developed and patented by Pesco. Two of four bearings "float" in the housing, and are directed toward the gears by discharge pressure. Pressure in the gear cavity counter-balances the "pressure-loading" force to maintain end clearance. This unique design provides extra-long life, high operating efficiency, uniform flow rates with volumetric efficiency to 97% and torque efficiency to 92%.

## FUEL PUMPS



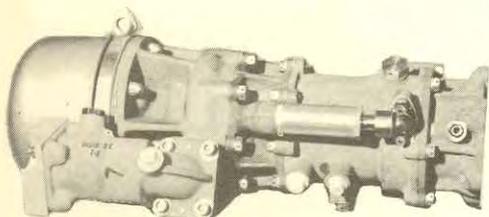
### *Fuel Gear Pumps*

Specified on almost every operation military and commercial aircraft in service today, Pesco gear-type fuel pumps have been performance-proved under the most severe operating conditions. Capacities range from 1.8 to 186 gpm with discharge pressures up to 1500 psig. Speeds range to 7000 rpm. These pumps are capable of handling all commercial and military fuels.



### *Fuel Booster Pumps*

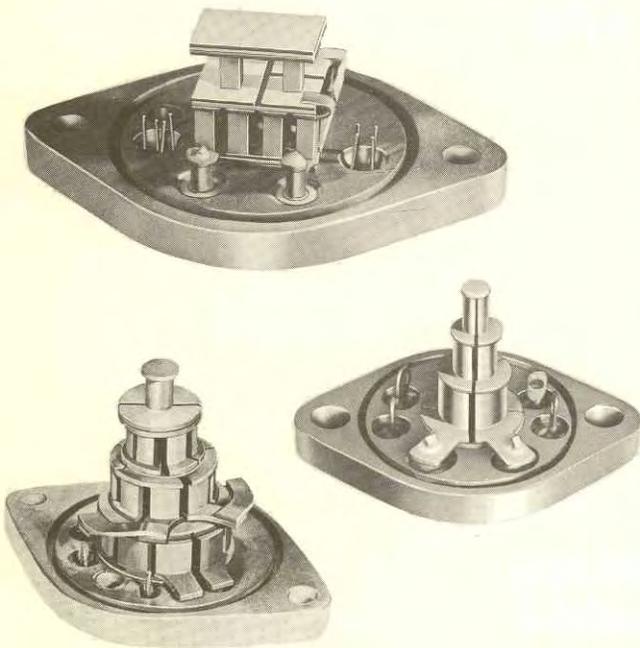
Lightweight, vane-type Pesco fuel booster pumps are designed to deliver pressurized fuel to engines at all altitudes. Both the pump and the electric motor which drives the unit are designed, developed, qualified and manufactured by Pesco to assure single-source responsibility. Tank-mounted and line-mounted models are available, with operating speeds to 24,000 rpm; pressures to 40 psi; and flows to 1,000 pph.



### *Centrifugal Fuel Pumps*

Increased emphasis on contaminants in fuel systems has dictated the need for examination of new pump concepts. Various types of centrifugal pumps, both in-line and tank-mounted, are being investigated at Pesco. Already developed is the after-burner pump for the F-111 aircraft and booster pumps for the C-130 and C-141 aircraft. The F-111 afterburner pump is one of the largest centrifugal types ever designed.

## THERMOELECTRIC COOLERS



Pesco thermoelectric coolers can be used wherever spot cooling is required to increase sensitivity and life in infrared detectors, semiconductors, electric components and special instrumentation. Cascaded cooling elements up to four stages give heat-pumping capacities from  $-35^{\circ}\text{C}$  to  $-99^{\circ}\text{C}$  under no-load conditions, and from  $-30^{\circ}\text{C}$  to  $-78^{\circ}\text{C}$  with loads to 15 mw.

Their miniature size and rugged construction makes thermoelectric coolers ideally suited for applications where space limitations and operating conditions are severe. A variety of types and sizes is available as basic hardware or in evacuated Kovar, glass or sapphire window-type enclosures.

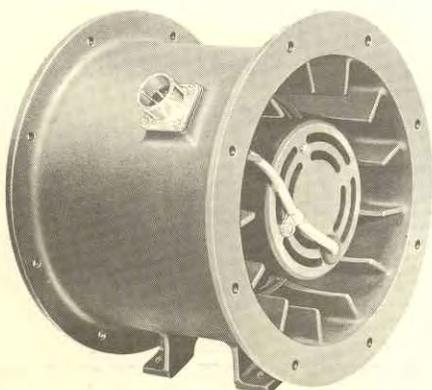
New cooler designs emphasize rugged, uniquely-cascaded 2-, 3- and 4-stage units with low power-consumption requirements.

## PACKAGED ELECTRONIC COOLERS



Completely-integrated heat-dissipation systems for cooling electronic equipment are products of Pesco. These high-performance cooling systems feature exceptional light weight, small size, integral construction and the reliability resulting from Pesco's single-source responsibility. Systems for liquid-to-air, liquid-to-liquid and air-to-air are available, with capacities ranging from 30 to 600 BTU/min.

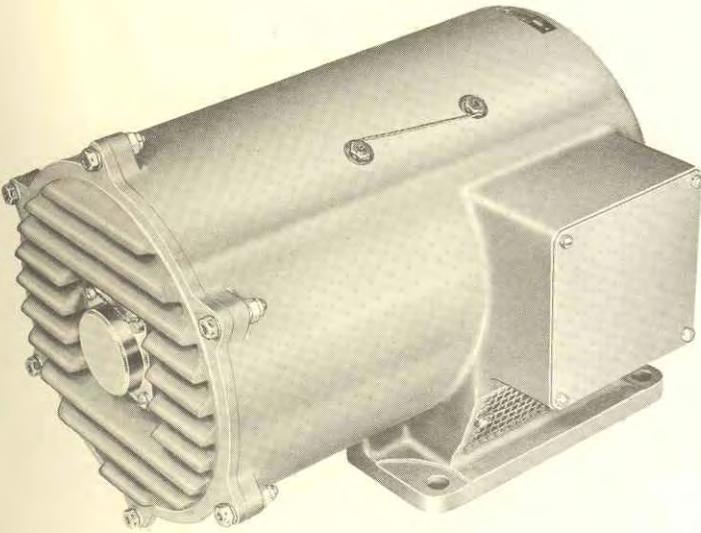
## AXIAL FLOW FANS



Pesco axial flow fans are designed for a wide variety of industrial and military applications where a rugged, integral, air-moving source is required in a compact package. Flow rates range from 20 to 45,000 cfm, and specially-designed "anti-stall" impellers eliminate dip in the stall range. Other features include reduced operating speeds and noise level, high blade loading, and exceptional weight-to-airflow ratios. A wide range of models—direct, geared, belted—with Pesco-built electric motors are available.

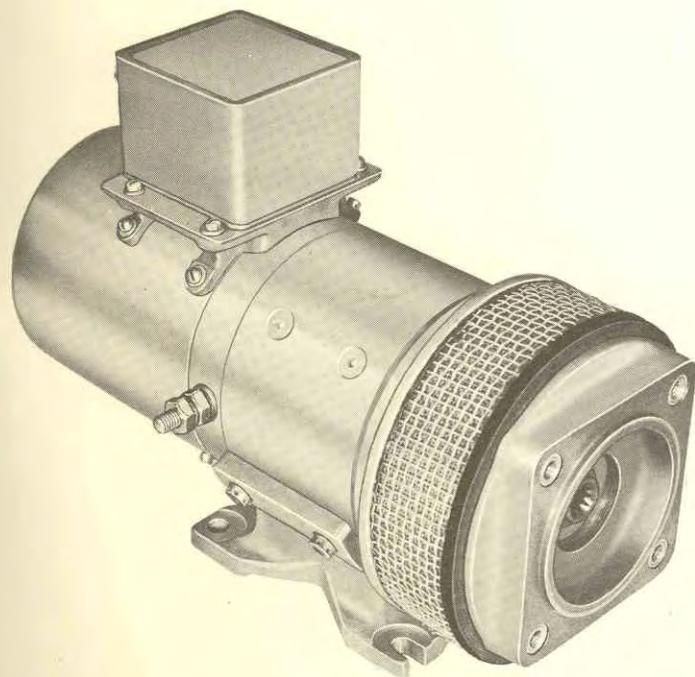
# PESCO PRODUCTS

## ELECTRIC MOTORS



### *High Frequency AC*

Designed to meet aircraft and space-industry requirements, these small, highly-reliable electric motors are suited to continuous-duty service under the most severe operating conditions. Designed for 400 cycle, single or 3-phase, 115-, 200- or 416-volt operation, they are available in six frame sizes with capacities from .018 to 16 HP. Speeds range up to 23,000 rpm.



### *Lightweight DC*

Pesco DC electric motors are designed to meet the demand of both military and industrial service. Highly efficient and completely reliable, they feature light weight and minimum size. Five frame sizes meet power requirements from .005 to 15 hp, with speeds ranging up to 15,000 rpm. Series, shunt or compound windings are available for 6- to 112-volt operation.

# MANUFACTURING

Precision is the watchword of Pesco production facilities, just as performance and reliability are inherent in all of Pesco products.

At Pesco, manufacturing is divided into groups according to the type of machine—chuckers, drills, gear cutters, millers, grinders and the like—by specific functions of departments, such as heat treating, anodizing and plating, receiving inspection, service inspection, assembly, testing or shipping, to name a few.

With each department functioning as an integral, though specialized section of the manufacturing complex, Pesco achieves the versatility and flexibility so vital in meeting each customer's most exacting requirements while assuring on-time delivery.

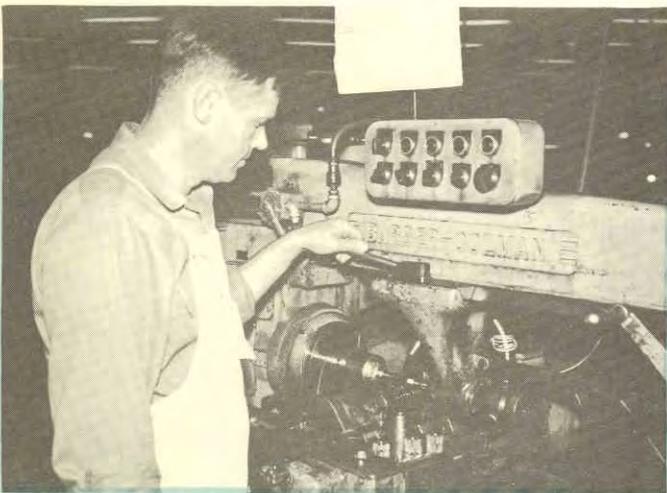
The factory organizational plan not only permits smooth well-ordered flow of materials and components, but is conducive to quality workmanship. Each department is manned with highly specialized personnel who are given an opportunity to operate extensively within their fields of training. Thus, they are able to increase their specialized skills and abilities consistently.

