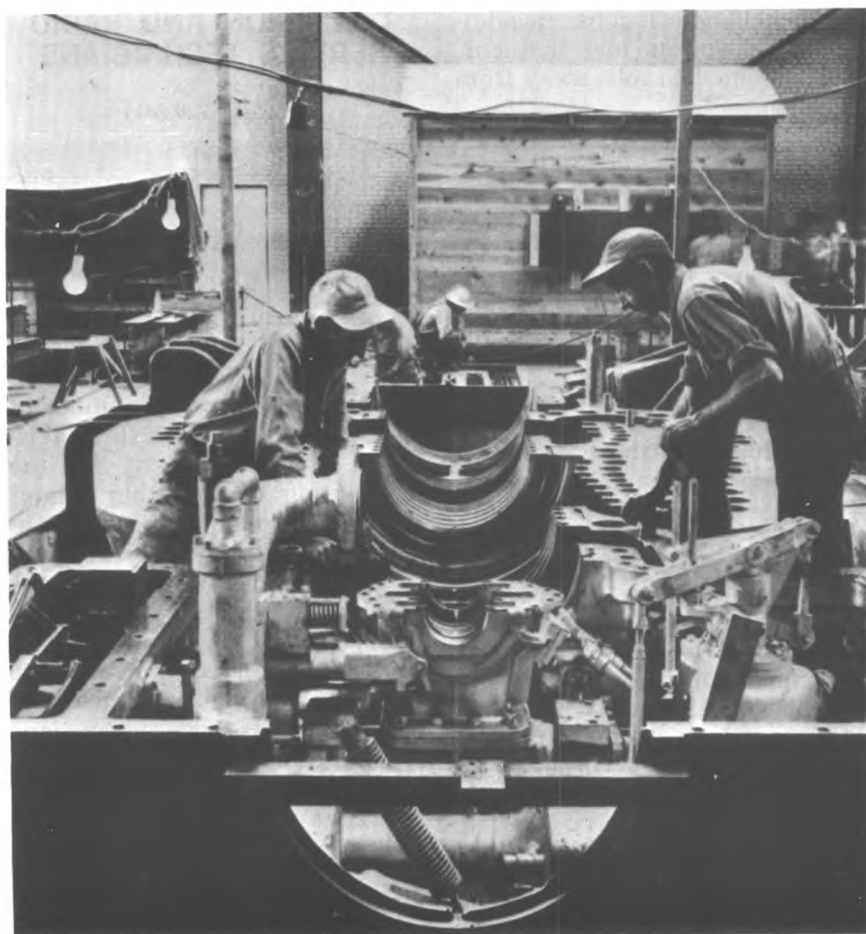




Millwrights check steam turbine installation in power plant.

industrialized States of Michigan, Ohio, Pennsylvania, Illinois, New York, and Indiana.

Training and Other Qualifications

Millwrights learn the trade by acquiring the skills informally or through apprenticeship programs. Those workers who pick up the trade informally usually work as helpers to skilled millwrights over a period of years until they acquire sufficient knowledge and experience to be classified as skilled workers. However, most training authorities agree that apprenticeship programs give young persons a more thorough preparation for this skilled trade.

Apprenticeship programs generally last 4 years. Apprentices in this trade are given shop training in dismantling, moving, erecting, and repairing machinery and other equipment. They also are trained in floor layout, the installation of machinery and other equipment, carpentry, welding, rigging, and the use of structural steel, wood, and concrete. The apprenticeship program includes related classroom instruction in shop mathematics, blueprint reading, hydraulics, electricity, and safety. Many companies require that apprentice applicants be high school graduates between 18 and 26.

High school courses in science, mathematics, mechanical draw-

ing, and machine shop practice are useful subjects for young men interested in becoming millwrights. Because millwrights often put together and take apart complicated machinery, mechanical aptitude is important to young men entering the trade. Strength and agility are other important qualifications for millwright work, which often requires considerable lifting and climbing.

Employment Outlook

Employment of millwrights is expected to increase slowly through the 1970's. The building of new plants, the addition of new machinery, changes in plant layouts, and the maintenance of increasing amounts of heavy and complex machinery and other equipment are factors expected to increase employment of millwrights.

In addition to new job openings that will be created by industrial expansion and increased mechanization, a few thousand workers will be needed annually to replace millwrights who transfer to other lines of work, retire, or die. Retirements and deaths alone are expected to result in about 1,500 job openings annually.

Earnings and Working Conditions

The earnings of millwrights depend mainly on the area of the country in which they are employed and the type of business in which their employer is engaged. Average straight-time hourly earnings of millwrights employed in manufacturing industries in 43 metropolitan areas surveyed in 1967-68 ranged from \$3.06 in Providence, R. I., to \$4.24 in Detroit, Mich. Nearly two-thirds of these workers earned \$3.60 an hour or more. Straight-

time hourly earnings for millwrights in 12 of the 43 metropolitan areas, selected to present wage data from various areas and regions of the country, during the 1967-68 survey period appear in the accompanying tabulation.

City	Rate per hour
	<i>Industrial millwrights (manufacturing industries)</i>
Akron	\$3.96
Boston	3.40
Buffalo	3.91
Fort Worth	3.24
Los Angeles-Long Beach and Anaheim-Santa Ana-Garden Grove	4.19
Louisville	4.10
Minneapolis-St. Paul	3.88
New Haven	3.08
New Orleans	3.80
Omaha	3.84
Rockford	3.80
Trenton	4.03

Millwrights employed by companies doing contract installation work and by construction companies usually have higher hourly wage rates than those employed in manufacturing industries. For example, the minimum average hourly wage rates for millwrights under union-management contracts doing construction work ranged from \$4.35 in Jackson, Miss., and Shreveport, La., to \$6.16 in Cincinnati, Ohio, on July 1, 1968, according to a national survey of building trades workers in 68 large cities.

Wage rates for apprentices generally start at 50 percent or more of the skilled worker's rate and increase to the journeyman's rate by the end of the training period.

Millwrights, most of whom work in factories, ordinarily work year round. Those who work for construction companies and for companies that manufacture and install machinery, or move and install machinery on a contract basis, may have periods of unem-

ployment between jobs. In addition, these workers may frequently be assigned to jobs away from their homes.

The work of millwrights involves certain hazards. For example, there is danger of being struck by falling objects or by machinery that is being moved. There also is the danger of falling from high work places. In addition, millwrights are subject to the usual shop hazards, such as cuts and bruises. Accidents have been reduced by the use of protective devices, such as safety belts, safety hats, eye protection, and shoes with metal tips. Millwrights must frequently work on dirty, greasy equipment.

Most millwrights belong to labor unions, among which are the International Association of Machinists and Aerospace Workers; United Brotherhood of Carpenters and Joiners of America (construction millwrights); United Steelworkers of America; International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; International Brotherhood of Pulp, Sulphite and Paper Mill Workers; and the International Union of Electrical, Radio and Machine Workers. Employer-union contracts covering millwrights usually include provisions for benefits such as paid holidays and vacations; hospitalization, medical, and surgical insurance; life insurance; sickness and accident insurance; and retirement pensions.

Sources of Additional Information

United Brotherhood of Carpenters and Joiners of America, 101 Constitution Ave. NW., Washington, D.C. 20001.

TELEVISION AND RADIO SERVICE TECHNICIANS

(D.O.T. 720.281)

Nature of the Work

Skilled television and radio service technicians use their knowledge of electrical and electronic parts and circuits to install and repair a growing number of electronic products. Of these, television receivers are by far the most prominent. Other major electronic products are radios (including home, automobile, and two-way mobile radios), phonographs, hi-fidelity and stereophonic sound equipment, intercommunication equipment, tape recorders, and public address systems. Many service technicians specialize in repairing one kind of equipment; for example, color television receivers or automobile radios.

Most of the skilled work done by television and radio service technicians involves diagnosing trouble in equipment and making necessary repairs and adjustments. Equipment may operate unsatisfactorily or break down completely because of faulty tubes, transistors, resistors, and other components; poor connections; aging of parts; and dirt, moisture, heat, and other basic troubles that affect all electronic equipment. When service technicians turn on television receivers or other equipment needing repair, signs of unsatisfactory performance, such as absence or distortion of picture or sound, may indicate what is wrong. Their job is to check and evaluate each possible cause of trouble, beginning with the simplest and most common cause—tube failure. In other routine checks, they look for loose or broken connections and for

parts that are charred or burned, due to excessive current or mishandling.

When routine checks do not locate the cause of trouble, service technicians use meter and electronic test equipment to check suspected circuits. For example, they may measure voltages until an unusual or irregular measurement indicates that part of the circuitry causing trouble. Commonly used test instruments are vacuum tube voltmeters, multimeters, oscilloscopes, signal generators, and other specialized instruments.

On service calls, service technicians advise customers as to what may be wrong with receivers, and whether receivers must be taken to shops for further analysis and repair. If possible, they explain what must be done to repair receivers and estimate

the cost of such repairs. After receivers are repaired on the customers' premises or returned from shops, service technicians explain what has been done. They may adjust the equipment to put it in proper operating condition.

Work usually done by television and radio service technicians in homes or other places where equipment is used includes making simple electrical checks with a voltmeter, changing tubes, and making necessary adjustments, including focusing the picture or correcting the color balance on a color receiver. They check high voltage circuits in color TV sets for excessive X-ray radiation. Service technicians who make customer service calls carry tubes and other components that are easily replaced in the customer's home. Apprentices or less experienced television service technicians may

install or repair antennas on roofs or in attics and run lead in wires from antennas to receivers.

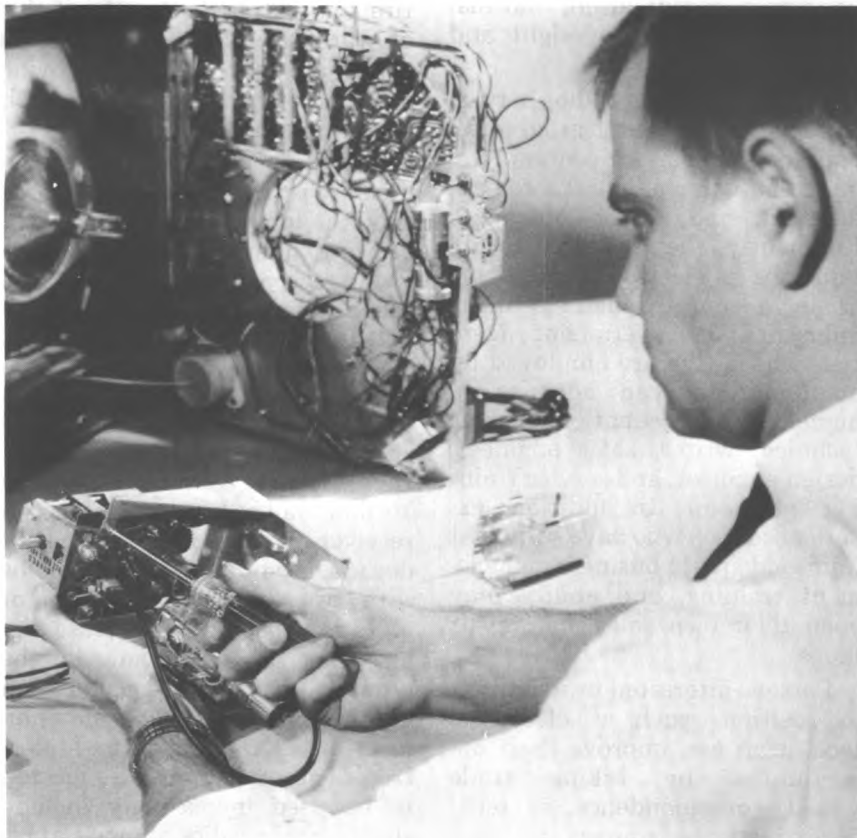
Radios, television receivers, and other equipment small enough to be carried by customers usually are repaired in service shops. Larger television receivers are repaired in shops when they develop troubles which appear after receivers have been operating for a few hours, or when the troubles can be located only with the more complex test equipment available in shops.