In addition to a full complement of standard machine tools—including engine lathes, turret lathes, automatic chuckers and bar machines, internal and external grinders, drill presses, and milling machines—Pesco is equipped with a wide range of close-tolerance special machines. Two precision jig mills, for example, assure production of parts with 0.0002" accuracy. A special grinder is capable of accuracies to 0.000020" on flats and 0.000010" roundness.

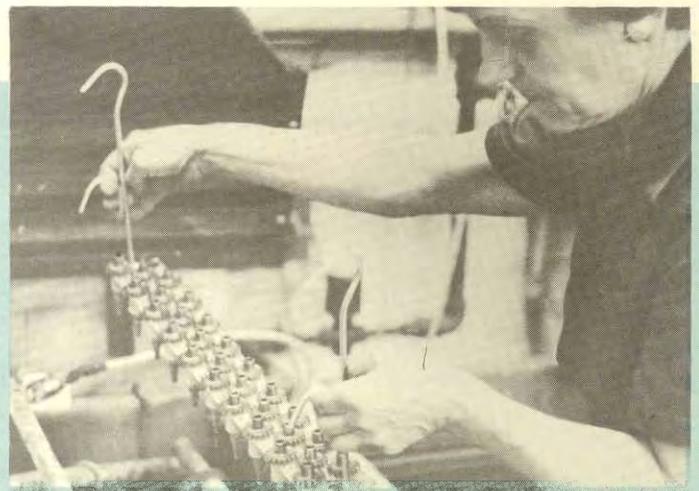
Three departments are devoted to precision gear cutting and grinding. One of these is in an atmospherically-controlled room where superfinishing and honing operations are performed.

Here, surface finishes of less than 1 microinch are obtained and gears are matched to within 0.000050".

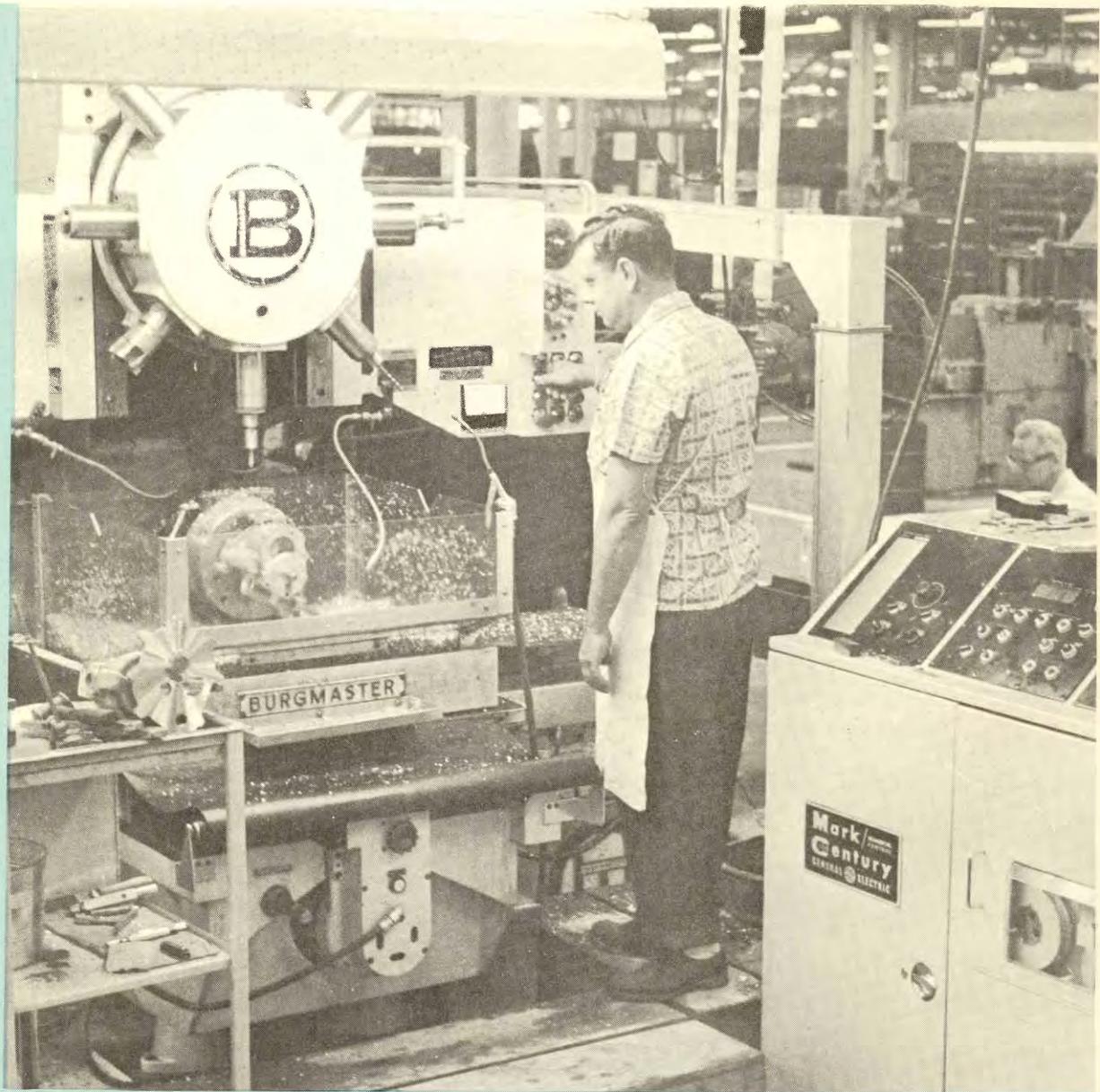
Sixteen automatic boring mills and twenty automatic screw machines are available for handling stock up to 3½" diameter. A complete heat-treating department with fourteen furnaces assures close supervision of metal characteristics. Anodizing and plating, along with auxiliary cleaning equipment, is provided in the plant.



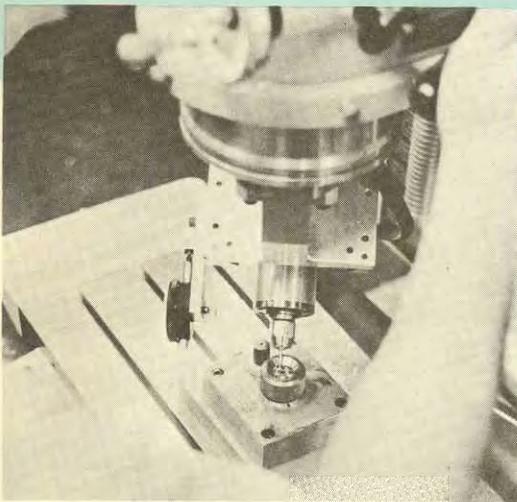
Precision pump gear teeth being milled on a Barber-Colman miller.



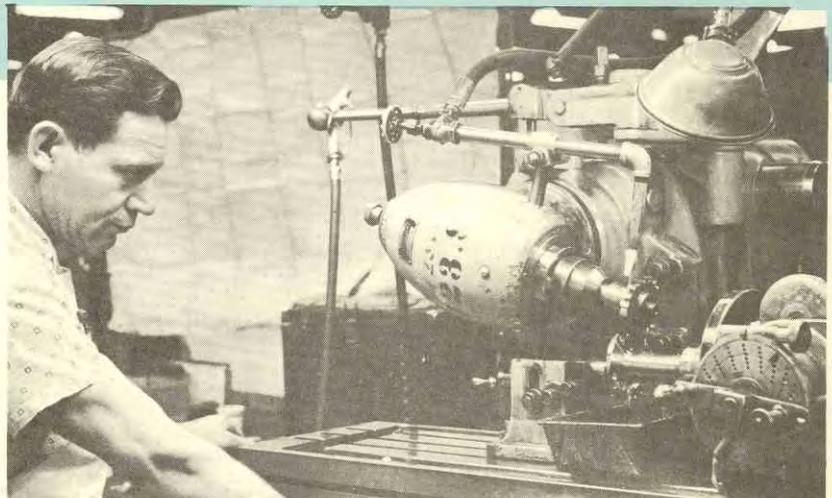
Anodizing gear sets for a Pesco hydraulic gear pump.



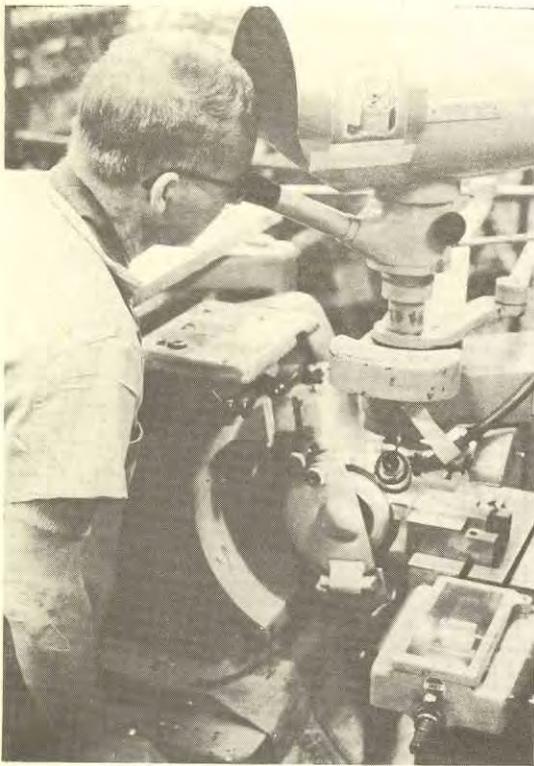
Burgmaster, 8-spindle numerical control machine.



Tiny cylinder barrels are ground on a Moore Jig Grinder.



Milling a cryogenic pump shaft.