Television and radio service technicians usually refer to wiring diagrams and service manuals that show connections within receivers, provide adjustment information, and describe causes of trouble associated with unusual symptoms. They must know how to use soldering irons, wire cutters, long-nosed pliers, wrenches, screwdrivers and, sometimes, magnifying glasses when they remove, adjust, or replace parts, components, or complete equipment such as automobile radios.

Places of Employment

About 125,000 television and radio service technicians were estimated to be employed in early 1969, of whom about one-third were self-employed. About three-fourths of all service technicians worked in service shops or in stores that sell and service television receivers, radios, and other electronic products. Most of the remaining service technicians were employed by government agencies and manufacturers, including manufacturers that operated their own service branches.

Television and radio service technicians are employed in almost every city because the products they service are used everywhere. However, employment of these workers is distributed geo-



graphically in much the same way as the Nation's population. Thus, they are employed mainly in the highly populated States and major metropolitan areas.

Training, Other Qualifications, and Advancement

Training in electronics is required to become a highly skilled television and radio service technician capable of working on various types of electronic equipment. Technical, vocational, or high school training in electronic subjects, mathematics, and physics have helped men to qualify as expert television and radio service technicians. Home study (correspondence school) courses are also helpful. Young men who enter military service may wish to investigate opportunities for training and work experience in servicing electronic equipment because such experience often is valuable in civilian electronics work, including television and radio servicing. From 2 to 3 years' combined training and on-the-job experience are required to become a qualified television and radio service technician. Men without previous training may be hired as helpers or apprentices if they show aptitude for the work or, like the amateur ("ham") radio operator, have a hobby in electronics.

An important part of the service technicians' training is provided by many manufacturers, employers, and trade associations. These organizations conduct training programs when new models or new products are introduced, as part of a continuing effort to keep service technicians abreast of the latest technical servicing and business methods. Service technicians also keep up with technical developments by studying manufacturers' instruc-

tion books and technical magazines, and by attending training meetings covering electronics service work.

Programs to train unemployed and underemployed workers for entry jobs in the television and radio service field were in operation in 19 states, in 1968, under the Manpower Development and Training Act. These programs usually lasted from about 6 months to a year. Given additional experience or training, which may include an apprenticeship, graduates of these programs may become skilled service technicians.

Television and radio service technicians must know how electronic components and circuits work, and why they function as they do. They also must be able to understand technical publications. Other essential qualifications include the ability to manipulate small parts and tools, good hand-eye coordination, normal hearing, and good eyesight and color vision.

Television and radio service technicians who work in large repair shops or service centers may be promoted to assistant foreman, foreman, and service manager. Frequently, they are able to obtain jobs as electronics mechanic or technician in manufacturing industries or government agencies. Those who are employed by manufacturers can advance to higher paying occupations such as technical writer, sales engineer, design engineer, and service training instructor. In addition, experienced men who have sufficient funds, adequate business management training, and ability may open their own sales and repair shops.

Persons interested in advancing to positions such as electronic technician can improve their opportunities by taking trade school, correspondence, or technical institute courses in elec-

tronic engineering, automatic controls, electronic engineering, television engineering mathematics, and other subjects related to electronics.

In 1969, television and radio service technicians were required to be licensed in several States and cities. To obtain a license, applicants are required to pass an examination designed to test their skill in the use of testing equipment and their knowledge of electronic circuits and components.

Employment Outlook

Employment of television and radio service technicians is expected to increase moderately throughout the 1970's. In addition to the openings that will arise from growth, thousands of job openings will result annually from the need to replace experienced service technicians who retire, die, or transfer to other fields of work. Death and retirements alone are expected to provide about 1,300 job openings each year through the 1970's.

Employment of service technicians is expected to increase over the long run, along with the growing number of radios, television receivers, phonographs, and other home entertainment products in use throughout the 1970's. Factors that will contribute to this growth include rising population and family formations, and rising levels of personal income. In 1967, more than 9 out of every 10 households had one television receiver or more. During the next decade, the number of households with two television receivers or more is expected to increase significantly, mainly because of the growing demand for color and lightweight, portable television receivers. Other consumer electronics products that are expected to be used increasingly include stereophonic radios, phonographs,

tape recorders, AM-FM radios, and portable transistor radios. New consumer products, such as home video tape recorders, as well as improved styling and design of existing products, also will stimulate demand. Greater use of non-entertainment products, such as closed-circuit television, two-way radios, and various medical electronic devices, also is expected. For example, closed-circuit television is being used increasingly to monitor production processes in manufacturing plants, and to bring educational programs into classrooms.

In recent years, technological improvements in television receivers and radios (such as the use of transistors in place of tubes) have reduced the amount of service this equipment requires. Technological improvements will continue to reduce servicing requirements in the years ahead and may tend to slow employment growth. However, technological developments will increase employment opportunities for those television and radio service technicians who have theoretical as well as practical knowledge of electronic circuits and know how to use the latest test equipment. Servicing television receivers, radios, and related electronic equipment is a complex field because of constant technological advances. Service technicians will have to update their training to cope with these changes.

Earnings and Working Conditions

National earnings data are not available for television and radio service technicians. However, information obtained in major metropolitan areas from proprietors of independent service shops and manufacturers who operate service centers indicated that, in early 1969, many service tech-

nicians in entry jobs had straight-time weekly earnings ranging from about \$80 to \$120; many experienced service technicians had weekly earnings ranging from about \$120 to \$240. Some "inside" (shop) service technicians received higher weekly earnings than "outside" (field) technicians.

Television and radio service technicians employed in local service shops or dealer service departments commonly work a 6-day, 48-hour week. In large shops, including manufacturers' service branches, they usually work a basic 40-hour week. Service technicians often work more than 8 hours a day and receive higher rates of pay for overtime work. Some employers of television and radio service technicians provide paid vacations and holidays after a specified length of service. Many also provide or help pay for health and life insurance benefits. Some shops are unionized.

Service on television, radio, and other home entertainment products is performed in shops and homes where working conditions are usually pleasant. Inside men work at benches, normally provided with stools. Outside men may spend several hours a day driving between shops and customers. Some physical strain is involved in lifting and carrying receivers. Perhaps the greatest hazard is the risk of falling from roofs while installing or repairing antennas. Electrical shock is another hazard, but it rarely has caused serious injury.

Sources of Additional Information

Additional information about jobs in television servicing may be obtained from local service technicians, local dealers who sell and service television receivers and other electronic equipment, local

television service associations, and manufacturers who operate their own service centers. Technical and vocational schools that offer courses in television and radio repair, or electronics, can provide helpful information about training. In addition, the local office of the State employment service would be a source of information about the Manpower Development and Training Act and other programs that provide training opportunities.

Information about the work of television and radio service technicians may also be obtained from:

National Alliance of Television Associations, 5908 South Troy Street, Chicago, Ill. 60629.

TRUCK MECHANICS AND BUS MECHANICS

(D.O.T. 620.281)

Nature of the Work

Truck and bus mechanics keep the Nation's trucks and buses in good operating condition. Truck mechanics maintain and repair heavy trucks used for intercity travel and on mining and construction jobs, and medium and small trucks used for local hauling. Bus mechanics maintain and repair a variety of buses, ranging from small ones used for local transit to large transcontinental buses. Although many mechanical parts of large trucks and buses are similar to automobile parts, truck and bus mechanics repair large engines, complex transmissions and differentials, air-brakes, and other components that are different from those found in automobiles.

Mechanics employed in the shops of organizations that main-



Truck mechanic repairs fan assembly of large truck.

tain and repair their own vehicles may spend much of their time performing preventive maintenance. During a periodic maintenance check, mechanics inspect brake systems, steering mechanisms, wheel bearings, universal joints, and many other parts, and make needed repairs or adjustments. By performing preventive maintenance, mechanics help assure safe vehicle operation, prevent wear and damage to parts, and reduce costly breakdowns.

When trucks and buses do not operate properly, these workers determine the cause of the trouble and make the necessary repairs. In large repair shops, mechanics may specialize in one or a few kinds of repair. For example, some mechanics specialize in major engine or transmission repair. If an engine needs to be rebuilt, the

mechanic removes it from the vehicle and disassembles it. He examines parts, such as valves, pistons, rods, and bearings for wear or defects, and replaces or repairs defective parts. Many mechanics specialize in the repair of diesel engines that power trucks and buses. Diesel and gasoline engines are similar but have different fuel and ignition systems. Therefore, a mechanic who has worked only on gasoline engines needs special training before he can qualify as a diesel mechanic. (See statement on Diesel Mechanics elsewhere in the *Handbook*.)

Truck and bus mechanics use common handtools such as screwdrivers, pliers, and wrenches; power and machine tools such as pneumatic wrenches, drills, grinders, and lathes; special purpose tools such as pump seal installers

and transmission jacks; and welding and flame cutting equipment. They also use various types of testing devices to help locate malfunctions. The latter may include relatively simple testing devices such as voltmeters, coil testers, and compression gages, or complicated analytical equipment such as oscilloscopes and dynamometers. Mechanics use hydraulic jacks and hoists to lift and move heavy parts.

When performing heavy work, such as removing engines and transmissions, two mechanics may work as a team, or a skilled mechanic may be assisted by an apprentice or helper. Mechanics generally work under the supervision of a shop foreman or service manager.

Places of Employment

A large proportion of the estimated 93,000 truck mechanics employed in 1968 worked for firms that own fleets of trucks. Fleet owners include trucking companies and companies that haul their own products such as dairies, bakeries, and construction companies. Other employers of truck mechanics include truck dealers, truck manufacturers, independent truck repair shops, firms that rent or lease trucks, and Federal, State, and local governments.

The large majority of the estimated 17,000 bus mechanics employed in 1968 worked for local transit companies and intercity buslines. Bus manufacturers employed a relatively small number of bus mechanics.

Truck and bus mechanics are employed in every section of the country, but most of them work in large towns and cities where trucking companies, buslines, and other fleet owners have large repair shops.

Training, Other Qualifications, and Advancement

Most truck or bus mechanics learn their skills on the job. In shops where fleets of trucks and buses are serviced, beginners usually perform tasks such as cleaning, fueling, and lubrication. They may be required to drive vehicles in and out of the shop. As beginners gain experience and as vacancies become available, they usually are promoted to mechanic helpers. In some shops, young persons—especially those who have prior automobile repair experience—are hired as helpers. Helpers learn mechanics' skills by assisting experienced mechanics in the performance of inspection and repair work. Most helpers are able to make minor repairs after a few months' experience and are allowed to handle increasingly difficult jobs as they prove their ability. Generally, 3 to 4 years of on-the-job experience is necessary to qualify as an all-round truck or bus mechanic. Additional training may be necessary for mechanics who wish to specialize in repairing diesel engines.

Most training authorities, including joint labor-management committees for the truck transportation industry, recommend a formal 4-year apprenticeship as the best way to learn these trades. Typical apprenticeship programs for truck and bus mechanics consist of approximately 8,000 hours of shop training and at least 576 hours of related classroom instruction. Frequently, these programs include training in both diesel and gasoline engine repair.

For entry jobs, employers generally look for young men who have mechanical aptitude and are at least 18 years of age and in good physical condition. Completion of high school is an advantage in getting an entry mechanic job because most employers be-

lieve it indicates that a young man can "finish a job" and has advancement potential.

Where the mechanic's job duties include driving trucks or buses on public roads, employers may require applicants to have a State chauffeur's license. If the employer is engaged in interstate transportation, the applicant also may be required to meet qualifications for drivers established by the U.S. Department of Transportation. He must be at least 21 years of age, able bodied, have good hearing, and have at least 20/40 eyesight with or without glasses. He must be able to read and speak English; have at least 1 year's driving experience (which may include driving private automobiles); and have a good driving record.

Young men interested in becoming truck or bus mechanics can gain valuable experience by taking high school or vocational school courses in automobile repair. Courses in science and mathematics are helpful since they give a young man a better understanding of how trucks and buses operate. Courses in diesel repair provide valuable related training. Practical experience in automobile repair gained from working in a gasoline service station, training in the Armed Forces, and working on automobiles as a hobby also is valuable.

Most employers require mechanics to purchase their handtools. Experienced mechanics often have several hundred dollars invested in tools. Employers ordinarily hire beginners who do not own handtools, but they are expected to accumulate them as they gain experience.

Employers sometimes send experienced mechanics to special training classes conducted by truck, bus, diesel engine, and parts manufacturers. In these classes, mechanics learn to repair

the latest equipment or receive special training in subjects such as diagnosing engine malfunctions.

Experienced mechanics who have supervisory ability may advance to shop foremen or service managers. Truck mechanics who have sales ability sometimes become truck salesmen. Some mechanics open their own gasoline service stations or independent repair shops.

Employment Outlook

Employment of truck mechanics is expected to increase moderately through the 1970's as a result of significant increases in the transportation of freight by trucks. More trucks will be needed for both local and intercity hauling as a result of increased industrial activity, continued decentralization of industry, and the continued movement of the population to the suburbs. In addition to the job openings expected to occur as a result of employment growth about 1,300 additional openings will occur annually because of job vacancies resulting from deaths and retirements. Opportunities to enter this occupation also will occur as some mechanics transfer to other lines of work.

Hundreds of job opportunities for bus mechanics are anticipated through the 1970's to replace experienced mechanics who retire, die, or transfer to other fields of work. However the number of bus mechanics employed during this period is expected to remain at approximately the present level. Continued growth in intercity bus travel is expected as a result of increasing population, new and improved highways, and reduction of railroad passenger service in many areas. However, the favorable employment effect of in-

creasing intercity bus travel is expected to be offset by a decline in local bus travel as a result of the growing use of private automobiles in city and suburban areas.

Earnings and Working Conditions

According to a survey covering metropolitan areas in late 1967 and early 1968, mechanics employed by trucking companies, buslines, and other firms that maintain their own vehicles had average straight-time hourly earnings of \$3.54. Average hourly earnings of these workers in individual cities ranged from \$2.66 in Chattanooga, Tenn., to \$4.45 in San Francisco-Oakland, Calif.

Apprentices' wage rates generally start at 50 percent of skilled workers' rates and are increased about every 6 months until a rate of 90 percent is reached during the last 6 months of the training period.

Most mechanics work between 40 and 48 hours per week. Because many truck and bus firms provide service around the clock, they employ mechanics on evening and night shifts, and on weekends. Mechanics usually receive a higher rate of pay when they work overtime or on evening or night shifts, weekends, or holidays. A large number of employers provide holiday and vacation pay; many pay part or all of the cost of financing employee health and life insurance programs and other employee benefits. Laundered uniforms are furnished free of charge by some employers.

Truck mechanics and bus mechanics are subject to the usual shop hazards such as cuts and bruises. If proper safety precautions are not followed, there is danger of injury when repairing heavy parts supported on jacks and hoists. Mechanics handle

greasy and dirty parts and may stand or lie in awkward or cramped positions for extended periods of time when repairing vehicles. Work areas usually are well lighted, heated, and ventilated, and many employers provide locker rooms and shower facilities. Although most work is performed indoors, mechanics occasionally make repairs outdoors when breakdowns occur.

Many truck and bus mechanics are members of labor unions. These include the International Association of Machinists and Aerospace Workers; the Amalgamated Transit Union; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; the Transport Workers Union of America; the Sheet Metal Workers' International Association; and the International Brotherhood of Teamsters, Chauffeurs, Warehousemen and Helpers of America (Ind.).

Sources of Additional Information

For further information regarding work opportunities for truck or bus mechanics, inquiries should be directed to local employers such as trucking companies, truck dealers, or bus lines; locals of unions previously mentioned; or the local office of the State employment service. The State employment service also may be a source of information about the Manpower Development and Training Act, apprenticeship, and other programs that provide training opportunities. General information about the work of truck mechanics and apprenticeship training may be obtained from:

American Trucking Associations,
Inc., 1616 P St. NW., Washing-
ton, D.C. 20036.

VENDING MACHINE MECHANICS

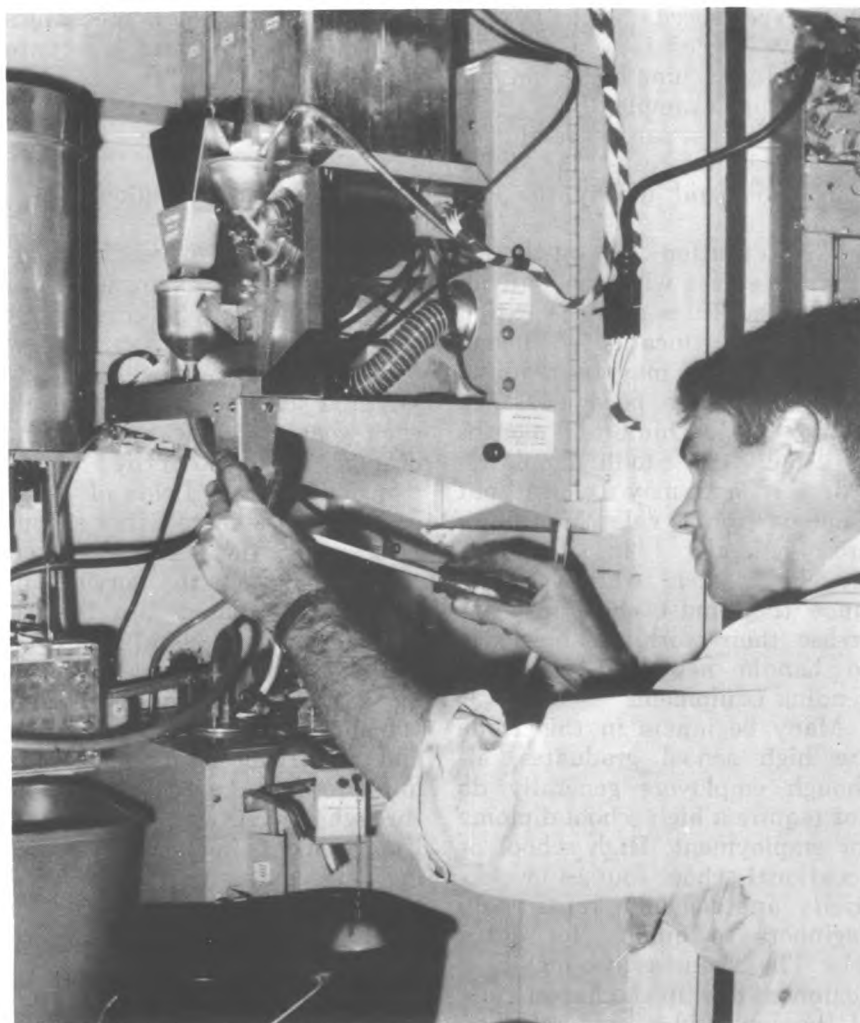
(D.O.T. 639.381)

Nature of the Work

The convenience of automatic, 24-hour merchandising and the great variety of items provided by vending machines have resulted in a nationwide industry and increasing job opportunities for skilled mechanics who maintain and repair these machines. The familiar gum ball, cigarette, or other mechanical, gravity-operated dispensing device no longer typifies modern vending machines. Today, vending machines include growing numbers of complex, electrically operated machines that dispense hot canned foods and ready-to-eat dinners, and brew individual cups of coffee flavored to taste.

Most vending machine mechanics work both in repair shops and at locations where machines are installed, such as schools, office buildings, factories, theaters, transportation terminals, and hospitals. Some work only in repair shops; others work only in the field and travel by car or small truck from one location to another to make machine repairs.

In the repair shops, mechanics repair complex vending machine components, such as water pumps, motors, and relays, and overhaul machines by replacing worn or damaged parts. They also may assemble new machines in the shop, following instructional materials supplied by the manufacturer. After the machines are assembled, they are filled with products or ingredients and test run. When working on relatively complex machines—for example, beverage dispensing machines—mechanics



check to see that the machines dispense proper quantities of ingredients and that their refrigerating or heating units operate properly. On gravity-operated machines, mechanics check springs, plungers, and merchandise-delivery systems. They also test coin and change-making mechanisms. When installing a machine on location, mechanics make the necessary water and electrical connections and recheck the machines for proper operation.

When a machine on location is reported to be defective, the mechanic first determines the cause of the trouble. He inspects the

machine for obvious troubles, such as loose electrical wires, malfunctions of the coin mechanism, and water and other leaks. He may test the machine's components to isolate the defective parts. After the mechanic locates the cause of the trouble, he may remove and repair or replace the defective parts, either on location or in his employer's service shop.

Preventive maintenance—avoiding trouble before it starts—is another major responsibility of the mechanic. For example, he periodically cleans electrical contact points, lubricates mechanical points, and adjusts machines

to perform properly. Both in the service shop and on location, mechanics use handtools, such as wrenches, screwdrivers, hammers, pliers, pipe cutters, electrical circuit testers and soldering irons. In the service shop, they also may use power tools, such as grinding wheels, saws, and drills.

Vending machine mechanics use operating and troubleshooting manuals to repair machine systems and components. They must know how and when to do soldering or brazing to repair piping systems; how to read diagrams of electrical circuits; and how to test electrical circuits and components. Mechanics who install and repair food vending machines must know State public health and sanitation standards as well as those established under local plumbing codes. They also must know and comply with safety procedures, especially when working with electricity and gas and when lifting heavy objects.

Repairmen are required to do some clerical work. For example, they may fill out reports, prepare repair-cost estimates, keep parts inventories, and order parts. If they are chief mechanics, they prepare work schedules for other mechanics. Mechanics employed by small operating companies frequently service as well as repair machines. These combination "repair-routemen" are responsible for periodically stocking machines, collecting money, filling coin and currency changers, and keeping daily records of merchandise distributed. (Additional information about vending machine routemen is included in the statement on routemen elsewhere in the *Handbook*. See index for page numbers.)