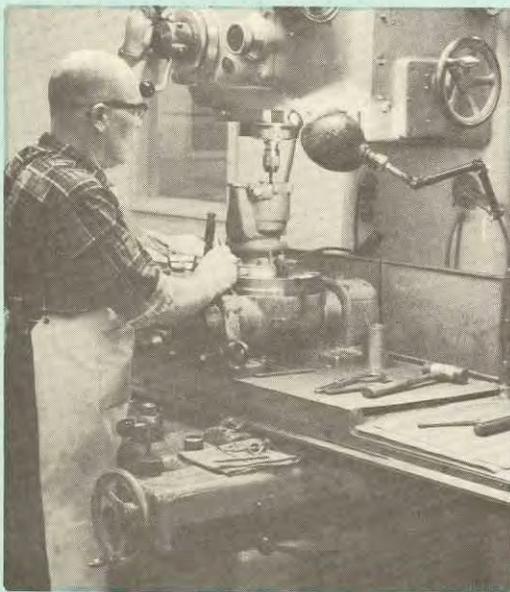


Sheffield Micro Form grinder.

## MANUFACTURING (cont.)

A complete, fully-equipped experimental model shop for the production of experimental models and prototypes is also provided. A completely-equipped tool making department produces many of the tools used at Pesco.

In Pesco's gage crib are precision and ultra-precision facilities for calibrating all master and working gages in accordance with military specifications MIL-Q-9858 (Quality Control) and MIL-Q-45662 (Gage Calibration System Requirements). In addition, there are Pesco facilities to meet or exceed all requirements of MIL-Q-5923 pertaining to general quality control practices.

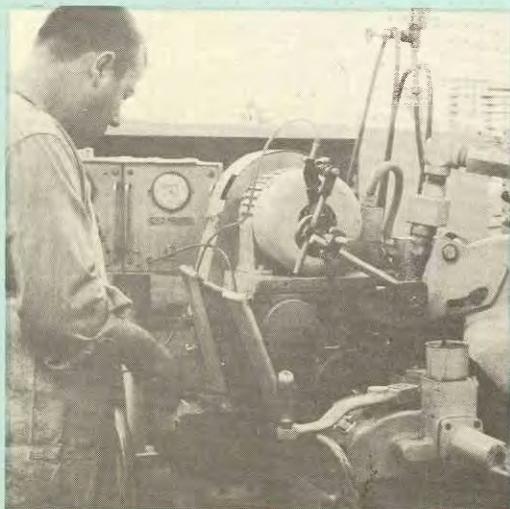


Boring operations on a fuel pump using a Linder jig borer.



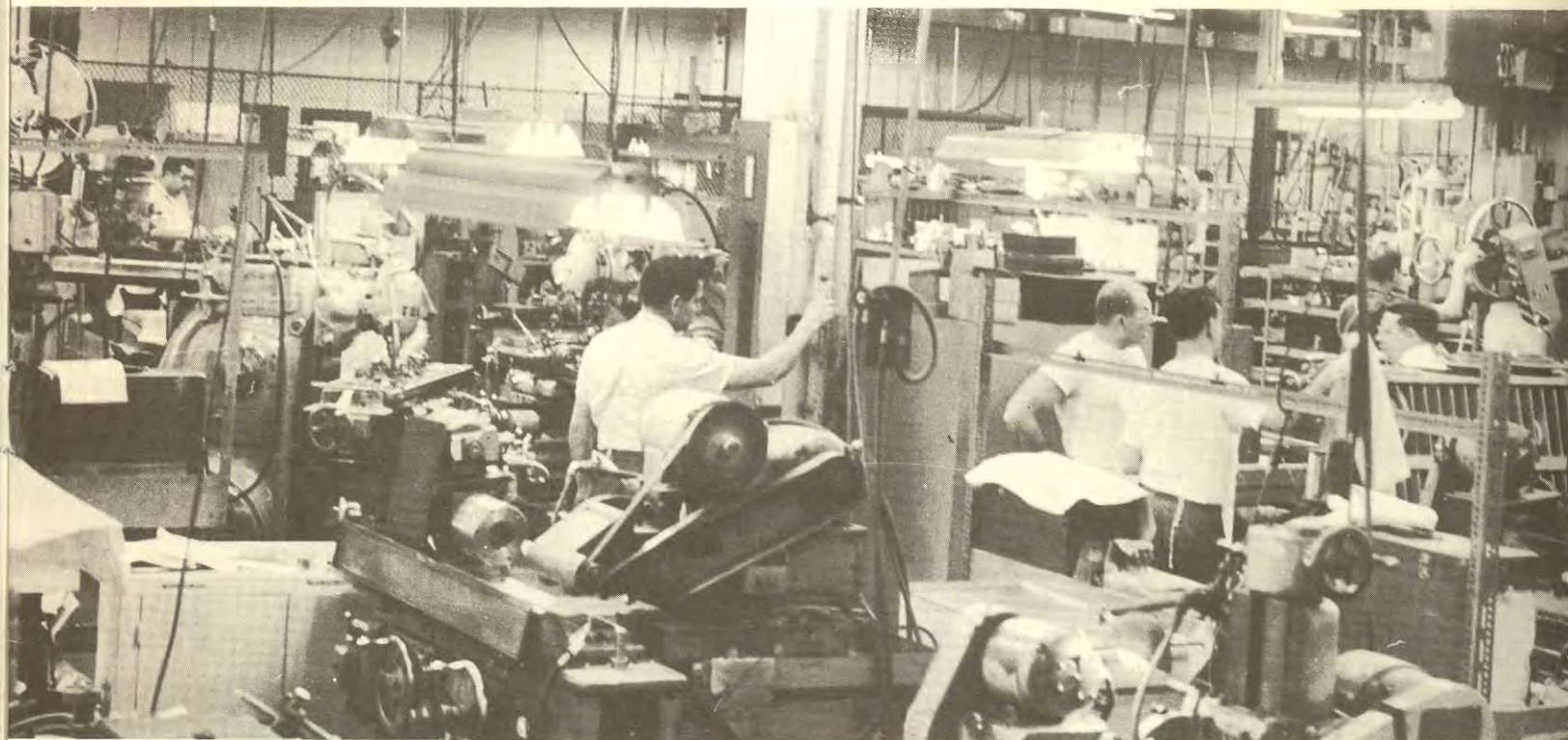
Binocular microscope used to deburr precision pump parts.

Grinding gear set journals on a Cincinnati angular head grinder.

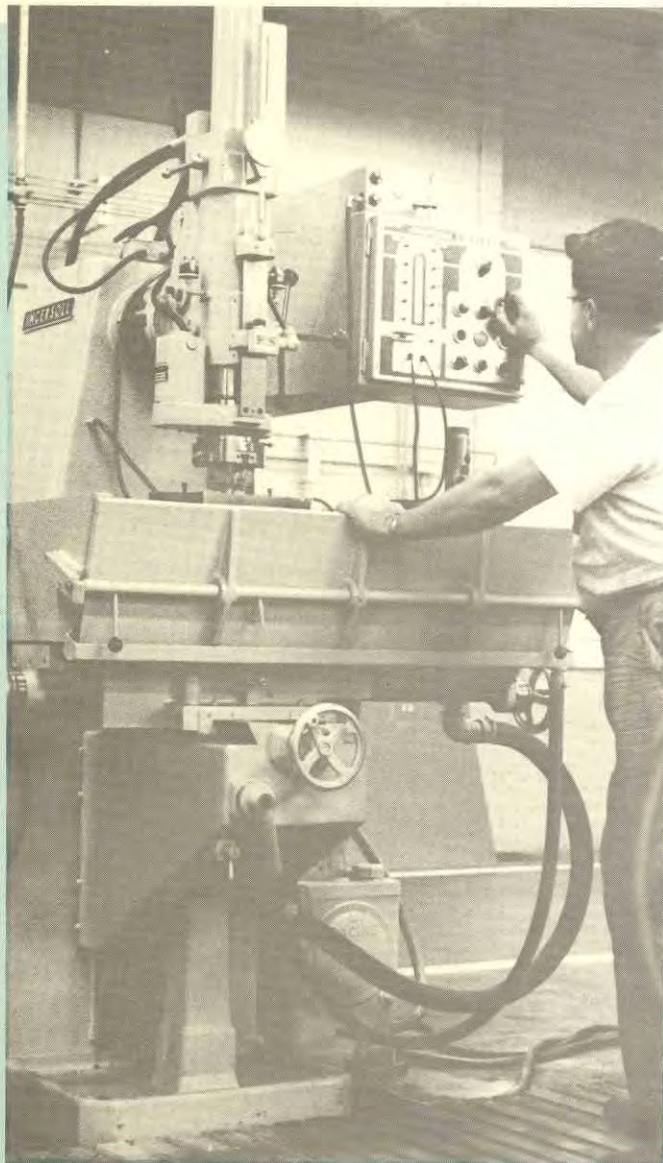


A battery of automatic turret lathes.

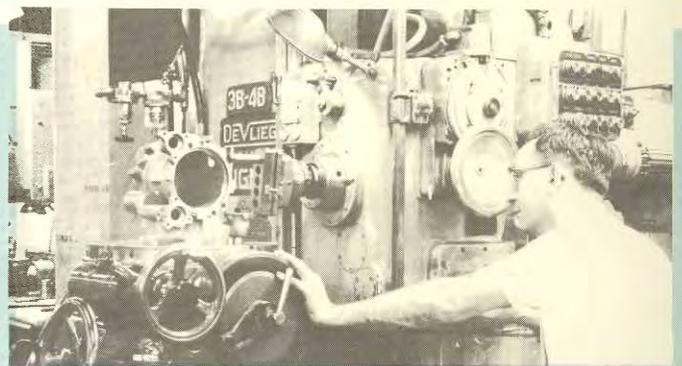




An overall view of the Pesco model shop.



Machining operation on an Ingersoll-Matson electrical discharge machine.



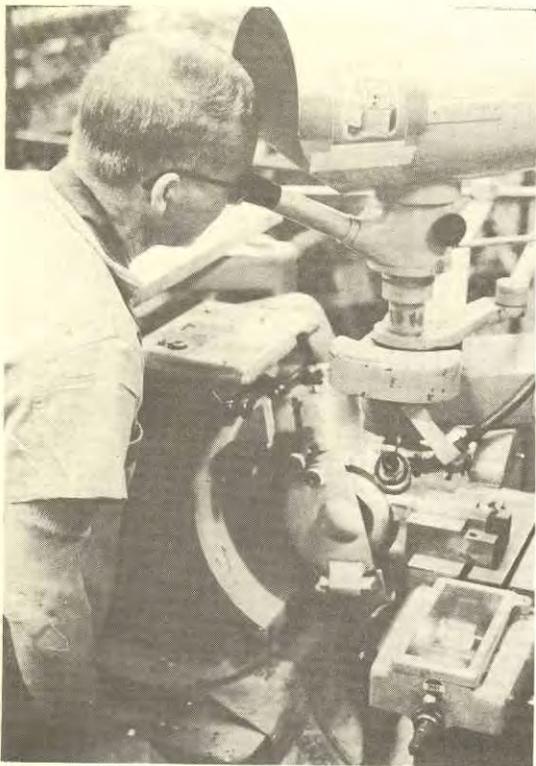
A DeVlieg Jig Mill is used to bore pump body ports.



The heat treating department is a part of Pesco integrated production facilities.

Comparator, used in making or repairing precision tools.



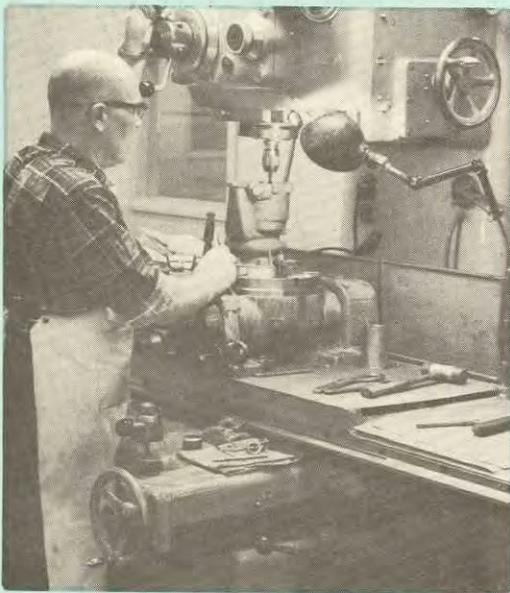


Sheffield Micro Form grinder.

## MANUFACTURING (cont.)

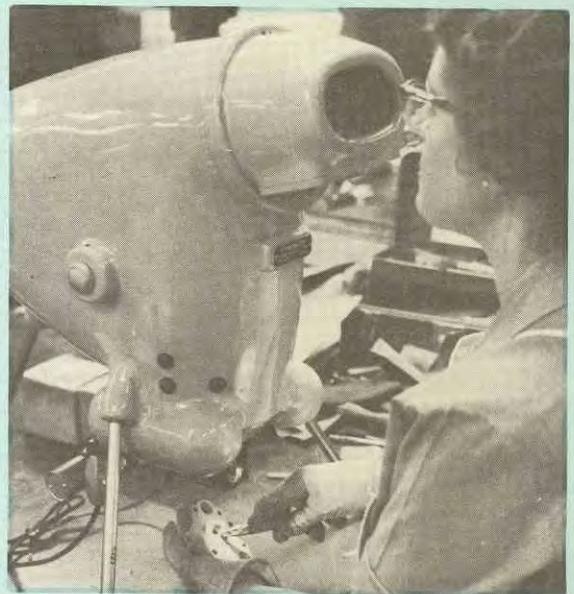
A complete, fully-equipped experimental model shop for the production of experimental models and prototypes is also provided. A completely-equipped tool making department produces many of the tools used at Pesco.

In Pesco's gage crib are precision and ultra-precision facilities for calibrating all master and working gages in accordance with military specifications MIL-Q-9858 (Quality Control) and MIL-Q-45662 (Gage Calibration System Requirements). In addition, there are Pesco facilities to meet or exceed all requirements of MIL-Q-5923 pertaining to general quality control practices.



Boring operations on a fuel pump using a Linder jig borer.

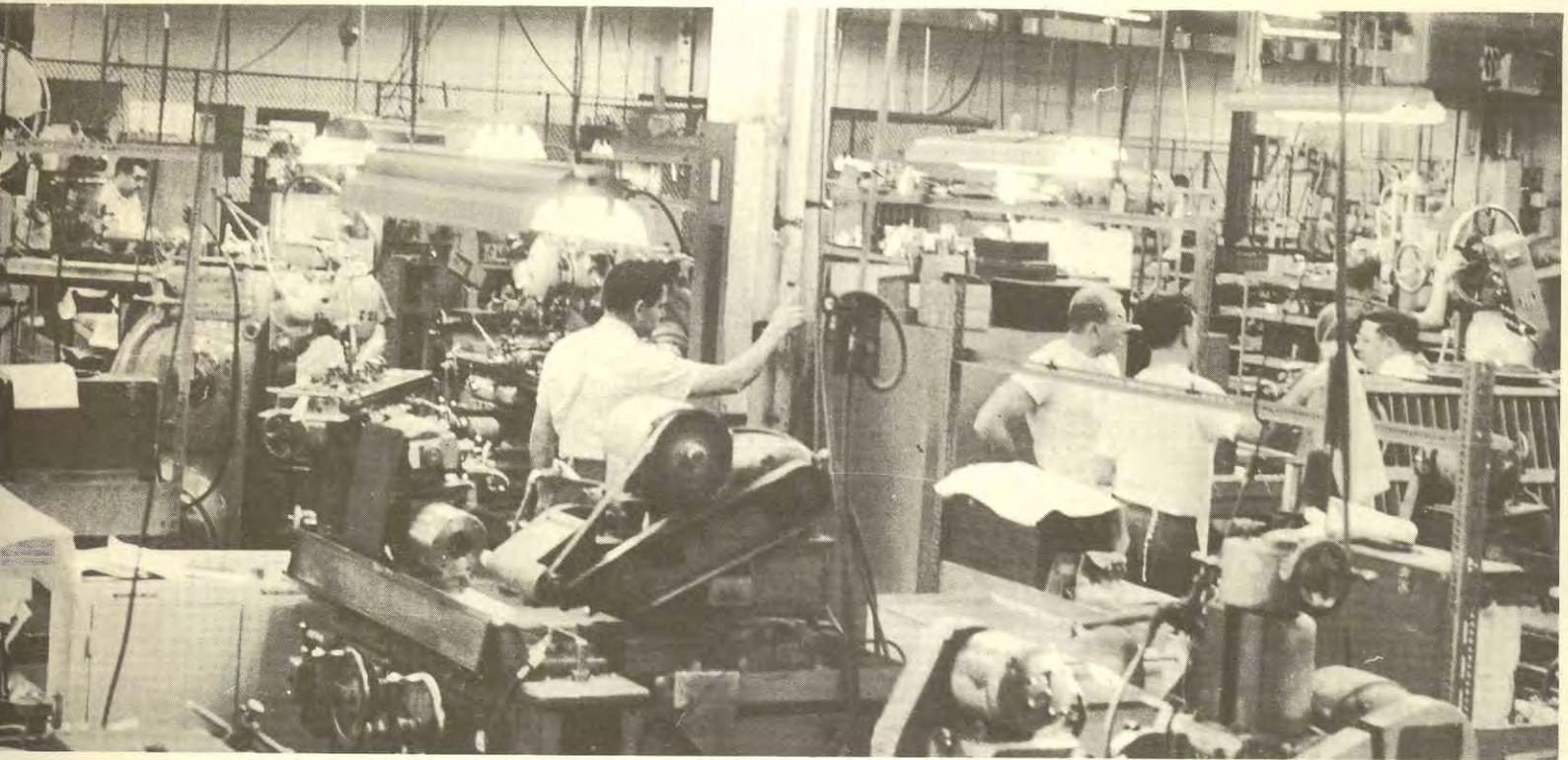
Grinding gear set journals on a Cincinnati angular head grinder.



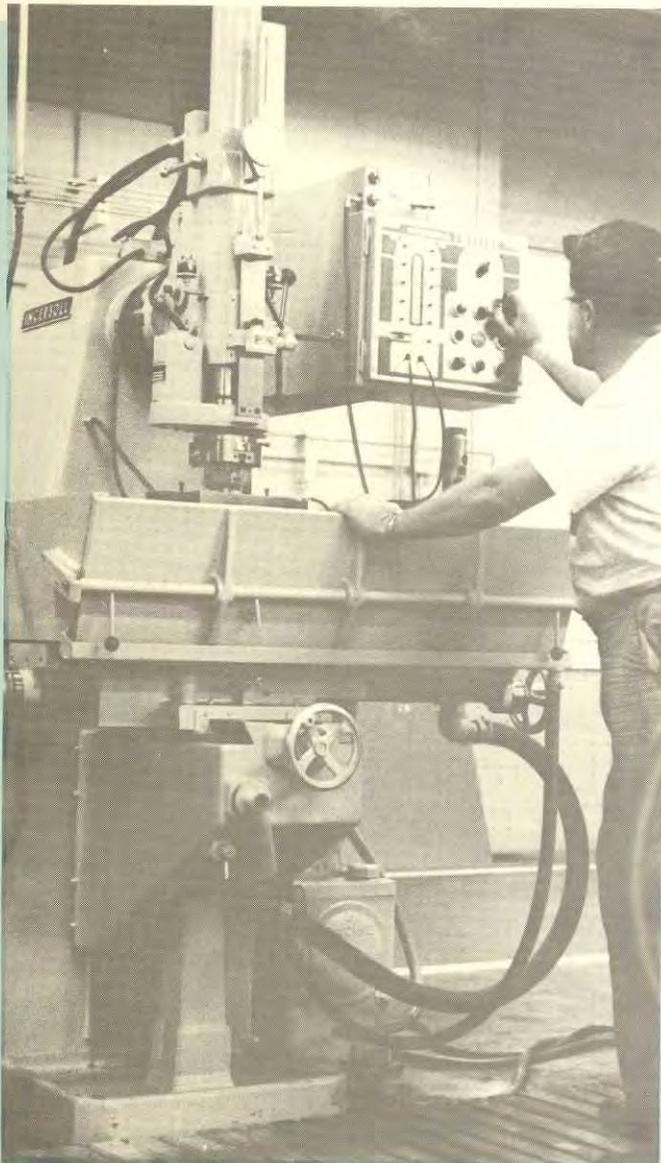
Binocular microscope used to deburr precision pump parts.

A battery of automatic turret lathes.

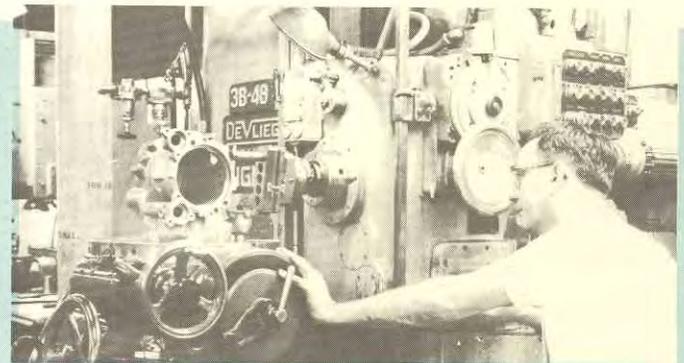




An overall view of the Pesco model shop.