Places of Employment

In 1968, more than 16,000 mechanics maintained and repaired

more than 4.5 million vending machines. Vending machine repairmen work mainly for operators who place machines in selected locations and provide necessary services, such as cleaning, stocking, and repairing. Some repairmen also are employed by beverage companies which have coin operated machines on location. Although vending machine operators are located throughout the country, most mechanics are employed in the major industrial and commercial centers where large numbers of vending machines are located.

Vending machine manufacturers employ some highly-skilled mechanics to explain technical innovations and ways to repair new machines to vending machine repairmen. Such instruction takes place either in manufacturers' service divisions in major metropolitan areas or in operator's repair shops.

Training, Other Qualifications, and Advancement

Young men usually enter this trade as general shop helpers. If the shop helpers show promise as mechanics, they may become trainees. Some young men are hired directly as trainees.

Mechanic trainees acquire skills on-the-job—observing, working with, and receiving instruction from experienced mechanics. Sometimes, trainees attend manufacturer-sponsored training sessions, which emphasize the repair of new and complex machines. Employers usually pay the wages and expenses of their trainees during training, which may last from a few days to several weeks.

Because vending machines are increasing in complexity, some operators encourage both trainees

and experienced mechanics to take evening courses in subjects related to machine operation and repair—for example, basic electricity. At least part of the tuition and book expenses for these courses is paid for by the employers.

The duration of on-the-job training varies with the individual's capabilities and the extent of his prior education. Although 1½ to 2 years may be required for a trainee to become skilled in his work, within 6 to 9 months he usually can handle simple repair jobs and may be sent out alone on trouble calls. Mechanics are generally "in training" throughout their working lives, since they must constantly increase their working knowledge to handle new and improved vending equipment.

Many beginners in this trade are high school graduates, although employers generally do not require a high school diploma for employment. High school or vocational school courses in electricity and machine repair help beginners to qualify for entry jobs. These courses also may help beginners to skip the lowest rung of the job ladder—general shop helper.

Employers require prospective repairmen to demonstrate mechanical ability, either through their work experience or by scoring well on mechanical aptitude tests. The ability to deal tactfully with people is important to employers who are considering applicants. A commercial driver's license and a good driving record are essential for most vending machine repair jobs.

Skilled mechanics may be promoted to senior mechanic or, in large companies, to shop foreman or supervisor. Advancement to service manager, who schedules repair work, is possible for a few mechanics having adminis-

trative ability. A few mechanics having initiative and adequate financial backing become independent operators.

Employment Outlook

Employment of vending machine mechanics is expected to increase moderately throughout the 1970's. In addition to new jobs created by growth, a few hundred job openings will result each year from the replacement of repairmen who retire, die, or transfer to other fields of work.

Some of the factors that stimulated past growth and increased the demand for the services of qualified mechanics are the introduction of new and improved machines that dispense a growing variety of merchandise; convenient, round-the-clock service; and the rising costs of selling low-priced, standard items through conventional procedures. Improvements in currency-changing devices also have stimulated the growth of the industry by making possible a greater variety of merchandise.

Other factors that will continue to contribute to the industry's growth include an expanding population; rising levels of personal income; movement of industrial plants, schools, hospitals, department stores, and other establishments to the suburbs where restaurants are often inconveniently located; and the rising popularity of light meals and snacks.

Earnings and Working Conditions

Wage data for vending machine mechanics are available from a number of union-management contracts in effect in early 1969 covering workers employed by operating companies in 24

States and the District of Columbia. Although these contracts show a very wide range of straight-time hourly pay rates for mechanics, the majority provided for hourly rates ranging between \$3.00 and \$4.00. Different hourly rates for shop mechanics and for field (street) mechanics were stipulated in several contracts. In a few, mechanics' rates differed, depending on the complexity of the machines being repaired.

Most vending machine repairmen work 8-hours, 5 days a week, and receive premium pay for over-time work. Since vending machines can be operated 24 hours a day, mechanics frequently are required to work at night and on weekends and holidays. Some union-management contracts stipulate higher rates of pay for nightwork and for emergency repair work on weekends and holidays.

Many union-management agreements covering vending machine mechanics include health insurance provisions for hospital, medical, and surgical benefits, usually financed by the employer. Some contracts provide for employer-financed retirement benefits. Vacation and holiday pay provisions are commonly included. Paid vacations are granted according to length of service—usually, 1 week after 1 year of service, 2 weeks after 2 years, and 3 weeks after 10 years. The majority of contracts provide for 7 or 8 paid holidays annually.

Vending machine repair shops are generally quiet, well-lighted, and have adequate work space. However, when working on machines on location, mechanics may work in cramped quarters, such as passageways, where pedestrian traffic is heavy. Repair work is relatively safe, although mechanics are subject to shop hazards such as electrical shocks

and cuts from sharp tools and metal objects.

Many vending machine mechanics employed in the larger operating companies are members of the International Brotherhood of Teamsters, Chauffeurs, Warehousemen and Helpers of America.

Sources of Additional Information

Further information about work opportunities in this trade can be obtained from local vending machine operators and local offices of the State employment service. Additional information about employment in this field is available from the National Automatic Merchandising Association, 7 South Dearborn St., Chicago, Ill. 60603.

WATCH REPAIRMEN

(D.O.T. 715.281)

Nature of the Work

The skilled craftsmen who clean, repair, and adjust watches, clocks, chronometers, and electromechanical and other timepieces are called watch repairmen or "watchmakers." When a watch is not operating properly, they diagnose the cause of trouble, often difficult to locate in complicated mechanisms. Their work requires precise and delicate handling of tiny parts.

To repair a watch, the craftsman first removes the entire "movement" of the watch from the case and using a magnifying eye glass called a loupe, examines its working parts, such as the hands, dial, and balance wheel assembly.

Depending on the reason for the malfunction, he may replace the mainspring, hairspring, balance and other wheels, stems and crowns, and hands or broken jewels and adjust improperly fitted wheels and other parts. The parts are cleaned and oiled before dials, hands, case, crystal, and watch band are reassembled. He then tests the repaired watch for accuracy.

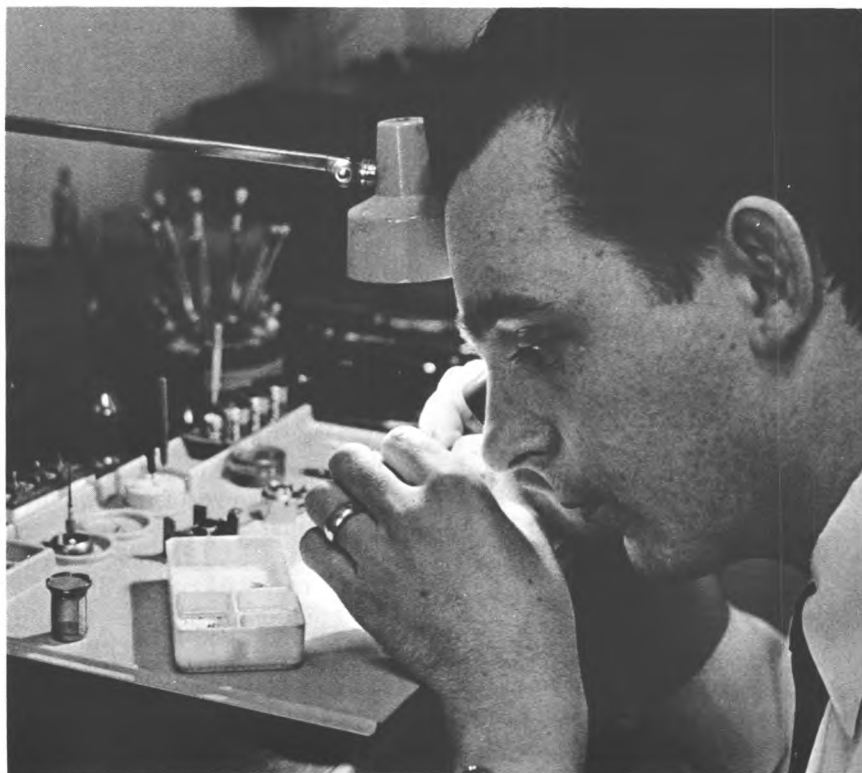
The development of interchangeable mass-produced watch parts has decreased the watch repairman's need to make parts by hand. However, he frequently must adjust factory-made parts for complicated timepieces to insure a "true" fit.

Watch repairmen use timing machines; cleaning machines, including ultrasonic cleaners; and handtools, such as tiny pliers, tweezers, and screwdrivers. The repair of electric and electromechanical watches and clocks requires the use of electrical meters.

Frequently, watch repairmen are proprietors of jewelry stores, and may do minor jewelry repair, and sell watches, jewelry, silverware, and other items. They also may hire and supervise salesclerks, other watch repairmen, jewelers, and engravers; arrange window displays; purchase goods to be sold; and handle other managerial duties.

Places of Employment

About 20,000 watch repairmen were employed in 1968, about half of whom were self-employed. Most self-employed watch repairmen owned small retail jewelry stores that perform repair work on the premises. Others operated their own trade shops and specialized in repairing watches for jewelry stores. Most of those who were not self-employed worked in retail jewelry stores, and the re-



Repairman uses loupe to examine movement of watch.

mainder worked in trade shops, wholesale establishments, and plants that manufacture watches, clocks, or other precision timing instruments.

A substantial number of individuals who received training as watch repairmen used their skill in jobs such as instrument maker, repairman, or assembler; laboratory technician; microminiaturization specialist in research, development, and engineering laboratories and in Federal, State, and local government agencies. A few watch repairmen were instructors in vocational schools.

The Nation's 20,000 retail jewelry stores are scattered throughout the country. The heaviest concentration of these stores is located in large commercial centers such as New York City, Chicago, Los Angeles, Philadelphia, and San Francisco.

Training, Other Qualifications, and Advancement

Many young people prepare for this trade through courses given in private watch repair schools, public vocational high schools, or post-high school training. Others are trained through formal apprenticeship or other on-the-job training programs.

There generally are no specific educational requirements for entrance into any of the approximately 40 watch repair schools, although most students are high school graduates. The length of time required to complete the course—usually 18 months—is determined by its content, the ability of the individual student, and whether attendance is full or part time. In most watch repair schools, a considerable amount of time is spent taking apart and reassembling vari-

ous kinds of watch movements, truing hairsprings, removing and replacing balance staffs, fitting friction jewels, and learning how to use a watchmaker's lathe and watch cleaning machines. Some schools offer courses in the repair of unusual types of timepieces, such as chronographs, calendars, and timers.

Most schools require students to furnish their own handtools. Training in instrument repair work in the armed services can be helpful for those who wish to become watch repairmen.

Students or watch repairmen interested in employment outside of jewelry stores or trade shops may require training in related subjects such as basic electronics, instrument repair, or microminiaturization technology which is provided on-the-job in many industries.

Important qualifications for success in this field are mechanical aptitude, finger dexterity, a sensitive touch, good vision (with or without glasses), and patience. For those interested in owning or working in retail stores, salesmanship and knowledge of business practices, accounting, and public relations are required.

A few States—Florida, Iowa, Indiana, Kentucky, Louisiana, Minnesota, North Carolina, North Dakota, Oregon, Michigan, and Wisconsin—require watch repairmen to obtain a license. To obtain a license, they must pass an examination designed to test their skill with tools and their knowledge of watch construction and repair.

Watch repairmen in all States, however, can demonstrate their degree of competence by passing one of two certification examinations given by the American Watchmakers Institute. Successful examinees receive the title of either Certified Master Watchmaker or Certified Watchmaker.

The Certified Master Watchmakers examination tests those who have truly mastered the craft while the Certified Watchmakers examination is for those who are proficient in the craft but not to the degree of a Certified Master Watchmaker. Annual voluntary up-grading examinations covering some new phase of watchmaking also are offered to those watch repairmen who desire to prove their ability to keep up with the times. Those who pass the up-grading examination receive a plaque of recognition.

Beginners with sufficient funds—about \$2,500 to \$3,500 is needed to purchase a watch-timing machine and other tools and equipment—may open their own watch repair shops. The usual practice, however, is to work for an experienced watch repairman before starting one's own business. Some owners of watch repair shops sell various items of jewelry, and may eventually establish retail jewelry stores. These stores require a more substantial financial investment.

Employment Outlook

Employment of watch repairmen is expected to show little or no change through the 1970's. However, hundreds of job openings will arise annually from the need to replace experienced workers who retire, die, or transfer to other fields of work.

The supply of qualified watch repairmen who can do all kinds of repair work quickly and accurately was inadequate in 1968. The number of workers being trained may continue to be insufficient to meet anticipated employment needs. Some new job openings for watch repairmen will

occur in retail stores and trade shops in small cities where business is expanding, and in newly established shopping centers in the suburbs of large cities. In addition, there will be a continuing demand for well-trained workers to use their watch repair skills in the production of miniaturized devices, especially in industries making scientific instruments and electronic equipment.

Several factors are expected to contribute to the demand for watch repairmen. The number of watches in use will rise as population and family incomes increase. The trends toward owning more than one watch, wearing watches as costume jewelry, and buying more children's watches are expected to continue. The popularity of small watches and the increasing use of more complicated timepieces—chronographs, electronic watches, calendar watches, and self-winding watches—also will help to maintain a large volume of repair work. Increased demand for miniaturized consumer goods, such as transistor radios, television sets, and hearing aids, and the trend in the missile, aircraft, instrument, and computer industries toward smaller and lighter weight components and assemblies, are expected to increase further the demand for individuals having watch repair training to work in establishments manufacturing these kinds of equipment. On the other hand, the factors that will tend to increase the demand for watch repairmen will be offset by other factors that will operate to decrease it. Sales of inexpensive watches that cost no more to replace than to repair probably will continue to increase, and competition from persons who are employed in other fields, but who repair watches in their spare time, is expected to continue.

Earnings and Working Conditions

Earnings of watch repairmen in entry jobs generally ranged from about \$90 to \$125 a week in 1968 and depended on individual ability and place of employment. Experienced watch repairmen employed in retail stores, trade shops, and watch manufacturing establishments received from \$120 to \$200 for a 40-hour week; supervisors or managers of large retail repair departments earned up to \$225 a week. In addition, watch repairmen in retail stores sometimes receive commissions based on sales of watches and other items in the store. Repairmen in large retail and manufacturing establishments often participate in life and health insurance programs and savings and investment plans. Watch repairmen who are in business for themselves usually earn considerably more than those working for a salary. Earnings of the self-employed depend on the amount of repair work done and, in the case of watch repairmen who own retail jewelry stores, the volume of sales and working hours.

Watch repairmen frequently work longer than the standard 40-hour week. Those who are self-employed or located in small communities usually work a 48-hour week or longer. The work involves little physical exertion and generally is performed in comfortable, well-lighted surroundings. This light, sedentary work frequently is recommended to certain handicapped workers.

Some watch repairmen are members of the International Jewelry Workers Union or the America Watch Workers Union (Ind.).

Sources of Additional Information

American Watchmakers Institute,
P.O. Box 11011, Cincinnati, Ohio
45211.

Retail Jewelers of America, Inc.,
1025 Vermont Ave. NW., Wash-
ington, D.C. 20005.

Information on training courses, as well as on watch repairing as a career, may be obtained from:

Information on watch repair job opportunities in retail stores can be obtained from:

Further information about work opportunities or training in this trade may be available from local offices of the State employment service.

PRINTING (GRAPHIC ARTS) OCCUPATIONS

Printing is an art, a leading industry, and one of our chief means of communication. In 1968, it provided employment for more than 1 million workers in a wide variety of occupations. Although these occupations are found principally in the printing, publishing, and allied industries, they also are found in government agencies and in private firms that do their own printing, such as banks, insurance companies, and manufacturers of paper products and metal containers. About one-third of all printing employees work in printing craft occupations. These craft occupations are described in detail later in this chapter. Other occupations in the printing industries include printing estimator, printing technician, mailer, computer programmer, and computer typist, as well as the usual administrative, clerical, maintenance, and sales occupations found in all industries.

Nature and Location of the Industry

The printing process is basically a means of transferring ink impressions of words, numerals, symbols, and photographs or other illustrations to paper, metal, or other materials. The most commonly used methods of printing are letterpress, lithography, gravure, flexography, and screen printing. Each method has special advantages and requires some special skills.

Included in the printing, publishing, and allied industries are the printing and publishing of newspapers, magazines, books, and advertising matter; the production of business forms; the production of greeting cards and

gift wrappings; commercial or job printing; bookbinding; and the provision of typesetting, photoengraving, platemaking, and other printing services, primarily for printing establishments.

In 1968, the largest division in terms of employment was newspaper printing and publishing, with over 363,000 employees in approximately 8,000 establishments. Most daily and many weekly newspapers throughout the Nation do their own printing. Although some major newspapers employ several hundred workers, many smaller dailies and weeklies have fewer than 20 employees.

Commercial or job printing establishments, the second largest division, employed over 340,700 workers in about 17,000 establishments. Establishments in this division produce a great variety of materials such as advertising matter, letterheads, business cards, calendars, catalogs, labels, maps, and pamphlets. They also print limited-run newspapers, books, and magazines. More than half of all workers in commercial shops are in establishments having fewer than 100 workers. A few large plants, each employing a thousand workers or more, account for about 8 percent of all commercial printing employees.

Printing jobs are found throughout the country. Almost every town has at least one printing shop of some kind—frequently, a small newspaper plant which also may do other printing. However, more than half of the Nation's printing employees are in five States—New York, Illinois, California, Pennsylvania, and Ohio. Within these States, most printing activities are in or near manufacturing, commercial, or financial areas such as New York,

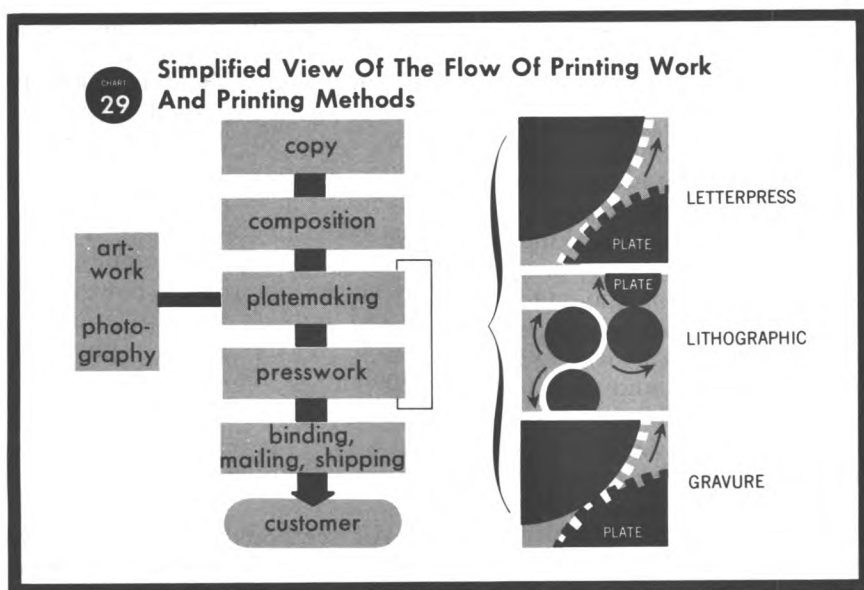
Chicago, Los Angeles, Philadelphia, San Francisco-Oakland, Cincinnati, and Cleveland. Other leading centers of printing employment are Boston, Detroit, Minneapolis-St. Paul, Washington, D.C., St. Louis, and Baltimore. Employment in book and magazine printing is highly concentrated in these areas. A much larger proportion of employment in newspaper plants, however, is found outside these centers because of the great number of small local newspapers.

Printing Methods

All methods of printing have certain common characteristics. A surface of metal, stone, wood, linoleum, rubber, or plastic is prepared so that part of it can be covered with ink. The ink is then transferred to a sheet of paper or other material which is pressed against the prepared surface.

In relief printing, the printing surface stands up from the rest of the surrounding printing plate area. Ink is rolled over the raised surface and then paper is pressed against it. The best known and most widely used example of this method is letterpress printing. Other examples of relief printing are flexography, in which a flexible rubber plate and rapid drying fluid inks are used; linoleum and wood block printing; and relief engraving on metal or plastic.

Flexography is widely used for printing on plastic films and foil bags, milk containers, gummed tape, and bread and candy wrappers. In lithography (offset printing), the printing plate surface is smooth, with both image and nonimage areas on the same level. Lithography is based on the principle that grease and water do not mix. The image areas of the plate are coated with a substance to which the greasy printing ink will adhere. On the press, the plate is moistened with water be-



fore each inking so that only the image areas take up the greasy ink from the inking roller. The inked image is transferred from the plate to a rubber blanket and then offset to the surface to be printed. The lithographic method can be used to produce practically all items printed by any other method. It is especially satisfactory for printing on rough-textured surfaces because of the flexibility of the rubber blanket.

In gravure printing, the image to be reproduced is etched into the surface of the printing plate. The whole surface is covered with ink and then wiped off, leaving ink only in the sunken or etched areas. When paper or other material is firmly pressed against the surface, the ink is lifted out and appears on the paper. Copper and steel plate engraving also uses this technique.

Screen printing is a method in which inks or other materials such as paint, varnish, and liquid plastic are forced by the action of a flexible blade through a stencil mounted on a finely woven screen, generally plastic or stainless steel. The shape of the stencil openings determines the design to be

printed. This process may be applied to a wide variety of surfaces such as conventional paper, cardboard, wood, glass, metal, plastic, and textiles. Screen printing is used on irregular surfaces and cylindrical surfaces as well as on flat surfaces.

Regardless of the method used, several basic steps are involved in the production of printed matter. (See chart 29.) They include layout—planning the composition and content of each page; typesetting and composition—producing and assembling the text type, headings, illustrations, and other materials into final page form; platemaking—preparing printing plates from the original composition for use on the printing presses; printing—transferring an image to a printing surface; and finishing—binding and mailing operations.

Printing Occupations

Production of printed materials involves workers in a wide variety of occupations. Printing craftsmen who in 1968 numbered over 412,300 represent a large segment

of these employees. Printing craftsmen usually specialize in one area of printing operations; for example, type composition, photography, platemaking, presswork, or binding. Their training, moreover, is confined largely to only one of the basic printing methods—letterpress, lithography, or gravure.