Machining operation on an Ingersoll-Matson electrical discharge machine.

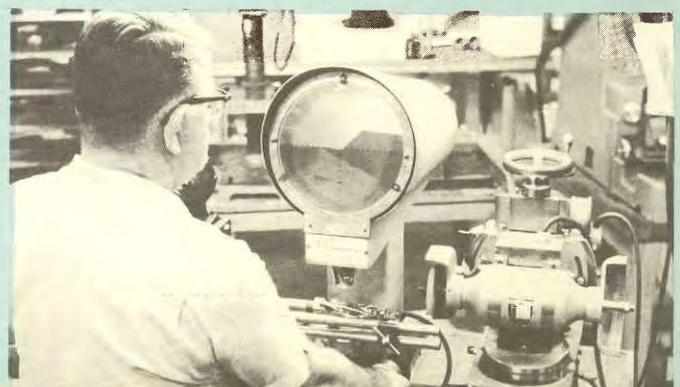


A DeVlieg Jig Mill is used to bore pump body ports.



The heat treating department is a part of Pesco integrated production facilities.

Comparator, used in making or repairing precision tools.



# Test Facilities

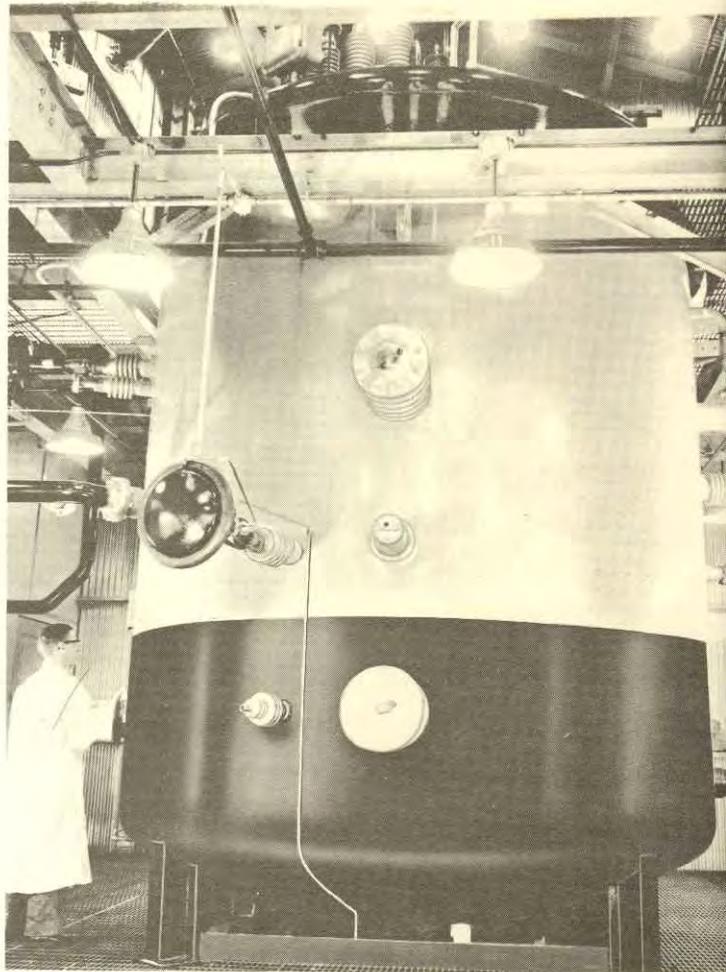
Because of Pesco's traditional emphasis on quality and product performance, test facilities play a significant role in plant operations.

The company maintains special laboratories for evaluation studies in metallurgical, electrical, chemical, hydraulic, fuel, and cryogenic applications, each equipped with full-range instrumentation and staffed by knowledgeable technical personnel.

A complete hydraulic and electrical test area for qualification and performance testing is also available.

Pesco's test facilities are capable of verifying product conformance to all applicable customer or military specification, and are prepared to document all data for customer review and analysis.

With aerospace goals demanding 100% reliability, Pesco test facilities assume a vital role in the company's integrated production program.



Special 7000 gallon Dewar for testing high flow liquid hydrogen pumps.

## CRYOGENIC LABORATORY

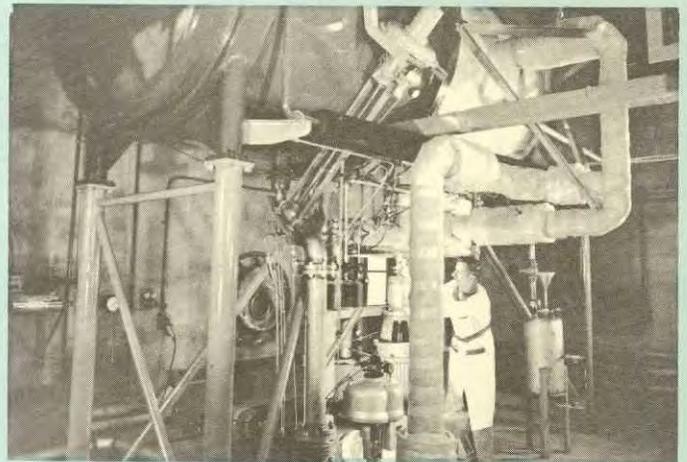
Located near Perry, Ohio, (30 miles northeast of the main plant) the Pesco Cryogenics Laboratory tests and evaluates system components developed to handle all types of cryogenic fluids efficiently and safely.

The cryogenics laboratory features special liquid hydrogen and liquid oxygen dewars and test cells, plus complete recording instrumentation and remote controls for measuring, calibrating, and controlling component performance.

A 7000-gallon vacuum insulated test dewar for high-flow liquid hydrogen pumps is a major installation. Smaller dewars are available for related projects.

The 51-acre installation is one of the few complete cryogenic laboratories maintained by a company for its own programming—typical of Pesco's concern with product quality and dependability.

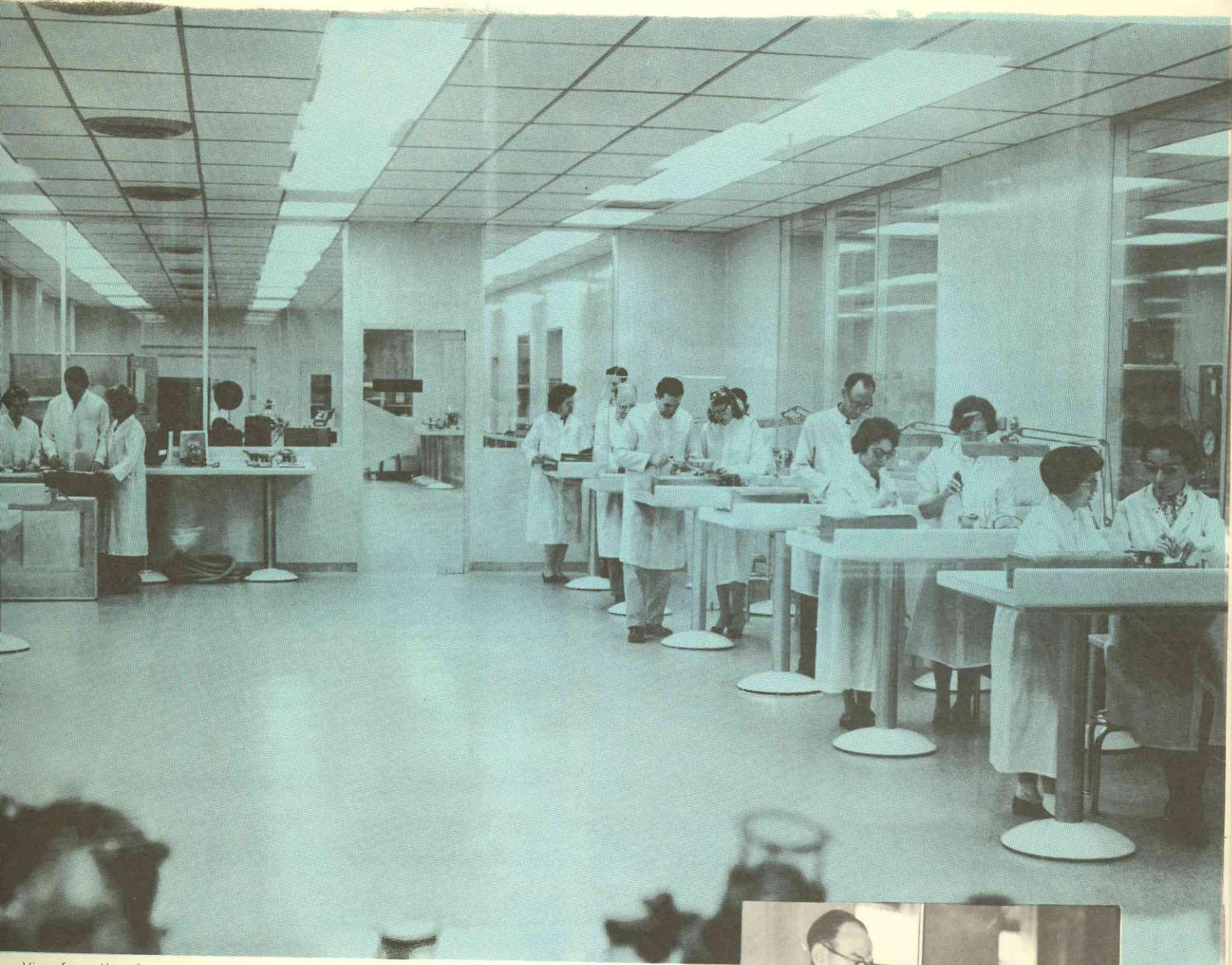
Aerial view of the cryogenic test facilities.



1600 gallon Dewar for testing in liquid oxygen.



Central instrument and control panels for all test buildings at the cryogenic center.



View from the clean room shows well-lighted spaciousness of assembly and hydro-test area.

## Clean-Environment Facilities For Assembly And Testing

To insure performance dependability, Pesco maintains a clean-room complex for inspection, cleaning, assembly, and testing of high-performance hydraulic power supplies for missile applications. Variable- and fixed-displacement units are processed in the area.

Conditions are closely controlled within the spacious,  
(cont.)



Air samples are taken every hour in the "white" area.

## Clean-Environment Facilities For Assembly And Testing

well-lighted facility. Filters installed in the air-conditioning system remove 95% of airborne particles larger than 5 microns (5 millionths of a meter). Temperature is maintained at 72°F with a permissible differential of plus/minus 2°; and relative humidity is approximately 45% (52° maximum dew point).

Walls, floors and bench tops inside the area are vinyl covered to facilitate cleaning and to eliminate flaking, scaling and powdering. Rooms in which the highest cleanliness standards are maintained are pressurized to a greater degree than adjacent areas, with a pressure variable ranging from .25 to .025 inches (water).

In the "white" area (where closest control is maintained), the atmosphere contains not more than 200 particles larger than 5 microns in each cubic foot of air. In secondary areas, the count is not more than 500 5-micron particles; in tertiary areas, not more than 1000 5-micron particles. In no area can there be more than 10 particles measuring 65 microns in any dimension.

Although electric motor drives for the units are manufactured, assembled, tested, and cleaned elsewhere in the Pesco plant, all hydraulic-pump components are cleaned, assembled, and tested in the clean room. Each hydraulic power supply unit undergoes from 60 to 120 hours of intensive testing before it is delivered to the customer.

Cleaning equipment includes a high-velocity jet system for flushing components with recondensed trichloroethylene; facilities for nitrogen drying; a stainless steel ultrasonic degreaser; and bagging/sealing equipment for cleaned parts.

Assembled units are normally subjected to static proof-pressure testing, then "run in" on specially-constructed test stands. To verify their dependability, the units are operated on vibration tables oscillating in three planes. Cycling ranges from 5 to 2000 cps at a rate of 2½ octaves per minute.

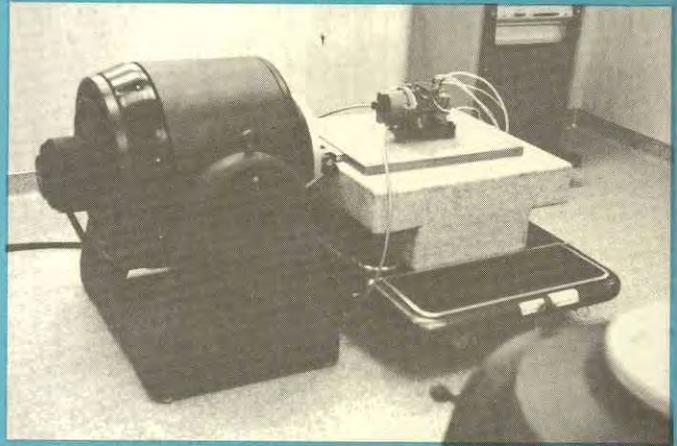
Equipment available for calibration and patch testing includes 7 variable-speed dynamometers with operational ranges of 300 to 20,000 rpm. In the Unit Test Room are Pesco-built consoles with closed-loop systems simulating missile-flight conditions, and oscillographic instruments to record the performance of each power supply unit.

Adjacent to the clean room is an electro-interference room providing RF shielding and complete instrumentation for checking against GM specifications for both conducted and radiated frequencies.

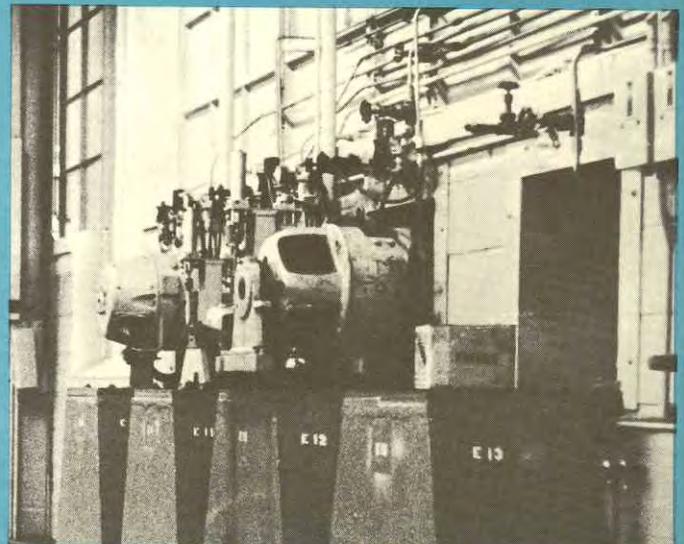
Pesco is prepared to compile and submit a comprehensive performance-data package with each hydraulic power supply unit—documentary proof of Pesco craftsmanship and Pesco quality.



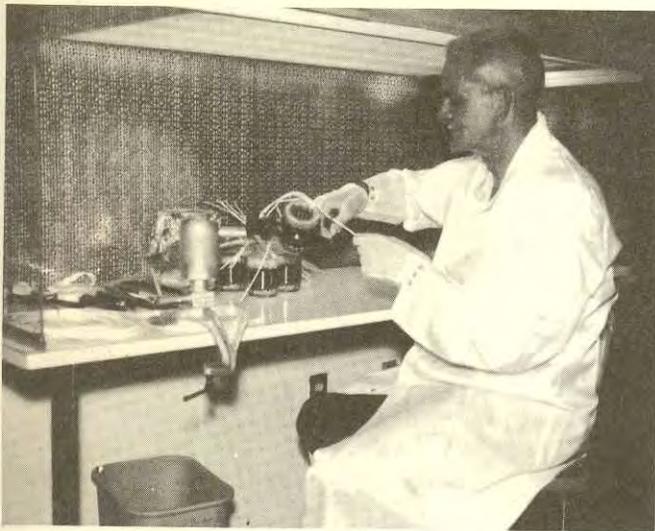
Assembled units are "run-in" at special test stands.



Assembled units are tested on this vibration table which oscillates in three planes from 5 to 2000 cps at 2½ octaves per minute.



Equipment available for calibration and patch testing includes seven variable speed dynamometers with operational ranges of 300 to 20,000 RPM.



Pure-Aire controlled environmental assembly station.

## ELECTRICAL LABORATORY

Components and circuitry are evaluated under operational conditions in Pesco's 5000-square-foot electrical laboratory.

Equipment includes a 10- to 2000-cps vibration table and an environmental chamber capable of simulating altitudes to 60,000 feet and testing performance at both high and low temperatures.

A high-speed dynamometer rated at 12,000 rpm and 15 hp; an explosion test chamber; a 12-KVA, 3-phase, 400-cycle load bank for alternator tests; high-speed recording potentiometers and string oscillographs are also available.

Power service includes 27- and 120-volt DC and 115/200/400 volt, 320-510-cycle AC.

## HYDRAULIC LABORATORY

A full range of equipment is installed in the 7500-square-foot area comprising Pesco's hydraulic laboratory.

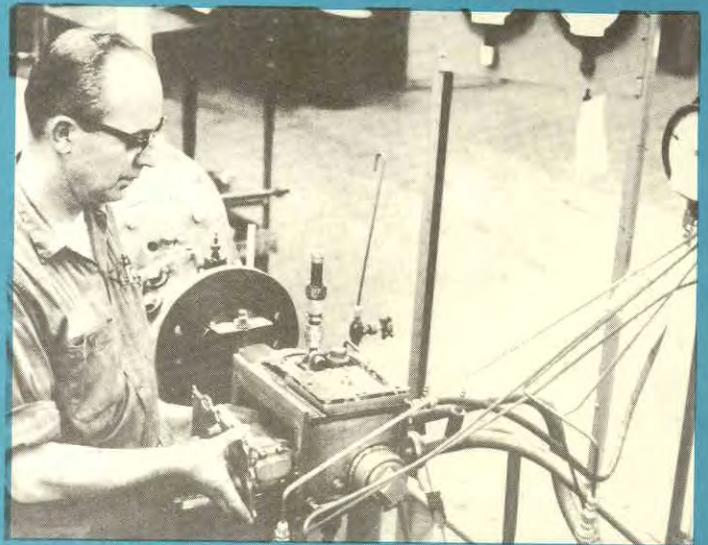
Dynamometer facilities include: eight dynamometers ranging in size from 15 to 150 horsepower; one high-speed unit rated at 80 horsepower at 13,000 rpm; and a Link gear-drive dynamometer attachment for speeds to 27,000 rpm. Related equipment: six constant-speed endurance stands ranging from 10 to 25 horsepower and four variable-speed run-in stands.

Instrumentation includes DuMont dual-beam and Bendix single-beam oscilloscopes; Ellis strain-gage amplifiers; DuMont Type 297 oscillographs and Type 321 high-speed oscillograph record cameras; Sorenson AC voltage regulators; Baldwin-Lima SR-4 torque pick-ups; assorted pressure and flow transducers and miscellaneous pressure and temperature recorders.

A six-channel Model 150 Sanborn recording oscillograph is also a significant part of the test equipment.



Torque measuring machine.



150 HP dynamometer.



Six channel model 150 Sanborn oscillograph.

## METALLURGICAL AND CHEMICAL LABORATORIES

Pesco's 2700-square-foot metallurgical and chemical facility is capable of thorough analysis and evaluation of both metallic and non-metallic materials.

The laboratory is equipped with such special devices as an emission spectrograph for chemical analyses of ferrous and non-ferrous metals; a Norelco X-ray diffraction unit to determine the crystalline structure of chemical and metallurgical specimens; and a Jarrel-Ash spectrograph for qualitative and quantitative analyses.

In the physical test area are installed a Tinius-Olsen tensile tester and a Krouse torsional fatigue tester. Adapters are available for tensile testing at temperatures to 1500°F and for fatigue testing at temperatures to 800°F.

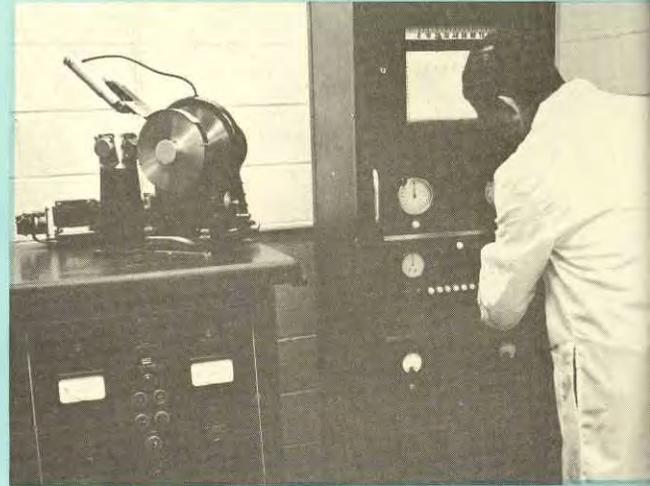
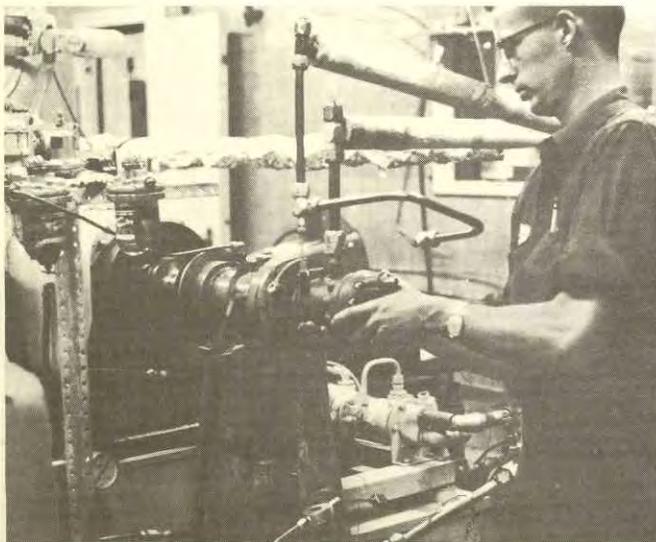
Equipment for metallographic and physical testing of fuels, lubricants, and elastomers is available in the chemical laboratory. The facility is also equipped for heat-treating and nitriding.