The estimated 191,000 skilled composing room workers employed in 1968 were the largest group of printing craftsmen. This group includes hand compositors, typesetting machine operators, makeup men, tape-perforating machine operators (teletypesetters), and proofreaders. Other large groups of skilled workers are printing pressmen and their assistants; lithographic craftsmen, including cameramen, artists, strippers, platemakers, and lithographic pressmen. Bookbinders, photoengravers, electrotypers, and stereotypers are other important printing craftsmen. Individual occupations are described in detail later in this chapter.

Maintenance machinists, who repair and adjust typesetting machines, printing presses, or bindery equipment, are another group of skilled workers employed in large plants.

In the skilled occupations, practically all the workers are men. However, many of the less skilled jobs, especially in the binderies, are held by women. Printing establishments also employ a great many persons as executives, salesmen, accountants, engineers, stenographers, clerks, and laborers. Newspapers and other publishers employ a considerable number of reporters and editors. These occupations are discussed elsewhere in the *Handbook*. (See index for page numbers.)

Because of the increasingly complex and highly mechanized printing equipment in use today, there is a growing need for tech-

nically trained people in all areas of printing management and production. For example, an increasing number of production technicians are being employed throughout the printing industry. These men are responsible for seeing that the standards established for each printing job are met. To do this, they must be thoroughly familiar with the printing processes, and the many technical instruments used in the plant to judge and control the quality of the printing.

The mailroom, chiefly in newspaper and periodical plants, is another area of employment closely related to printing production. Here workers address, bundle, and tie the printed matter for distribution. Modern mailroom processes are mechanized to a considerable extent. Mailers operate addressing, stamping, stacking, bundling, and tying machines.

Training and Other Qualifications

Apprenticeship is a common method of entry into the printing crafts. In some instances, it is the only means by which one may be trained to become a journeyman (skilled worker) in a unionized shop. Formal apprenticeship also is required for journeyman status in many larger establishments not covered by union contracts.

At the beginning of 1969, about 11,000 registered apprentices were in training in the skilled printing crafts. A registered apprentice is an employee who, under an expressed or an implied agreement, receives instruction in an apprenticeable occupation for a stipulated term and is employed in an apprenticeship program registered with a State apprenticeship agency or the U.S. Department of Labor's Bureau of Apprenticeship and Training. In ad-

dition, several thousand apprentices were in nonregistered programs. A substantial number of persons also were learning a printing trade while working as helpers, particularly in small printing shops or lettershops, or through a combination of work experience and schooling.

Printing trades apprenticeships usually last from 4 to 6 years, depending on the occupation and the shop or area practices. The apprenticeship program covers all phases of the particular trade and generally includes classroom or correspondence study in related technical subjects in addition to training on the job. As new printing methods have been developed and introduced, they generally have been incorporated into the duties of the traditional printing crafts and included in the apprentice training programs. Apprenticeship applicants generally are required to be between 18 and 30 years of age and must pass a physical examination. However, in many printing crafts, there is no maximum age limit for entry into an apprenticeship.

In selecting applicants for printing craft jobs, most employers require a high school education or its equivalent. A thorough knowledge of spelling, punctuation, the fundamentals of grammar, and basic mathematics is essential in many of the printing trades. A knowledge of the basic principles of chemistry, electronics, and physics is becoming increasingly important because of the growing use of photomechanical and electronic processes in printing. An artistic sense is also an asset since the finished product should be pleasing in balance and design. Most printing crafts require persons with good eyesight, about average physical strength, and a high degree of manual dexterity. Mental alertness, speed combined with ac-

curacy, neatness, patience, and the ability to work with others are also necessary. The ability to distinguish colors is important in areas of printing where color is used. Many employers require applicants to take one or more aptitude tests developed for printing industry occupations by the U.S. Department of Labor. These tests are given in the local offices of State employment services. Apprentices often are chosen from among the young men already employed in various unskilled jobs in printing establishments who demonstrate the mechanical aptitudes essential for the printing crafts.

About 4,000 schools—high schools, vocational schools, technical institutes, and colleges—offer courses in printing. These courses may help a young person to be selected for apprenticeships or other job openings in the printing and publishing industries.

Employment Outlook

There will be many opportunities to enter the skilled printing trades through the 1970's. These opportunities will occur primarily as a result of the need to replace experienced workers who retire, die, or transfer to other fields of work. Many of these opportunities, however, will be in new types of jobs because of technological changes in production methods. Retirements and deaths alone may provide about 8,000 openings each year during the decade. Slight employment increases in some printing trades also are expected to provide a small number of additional job openings annually.

A continued rise in the volume of printed material is expected because of population growth, the increasingly high level of education, the expansion of American

industry, and the trend toward greater use of printed materials for information, packaging, advertising, and various industrial and commercial purposes. However, employment in skilled printing trades occupations is not expected to increase significantly because of the continuing introduction of laborsaving technological changes in printing methods. These changes, primarily in the areas of type composition, platemaking, and bindery operations, include the increasing use of electronic devices such as computers, electronic etching and color-separating equipment, and electronic controls for highly mechanized bindery equipment.

Employment growth will vary among the printing trades. For example, employment of compositors, the largest group of printing craftsmen, is expected to decrease slightly despite the continued increase in the volume of printing because of laborsaving technological changes in typesetting and composition. Employment of lithographic craftsmen, however, is expected to increase because of the growing use of lithography (offset printing).

Earnings and Working Conditions

Earnings of production workers in the printing and publishing industry, including the unskilled and semiskilled workers and printing craftsmen, are among the highest in manufacturing industries. In 1968, production workers in this industry averaged \$133.28 a week, or \$3.48 an hour, compared with \$122.51 a week, or \$3.01 an hour, for production workers in all manufacturing.

Earnings of individual printing craftsmen vary from one occupation to another. Generally, the wage rates in large cities are higher than in small communities.

	Average union hourly rate July 1, 1968 ¹	
	News- paper	Book and job
Bookbinders		\$4.45
Compositors:		
Hand	\$4.40	4.44
Machine operators	4.43	4.45
Electrotypers		4.99
Photoengravers	4.71	
Pressmen (journeymen)	4.32	
Pressmen (cylinder)		4.34
Pressmen (platen)		3.83
Stereotypers	4.25	4.64
Mailers	3.98	3.61

¹Average day rates.

Wage rates also differ by type of printing establishments. The following tabulation shows the average union minimum hourly wage rates for daywork for selected printing occupations in 69 large cities on July 1, 1968. These rates are the minimum basic rates for the individual occupational classifications. They do not include overtime, other special payments, or bonuses.

A standard workweek of 37½ hours was specified in labor-management contracts covering about 2 out of 5 of the organized printing trades workers, although standard workweeks of 36¼ hours and 35 hours were also in effect. A 40-hour workweek was standard in some establishments in the industry. Time and a half generally is paid for overtime. Work on Sundays and holidays is paid for at time and one-half or doubletime rates in most commercial printing establishments. In newspapers plants, however, the craftsmen's workweek often includes Sundays. Time and one-half or double time is paid for these days only when they are not part of the employee's regular shift. Night-shift workers generally receive pay differentials above the standard day rates.

The starting wage rates of apprentices are generally from 40 to 50 percent of the basic rate for journeymen in the shop. Wages are increased periodically, usually every 6 months, until in the final

year or half year of training, the apprentice receives from 80 to 95 percent of the journeyman rate. Apprentices who have prior civilian or military experience sometimes can obtain credit which will start them above the beginning apprentice pay rate, and also reduce the length of time required to become a journeyman if they successfully pass examinations provided for situations of this nature. In exceptional cases, these provisions also apply to apprentices with technical school training. In some of the trades, apprentices may be upgraded when they show exceptional progress.

Paid vacations generally are provided for printing craftsmen. The most common provision in labor-management agreements is 2 weeks' vacation with pay after 1 year's employment. Many agreements, however, provide for 3 weeks' vacation with pay after 1 year or more of employment, and an increasing number provide for 4 weeks with pay after 20 or 25 years. Other major benefits, such as paid holidays, retirement pay, life and disability insurance, hospitalization, and severance pay, are also common. In addition, a number of printing trade unions have for many years operated their own programs providing their members with one type of benefit or more, such as life insurance, retirement, sickness, or disability payments.

The injury-frequency rate in

the printing industry is somewhat lower than the average for all manufacturing industries.

A large proportion of the printing trades workers are members of unions affiliated with the AFL-CIO. The largest printing trades unions are the International Printing Pressmen and Assistants' Union of North America; the International Typographical Union; and the Lithographers and Photoengravers Union. Other printing trades unions include the International Brotherhood of Bookbinders; the International Stereotypers' and Electrotypers' Union of North America; and the International Mailers Union (Ind.). The majority of unionized lithographic workers are in plants under contract with the Lithographers and Photoengravers International Union, which includes both printing craftsmen and other lithographic workers.

Sources of Additional Information

Information on opportunities for apprenticeship or other types of printing employment in a particular locality may be obtained from various sources. Applicants may apply directly to the printing establishments in their areas. The names and locations of local printers usually can be obtained from the classified section of the local telephone directory. In addition, the local unions and employer associations in the printing industry often can provide information regarding apprenticeship openings. In recent years, there has been an increasing use of local offices of the State employment services as information exchanges for apprenticeship openings. Some of these offices provide services such as screening applicants and giving aptitude tests.

General information on the printing industry may be obtained by writing to the following organizations:

American Newspaper Publishers Association, 750 Third Ave., New York, N.Y. 10017.

Education Council of The Graphic Arts Industry, Inc., 4615 Forbes Ave., Pittsburgh, Pa. 15213.

Graphic Arts Technical Foundation, 4615 Forbes Ave., Pittsburgh, Pa. 15213.

Gravure Technical Institute, 60 East 42d St., New York, N.Y. 10020.

International Typographical Union, P.O. Box 157, Colorado Springs, Colorado 80901.

Printing Industries of America, Inc., 5223 River Road, Washington, D.C. 20016.

(See sections on individual printing occupations for names of labor organizations and trade associations which can provide more information on specific printing trades.)



Compositors make up page from lines set by machine.

COMPOSING ROOM OCCUPATIONS

(D.O.T. 650.582, 654.782, and 973.381)

The printing process begins in a composing room where manuscript copy is set in type, proofed, and checked for errors. Machine and handset type, and other materials, such as photoengravings, are assembled there and prepared for the pressroom.

In 1968, about half of all printing craftsmen—about 191,000—were employed in composing room occupations. These occupations offer many opportunities for persons interested in learning a skilled craft. Compositors usually have year-round employment and

very good earnings. Composing room workers include compositors who set type by hand; typesetting machine operators who operate semiautomatic typesetting machines; tape-perforating machine operators who perforate tapes used to operate some typesetting machines; *bankmen* who assemble type in shallow trays called "galleys" and make trial proofs of this type; *proofreaders* who check the galley proofs with the original copy for errors; *make-up men* who assemble type and photoengravings in page forms; and *stonehands*, who arrange the pages in proper sequence.

Compositors are employed in newspaper plants, commercial printing shops, in book and periodical printing plants, and in typographic composition firms that set type for printing establishments, advertising agencies, and advertising departments of large business firms. One-third of all compositors work in newspaper plants. A large number are employed in establishments that specialize in setting type for book and magazine publishers.

Skilled composing room workers are employed in almost every community throughout the country, but they are concentrated in large metropolitan areas such as New York, Chicago, Los Angeles, Philadelphia, Boston, San Francisco, Detroit, Minneapolis-St. Paul, Cleveland, and Washington, D.C.

Nature of the Work

Hand compositors (typesetters) (D.O.T. 973.381) make up the oldest composing room occupation. Today the majority of type that is set by hand is for work requiring very fine composition, usually larger size type being used for advertising copy, and for small jobs where it would

be impractical to set the type by machine.

In setting type by hand, the compositor, reading from the manuscript copy, first sets each line of type in a "composing stick" (a device which holds type in place) letter by letter and line by line. When this stick is full, he slides the completed lines onto a shallow metal tray called a "galley."

Typesetting machine operators are craftsmen who operate semiautomatic machines which set type much more rapidly than the hand compositors. The type size used in machine set composition ordinarily is much smaller than that set by hand.

Linotype (or Intertype) machine operators (D.O.T. 650.582) reading from the copy clipped to the machine's copy board, select letters and other characters by operating a keyboard which has 90 keys. As they press the keys, the letters, in forms of metal molds called matrices, are assembled into lines of words. A spaceband key provides the neces-

sary spacing between words. As they complete each line, the operators touch a lever and the machine automatically casts the line of type into a solid metal strip called a "slug." The slugs are then deposited in a galley and are later assembled into the type forms from which either the printing impressions or the plates are made. Nearly all newspaper plants, large commercial shops, and typographic composition firms use these machines and operators to set type. In the smaller plants, the typesetting machine operator maintains and repairs as well as operates the typesetting machine. In the larger plants, maintenance machinists are employed to make all but minor adjustments to the machines.

Other typesetting machine operators work on Monotype machines. One machine is called the Monotype keyboard and the other is the Monotype caster.

Monotype keyboard operators (D.O.T. 650.582) operate keyboards quite similar to those on a typewriter, but which include about four times as many keys. The keyboard machine produces a perforated paper tape which later is fed into the casting machine. The keyboard operator must be able to handle complicated copy, such as statistical tables.

Monotype caster operators (D.O.T. 654.782) operate the casting machines which automatically cast and assemble the type, guided by the perforations in the paper tape prepared by the keyboard machine. As the rolls of perforated tape are fed into the machines, the proper matrices for casting letters are selected automatically by means of the perforations in the tape. Molten metal is forced into the matrix to form the individual character. The Monotype casting machine, as the name suggests, casts type



Linotype operator sets copy.



Monotype keyboard operator prepares perforated tape.

one letter or character at a time. This permits some corrections to be made by hand without the need to reset an entire line. The principal duties of caster operators are to insert the tape, adjust and tend the machine while it is operating, and do necessary maintenance and repair work. Only one caster operator is employed to every two or three keyboard operators. Typographic composition firms are the largest employers of both Monotype keyboard and caster operators.

Phototypesetting machine operators (D.O.T. 650.582) set type on machines which may be similar in appearance or method of operation, or both, to those which cast type in hot metal. In phototypesetting, however, a photographic process replaces the function of the hot metal, and the final product is a film or photographic paper print of the type rather than a metal slug. In one type of machine, as the operator

presses the keys, the individual matrices or mats, which contain small film negatives, are assembled and photographed on film, character by character, to form a line of type. In other phototypesetting machines, a perforated paper tape or a magnetic sound tape is fed into a phototypesetting machine which "reads" the tapes and photographs the individual characters indicated on the tape.

Some typesetters operate photolettering machines which produce lines or individual characters in large-size type such as that used for newspaper headlines and for advertisements. As in phototypesetting, a photographic process is involved, and the final product is on film or paper.

In addition to machine operation, the phototypesetter must be familiar with the fundamentals of photography, including dark-room procedures, because frequently he has to develop the

film on which the type has been photographed. He also may assemble and arrange developed film into pages. This process, called "stripping," corresponds to page makeup in the hot metal type process. The operator also makes minor repairs on the phototypesetting machine. Since much of this equipment has electronic controls, the operator needs a basic working knowledge of the principles of electronics.

Typesetting machine operators also set type by the "cold type" method. The type is set on paper, using machines that are similar to typewriters. These machines automatically space letters and lines. "Cold type" composition may be set directly on a paper or even a metal sheet from which the plate is to be made, or the cold type images may be cut from paper and pasted on layout sheets. The process of assembling and pasting this type on layout sheets is called paste makeup, and is somewhat similar to hand composition. The worker who assembles and pastes up all the materials for a page is called a *paste-makeup man*. Cold type composition frequently is used by newspapers for display advertising, and by small newspapers to set regular text copy.

Typesetters frequently operate tape-perforating machines called teletypesetters. These are machines with keyboards similar to those of typewriters. The machines are fitted with reels of tape that are perforated as the keys are struck. The perforated tapes are inserted in line casting machines, which set the type as directed by the perforations. After the tape has been punched, it may be sent by teletype to other cities where it is automatically reperforated and used to control the operation of linecasting machines.

Training and Other Qualifications

Most compositors acquire their skills through apprenticeship training. In union shops, apprentices often are selected from among the helpers. Some compositors acquire their skills while working as helpers for several years (particularly in small shops and in the smaller communities) or through a combination of trade school and helper experience.

Tape-perforating machine operators must be expert typists. They generally acquire their typing skill in commercial courses in high school or in business school. It is not necessary for these operators to be trained as journeymen compositors to perform their work efficiently; however, they must be familiar with printing terms and measurements. The training period for tape-perforating machine operators is generally about a year. Journeymen compositors sometimes transfer to this occupation.

Generally, apprenticeship covers a 6-year period of progressively advanced training, supplemented by classroom instruction or correspondence courses. However, this period may be shortened by as much as 2 to 2½ years for apprentices who have had previous experience or schooling or who show the ability to learn the trade more rapidly. The time and emphasis spent upon any particular phase of training varies from plant to plant, depending upon the type of printing establishment.

A typical apprenticeship program for compositors includes instruction in elementary hand composition, page makeup, lock-up, lineup, and proofreading. After basic training as a hand compositor, the apprentice receives intensive training in one specialized field or more, such as the

operation of typesetting machines, including phototypesetting and teletypesetting machines, as well as specialized work in hand composition and photocomposition.

Applicants for apprenticeship generally must be high school graduates and in good physical condition. They sometimes are given aptitude tests. Important qualifications include training in English, especially spelling, and in mathematics. Printing and typing courses in vocational or high schools are good preparation for apprenticeship applicants, and a general interest in electronics and photography is becoming increasingly useful. Artistic ability is an asset for a compositor in layout work.

Apprentices are paid according to a predetermined wage scale, which increases as the apprenticeship period advances. At the beginning of 1969, there were about 3,900 registered apprentices in training for skilled composing room jobs.

Employment Outlook

A few thousand job openings for composing room workers are expected annually through the 1970's because of the need to replace experienced workers who retire or die. Retirement and deaths alone should provide approximately 4,000 job openings annually.

In spite of the anticipated expansion in the volume of printing in the United States during the 1970's, employment of compositors is expected to decline slowly because of technological changes in typesetting equipment that will make it possible to set type faster using fewer operators. For example, over the past decade there has been an increasing use of automatically operated typeset-

ting machines. These machines, which set lines of type in metal or on film, are activated by an electronic device into which perforated tapes are fed. The perforations indicate characters, words, sentences, length of lines, spacing, and hyphenation. The recent introduction of computers, programmed to perforate the codes for spacing, length of line, and hyphenation simplifies the work of the tape-perforating machine operator, and increases the speed at which type can be set.

Technological changes also will affect significantly the educational and skill requirements for composing room workers. The greater use of phototypesetting, for example, requires compositors to have some photographic skills. Since much of the new typesetting equipment is operated by electronic systems, a knowledge of the application of electronic principles to the operation of this equipment is becoming increasingly important for the compositor.

Earnings and Working Conditions

As is true for most printing crafts, wages of skilled composing room workers are relatively high compared with skilled workers generally. However, there is considerable variation in wage rates from place to place and from firm to firm. The average union minimum hourly wage rate for hand compositors on the day shift in 69 large cities was \$4.40 in newspaper plants and \$4.45 in book and job shops on July 1, 1968. Union minimum wage rates for compositors in book and job shops ranged from \$2.93 an hour in Tampa, Fla., to \$4.93 in San Francisco, Calif. In newspaper establishments, the union minimum hourly wage rates for day-shift compositors ranged from

\$3.73 an hour in Lubbock, Tex., to \$5.49 in Chicago.

Working conditions for compositors vary from plant to plant. Some heat and noise are made by hot metal typesetting machines. In general, the newer plants are well lighted and clean, and many are air conditioned. Composing room jobs require about average physical strength. Hand compositors are required to stand for long periods of time and to do some lifting. Young men with some types of physical handicaps, such as deafness, have been able to enter the trade and do the work satisfactorily. Many compositors work at night on the second or third shift for which they generally receive additional pay.

A substantial proportion of compositors are members of the International Typographical Union.

Sources of Additional Information

International Typographical Union, P.O. Box 157, Colorado Springs, Colo. 80901.

International Typographic Composition Association, Inc., 2233 Wisconsin Ave. NW., Washington, D.C. 20007.

Printing Industries of America, Inc., 5223 River Road, Washington, D.C. 20016.

See page 503 for additional sources of information.

PHOTOENGRAVERS

(D.O.T. 971.381 and .382)

Nature of the Work

Photoengravers make metal printing plates of illustrations and other copy that cannot be set up

in type. The printing surfaces on these plates stand out in relief above the nonprinting spaces, as do the letters and the accompanying type. Similarly, gravure photoengravers, a specialized type of photoengraver, make gravure plates in which the image is etched below the surface for use in reproducing pictures and type.

In making a photoengraving plate for the letterpress process, the entire job may be done either by one man or by a number of skilled workers, each specializing in a particular operation. Specialists include cameramen, printers, etchers, finishers, routers, blockers, and proofers. In the large shops, the work is divided almost always among a number of these specialists.

A *cameraman* starts the process of making a photoengraving plate by photographing the material to be reproduced. Plates made from line drawings are called line plates and those from photographs are called halftone plates. After the cameraman develops the negative, the *printer* prints the image on a metal plate by coating the plate with a solution sensitive to light and then exposing it and the negative to arc lights. The image areas are protected by chemical means so that when the plate is placed in an acid bath by the *etcher*, only the nonimage areas are etched away, leaving the image areas to stand out in relief.

A number of other photoengraving operations may be performed, depending on the quality



Cameraman photographs material to be reproduced.

of the printing required. Photoengravings for very high quality books or periodicals, for example, require more careful finishing than those for newspapers. The *finisher* carefully inspects and touches up the plate with handtools; the *router* cuts away metal from the nonprinting part of the plate to prevent it from touching the inking rollers during printing; the *blocker* mounts the engraving on a suitable base to make it reach the right height; and the *proofer* prints a sample copy on a proof press.

The operations involved in gravure photoengraving are much like those in letterpress photoengraving, except that the image areas rather than the background are etched away.