## FUEL LABORATORY

Performance testing of components utilizing all aircraft fuels is a function of the fuel laboratory, a 13,000-square-foot area completely equipped for full-range evaluation.

Equipment includes: seven dynamometers varying from 1 to 150 horsepower; seven endurance stands from 25 to 150 horsepower; eight booster-pump endurance stands; and one 200-horsepower dynamometer capable of testing high-speed centrifugal pumps at speeds to 30,000 rpm.

200 HP dynamometer for fuel pump tests.



Norelco X-ray diffraction unit.

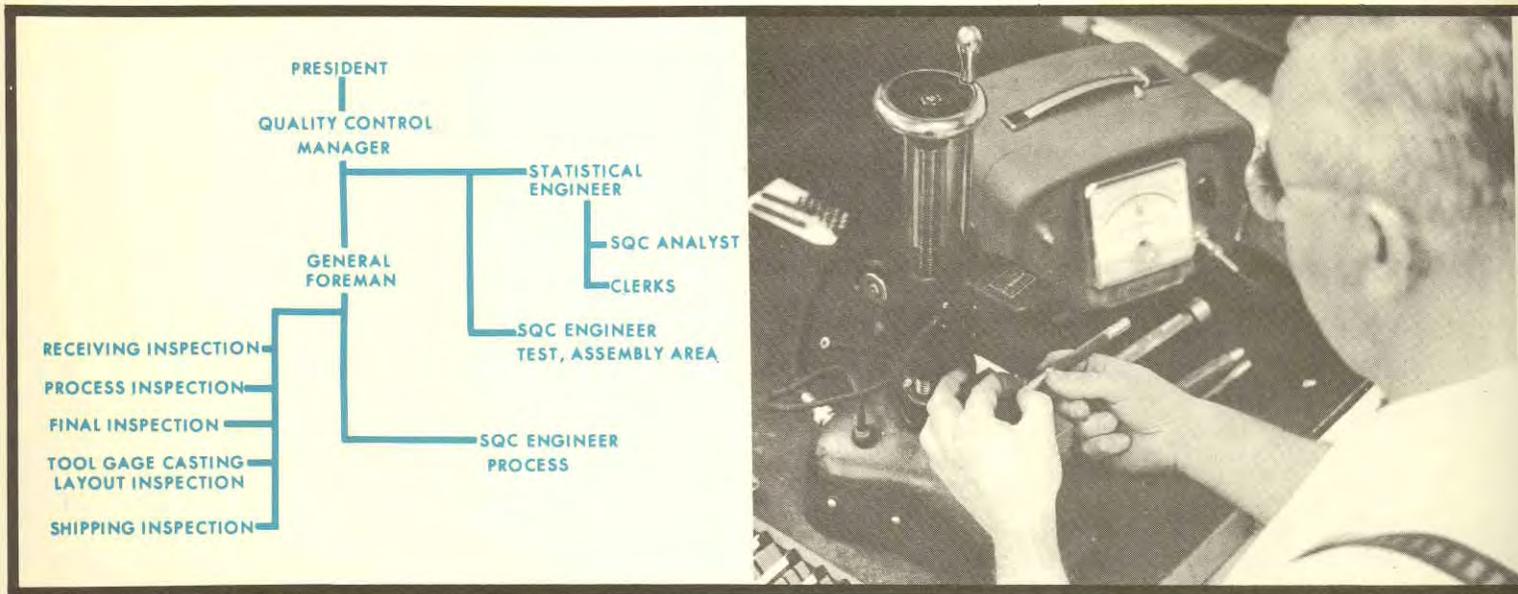


Jarrel-Ash spectrograph.



Endurance test stand for fuel pumps.

# Quality Control



In Pesco's production philosophy, quality control is cognizant of all phases of manufacturing. In practice, quality control is "materials control," assuring consistency and acceptability through all processing steps from receiving inspection to final approval.

The program is supervised by the quality control manager, who formulates, outlines and directs overall activity. He and his department are responsible for tracing all materials, acting to correct defects, monitoring vendors, and reporting to customers.

The statistical section of the department analyzes data from the floor, including process quality charts, checkoff cards, scrap reports, rework reports, and process warning cards.

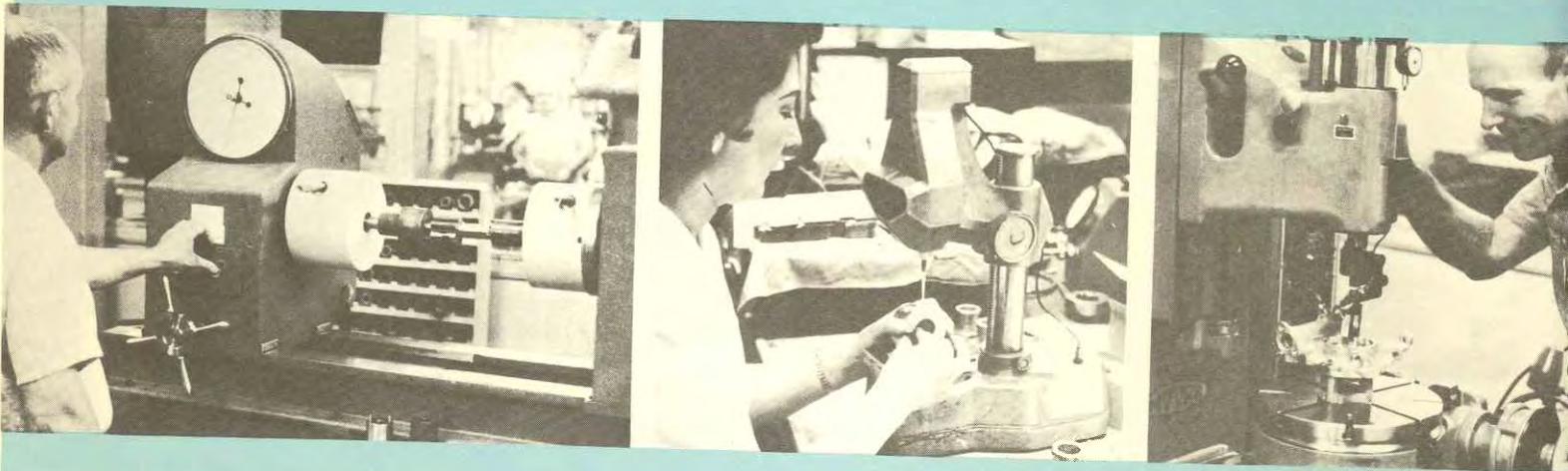
Checkoff cards used in receiving, zone, final, and

shipping inspection are correlated by the analyst section. This form is a medium of instruction for all inspectors checking detail or assembled parts to the correct A.Q.L., and are frequently revised to tighten or loosen inspection procedures to reflect the history or qualifications of the vendor.

The supervisors of quality control are responsible for dimensional checks on all assemblies, sub-assemblies, and detail parts—whether supplied by vendors or processed at Pesco. They function under the direction of the general foreman of quality control (chief inspector).

To show the scope and emphasis on quality control relating to every Pesco-built item, procedures are outlined in the following paragraphs.

# Quality Control



## RECEIVING INSPECTION

All raw materials, castings, and finished or semi-finished parts purchased by Pesco are inspected upon delivery. No production order of castings is accepted without specific approval from the casting layout department. Samples of bar stock, castings, rubber, and plastics are submitted to the chemical and metallurgical laboratory for acceptance before the items are released to production. Checkoff cards detail full instructions for inspection, and include information pertinent to the history of the item and the vendor.

## IN-PROCESS INSPECTION

Responsibility for acceptability of work in process is shared by two groups: process inspection and zone inspection.

Process inspectors give first-piece approvals on all new setups. The group also checks dimensions and physical characteristics of parts being processed.

For purposes of quality control, the plant is divided into four zones. When machining is completed in one zone, the pieces must pass inspection by the cognizant zone unit.

If acceptable, they progress into a subsequent zone for further processing. Unacceptable pieces must be screened, and either reworked or scrapped.

The system has been instituted to remove discrepant parts from the production line as soon as expedient to prevent expenditure of time or money on ultimate rejects.

## FINAL INSPECTION

All Pesco parts undergo comprehensive final inspection after completion of machining or special processing. Engineering drawings and checkoff cards listing the requirements of applicable specifications function as yardsticks to assist personnel in checking at the proper level of inspection for each characteristic.

Materials and components found acceptable are so

### ***For Performance Dependability...***

The Pesco quality and reliability-control functions have been established to accomplish the following objectives:

1. Detect defective workmanship and material both in items originating at Pesco or purchased from vendors.
2. Determine causes of repeated rejects.
3. Assist other departments also charged with responsibility for eliminating reasons for sub-standard production.
4. Assure compliance with engineering drawings and specifications.
5. Maintain accurate and thorough historical records.
6. Assist in the administration of general quality-improvement programs.

7. Observe and implement special customer requirements and regulations.
8. Improve inspection techniques and reduce costs without jeopardizing quality.
9. Train inspection personnel and establish guidelines for accuracy and efficiency.
10. Investigate promptly all customer complaints.

A reliability section operates within this area of quality control, formulating programs for newly-designed units as well as for "in-production" models. New units satisfying all requirements of a five-phase qualifying program become "in-production" units. The reliability-control activity continues as long as the model is in production.

indicated on the checkoff cards. Issue of stock tickets signifies approval.

Items accepted by Pesco procedures are submitted to Air Force quality control personnel for a subsequent inspection. Parts can be moved to stock only after Air Force approval is stamped on stock tickets.

## **TEST**

Functional testing is a 100% program to assure conformance to specification established jointly between Pesco's engineering department and the customer.

All units are serial numbered at this time, and recorded data of all tests is delivered with the product. Daily, weekly, and monthly reports advise the manufacturing and quality control groups of trend or deviations from the production pattern.

## **SHIPPING INSPECTION**

At Pesco, shipping inspection is a two-station sequence. Station 1 receives units after test acceptance and

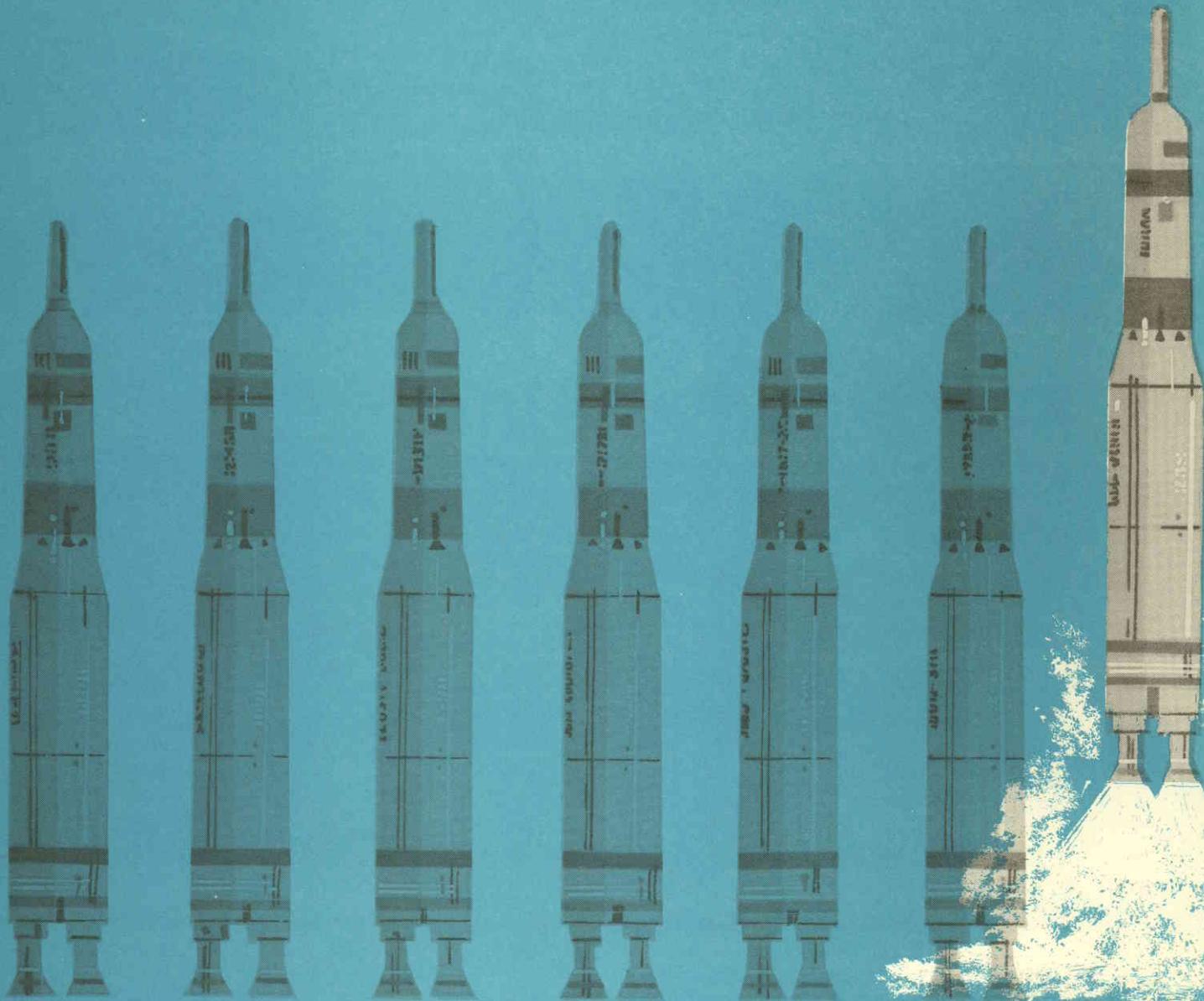
checks them against outline and assembly drawings. The group also inspects for damage which may have resulted from mounting of parts in test rigs.

Station 2, located at the end of the shipping line, is the last checkpoint prior to packaging. Here, serial numbers and model numbers are verified and compared with the customer order.

Because all units processed and assembled require military approval, each product is then submitted to an Air Force quality control team stationed permanently at Pesco. Only when paperwork carries the Air Force stamp of approval are the units shipped.

As further certification of Pesco quality, Pesco facilities undergo periodic surveys in accordance with MIL-Q-5923, *General Quality Control Requirements*. Pesco facilities and operations meet all appropriate military standards.

Functionally, Pesco's quality control department is inherently flexible. In this way, product modifications and diverse contractual requirements can be assimilated into an over-all plan with minimum deviation from the basic production program.



## Reliability

*Quality* and *reliability* have different meanings.

*Quality* is the ability of a part to meet its specifications at any point of reference. *Reliability* is the probability that a device will perform its intended function for a given length of time. It has also been designated as "mean time between failures" (MTBF).

Because of its significance in aerospace applications, reliability gets day-to-day emphasis at Pesco. Materials are consistent, manufacturing processes are identically repetitive, and records are comprehensive—three conditions which are essential to reliability control. Normal

deviations are traceable directly to a vendor or a production operation.

Reliability, of course, is an engineering function at Pesco, too. Design analysis by reliability engineers eliminates most sources of failure, and mathematical models can be utilized to predict the service life of Pesco products. Periodic tests verify the accuracy of predictions.

Pesco personnel throughout the production structure are oriented in the reliability concept. They take a vital interest in producing devices which will perform dependably at realistic cost to the customer.

# Service Engineering, Training And Provisioning

Training and technical service functions are the responsibility of Pesco's service engineering department.

The service engineering department is responsible for overhaul and repair service, service publications, field service, and service engineering.

Where appropriate, the department assigns its field service repairman and engineering consultants to visit customer facilities to repair Pesco units or assist in the installation of Pesco equipment in airframes or engines.

The department also maintains a bonded stockroom and inventory control system to support overhaul programs for which the government furnishes parts.

Each distributor of Pesco products for commercial aircraft maintains comprehensive service facilities for accessory repair and parts distribution. Personnel have received factory training at Pesco and are competent technicians qualified for expert service and field overhaul.

## ***DISTRIBUTORS ARE:***

### **PACIFIC AIRMOTIVE CORP.**

Burbank, California

### **MID-CONTINENT AIRMOTIVE CORP.**

Kansas City, Kansas

### **MERCURY AVIATION INC.**

Minneapolis, Minnesota

### **AIRWORK CORP.**

Millville, New Jersey

### **UNITED AIRCRAFT OF CANADA, LTD.**

Montreal, Canada

### **BORG-WARNER INTERNATIONAL**

Export Sales

Chicago, Illinois

### **STANDARD AIRCRAFT EQUIPMENT CO., INC.**

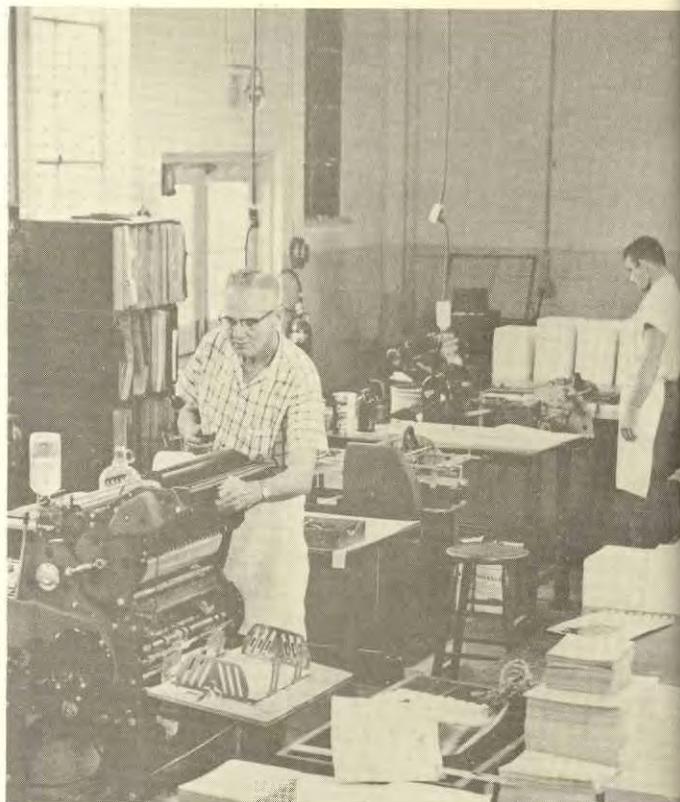
Mineola, New York

## PROVISIONING

Pesco's provisioning section, organized in 1949 as one of the first in the industry, is a team of service engineers, designers, and specialized technical personnel. The group is capable of determining at any stage—from initial design to actual service—the spare parts required for Pesco units.

Pesco is an acknowledged pioneer in the "kit" concept of provisioning for military requirements. Pesco engineers work in close conjunction with military specialists in determining overhaul and replacement schedules for Pesco-built units, and supplies integrated "kits" for preventive maintenance and simplified repair.

Provisioning at Pesco is a flexible program, permitting a procedure for procurement of spares and follow-up engineering changes to be developed to each customer's specifications.



Pesco Publications Department has a print shop fully equipped with three offset and one letterpress for the production of handbooks, manuals and service bulletins.

## TECHNICAL PUBLICATIONS

All data and illustrations pertinent to maintenance, overhaul, and repair required by military or commercial contracts are prepared and produced by the publications department.

The department functions as a self-sufficient activity directly responsible to the sales department. It is staffed with technical writers, illustrators, photographers, and printers experienced in publishing ATA manuals, military handbooks, Pesco Serviscripts, and service bulletins.

Complementing the publications department is a fully-equipped print shop with offset and letterpress facilities for production of handbooks, manuals, and service bulletins. Equipment for process photography and plate making is also available.

Data required by all general and specific military specifications appropriate to the customer are compiled by department personnel. The material is inspected by Air Force handbook inspectors in residence at Pesco.