Places of Employment

About 18,000 journeymen photoengravers were employed in 1968. The great majority of photoengravers (about 12,000) are employed in commercial service shops where the main business is making photoengravings for use by others. Newspaper and roto-gravure shops employ several thousand photoengravers. In addition, book and periodical shops and the U.S. Government Printing Office also employ photoengravers. Many of these craftsmen have their own shops. Photoengravers' jobs are highly concentrated in the largest printing centers, particularly New York, Chicago, Philadelphia, and Los Angeles.

Gravure photoengravers work mainly in independent gravure plants. Most of them work for the small number of big firms which handle a large proportion of all gravure work. A few large newspapers and commercial plants also

have departments where this work is done. Gravure plants are concentrated in a few States, particularly New York, Pennsylvania, Illinois, and Kentucky.

Training and Other Qualifications

The most common way to become a photoengraver is through apprenticeship training. At the beginning of 1969, there were over 560 registered apprentices in training for skilled photoengraving occupations. The apprenticeship program generally covers a 5 year period and includes at least 800 hours of related classroom instruction. Besides the care and use of tools, the apprentice is taught to cut and square negatives, make combination plates, inspect negatives for defects, mix chemicals, sensitize metal, and operate machines used in the photoengraving process.

Apprenticeship applicants must be at least 18 years of age and generally must have a high school education or its equivalent, preferably with courses in chemistry and physics and training in art. Credit for previous experience acquired in photoengraving work may shorten the required apprenticeship time. Many employers require a physical examination for prospective photoengravers; the condition of the applicant's eyes is particularly important because a photoengraver's duties involve constant close work and color discrimination.

Employment Outlook

A few hundred job openings are expected each year through the 1970's because of the need to replace photoengravers who retire or die. However, no increase in

the total number of these craftsmen is anticipated over the next decade despite the growing use of photographs and other illustrations, and the increasing use of color. The introduction of more rapid etching techniques, the application of electronics to engraving and to color separation, and the increasing use of offset printing, which requires no photoengravings, will limit the number of photoengravers needed.

Earnings and Working Conditions

Photoengravers are among the highest paid printing craftsmen. The average union minimum hourly wage rate for photoengravers in 69 large cities on July 1, 1968, was \$4.99 in book and job shops and \$4.71 for the day shift in newspaper plants. Union average minimum hourly rates ranged from \$3.51 an hour in New Orleans, La., to \$5.51 an hour in New York.

The great majority of photoengravers are union members. Nearly all unionized photoengravers are represented by the Lithographers and Photoengravers International Union.

Sources of Additional Information

American Photoplatemakers Association, 166 West Van Buren St., Chicago, Ill. 60604.

Lithographers and Photoengravers International Union, 233 West 49th St., New York, N.Y. 10019.

Printing Industries of America, Inc., 5223 River Road, Washington, D.C. 20016.

See page 503 for additional sources of information.

ELECTROTYPERS AND STEREOTYPERS

(D.O.T. 974.381 and 975.782)

Nature of the Work

Electrotypers (D.O.T. 974.381) and *stereotypers* (D.O.T. 975.782) make duplicate press plates of metal, rubber, and plastic for letterpress printing. These plates are made from the metal type forms prepared in the composing room. Electrotypes are used mainly in book and magazine work. Stereotypes, which are less durable, are used chiefly in newspaper work. Electrotyping and stereotyping are necessary because most volume printing requires the use of duplicate printing plates. When a large edition of a book, magazine, or newspaper is printed, several plates must be used to replace those which become too worn to make clear impressions. Also, by means of duplicate plates, printers can use sev-

eral presses at the same time, and thus finish a big run quickly. This is especially important in publishing daily newspapers. Furthermore, the rotary presses used in many big plants require curved plates which can be made by either electrotyping or stereotyping processes from the flat type forms.

Several steps are required to produce a duplicate, curved metal plate ready for use in the pressroom. In electrotyping, the first step is making a wax or plastic mold of the type form, coating it with special chemical solutions, and then suspending it in an electrolytic solution containing metal. This leaves a metallic shell on the coated mold; this shell then is stripped from the mold, backed with metal or plastic, and carefully finished.

The stereotyping process is much simpler, quicker, and less expensive than electrotyping, but it does not yield as durable or as fine a plate. Stereotypers make molds or mats of paper-maché (a

strong material composed of paper pulp) instead of wax or plastic. This involves placing the mat on the type form and covering it with a cork blanket and sheet of fiberboard. The covered form is run under heavy power-driven steel rollers to impress the type and photoengravings on the mat. Then the mat is placed in a stereotype casting machine which casts a composition lead plate on the mold. In many of the larger plants, stereotype plates are cast in automatic machines.

In many of the larger plants, electrotypers and stereotypers perform only one phase of the work, such as casting, molding, finishing, or blocking. However, journeymen must know how to handle all the tasks involved in their respective trades.

Many electrotypers work in large plants that print books and periodicals. The majority of stereotypers work in newspaper plants, but some are employed in large commercial printing plants. Electrotypers and stereotypers also are employed in independent service shops which do this work for printing firms.

Training and Other Qualifications

Nearly all electrotypers and stereotypers learn their trades through apprenticeship. Electrotyping and stereotyping are separate crafts, and there is little transferability between the two. The apprenticeship program of each trade covers all phases of the work and almost always includes classes in related technical subjects as well as training on the job. Apprenticeship training for electrotypers and stereotypers usually covers a 5- or 6-year period of reasonably continuous employment.

Apprenticeship applicants must be at least 18 years of age and,



Stereotyper makes mat.



Stereotypers place mat into casting machine.

in most instances, must have a high school education or its equivalent. If possible, this education should include mechanical training and courses in chemistry. Physical examinations and aptitude tests often are given to prospective apprentices. The emphasis placed upon different phases of training varies from plant to plant, however, depending upon the type of printing establishment.

Employment Outlook

There will be some opportunities for new workers to become electrotypers and stereotypers through the 1970's because of retirements, deaths, or transfers of workers to other occupations. However, the total number of electrotypers and stereotypers is expected to continue to decline moderately.

This decline will occur in spite of the anticipated increase in the total volume of printing because of technological changes. For ex-

ample, the increasing use of automatic plate casting eliminates many steps in platemaking, and plastic and rubber plates are being made increasingly outside electrotyping and stereotyping shops. Furthermore, the increasing use of offset printing reduces the need for electrotypers and stereotypers, since this type of plate is not required in offset printing.

Earnings and Working Conditions

On July 1, 1968, the union minimum hourly wage rates in 69 large cities averaged \$4.45 an hour for electrotypers, \$4.64 an hour for stereotypers in book and job shops, and \$4.25 an hour for stereotypers on day shift in newspaper plants. Union minimum hourly wage rates for electrotypers in book and job plants ranged from \$3.60 an hour in Baltimore, Md., to \$5.05 an hour in New York. In newspaper plants, rates for day-shift stereotypers ranged from \$3.57 an hour in Springfield, Mass., to \$5.99 an hour in Chicago.

Much of the work requires little physical effort since the preparation of duplicate printing plates is highly mechanized. However, there is some lifting of relatively heavy, hot press plates.

Nearly all electrotypers and stereotypers are members of the International Stereotypers' and Electrotypers' Union of North America.

Sources of Additional Information

International Stereotypers' and Electrotypers' Union of North America, 10 South La Salle St., Chicago, Ill. 60603.

International Association of Electrotypers and Stereotypers, Inc., 758 Leader Building, Cleveland, Ohio 44114.

Printing Industries of America, Inc., 5223 River Road, Washington, D.C. 20016.

See page 503 for additional sources of information.

PRINTING PRESSMEN AND ASSISTANTS

(D.O.T. 651.782, .885, and .886)

Nature of the Work

The actual printing operation is performed in the pressroom. Printing pressmen "makeready" (prepare) type forms and press plates for final printing and tend the presses while they are in operation.

The object of makeready, which is one of the most delicate and difficult parts of the pressman's work, is to insure printing impressions that are distinct and uniform. This is accomplished by means such as placing pieces of paper exactly the right thickness underneath low areas of the press plates to level them, and by attaching pieces of tissue paper to the surface of the cylinder or flat platen which makes the impression. Pressmen also have to make many other adjustments—for example, those needed to control margins and the flow of ink to the inking roller. In some shops, they are responsible not only for tending the presses but also for oiling and cleaning them and making some minor repairs. On the larger presses, pressmen have assistants and helpers.

Pressmen's work may differ greatly from one shop to another, mainly because of differences in the kinds and sizes of presses used. Small commercial shops generally have small and relatively simple presses that often are

fed paper by hand. At the other extreme are the enormous web-rotary presses used by the larger newspaper, magazine, and book printing plants. These giant presses are fed paper in big rolls called "webs," up to 50 inches or more in width. They print the paper on both sides by means of a series of cylinders; cut, assemble, and fold the pages; and, finally, count the finished newspaper sections which emerge from the press ready for mailing. These steps are accomplished automatically by means of many different mechanisms, each of which calls for constant attention while a run is being made. Presses of this kind are operated by crews of journeymen and less skilled workers under the direction of a *pressman-in-charge*.

Although the basic duties of *lithographic (offset) pressmen* are similar to those of letterpress and gravure pressmen, a number of differences exist, principally because of the specialized character of lithographic presses. (See p. 512 for further details.)

The duties of *press assistants* range from feeding sheets of paper into hand-fed presses to helping pressmen makeready and operate large and complicated rotary presses. Workers whose main responsibility is feeding often are called *press feeders*. The ratio of assistants to pressmen differs from one establishment to another, depending on the size of the plant, the type of press used, and other factors. Many shops are too small to have pressroom assistants.

Training and Other Qualifications

As in other printing crafts, the most common way of learning the pressman's trade is through apprenticeship. Some workers have been able to learn the skills of the

trade while working as helpers or press assistants or through a combination of work experience in the pressroom and vocational or technical school training.

The length of apprenticeship and the content of training depend largely on the kind of press used in the plant. The apprenticeship period in commercial shops is 2 years for press assistants and 4 years for pressmen. In newspaper establishments the apprenticeship period is 5 years. The apprenticeship period for pressmen operating web presses is generally 5 years. On-the-job training includes the care of pressroom equipment, makeready, running the job, press tending and maintenance and working with various types of inks and papers.

In addition to on-the-job instruction, the apprenticeship involves related classroom or correspondence schoolwork. At the beginning of 1969, about 3,500 registered apprentices were in training.

Individual companies generally choose apprentices from among press assistants and others already employed in the plant. Young men often may work for 2 or 3 years in the pressroom before they are selected to begin 2- to 4-year training periods leading to journeyman status. A high school education or its equivalent generally is required. Because of technical developments in the printing industry, a year of chemistry and a year of physics should be included. Mechanical aptitude is important in making press ad-



Pressman adjusts stereotype plate on newspaper press.

justments and repairs. An ability to visualize color is essential for work on color presses, which are being used increasingly. Physical strength and endurance are necessary for work on some kinds of presses, where the pressmen have to lift heavy type forms and press plates and stand for long periods.

Employment Outlook

Employment of pressmen is expected to increase moderately throughout the 1970's. The total amount of printing and the use of color are expected to increase, requiring larger and more complex presses. However, continued improvements in the speed and efficiency of printing presses will limit the need for additional pressmen.

The need to replace workers who retire, die, or transfer to other fields of work also will result in job opportunities for new workers. Retirements and deaths alone may result in about 1,600 job openings each year.

Earnings and Working Conditions

The earnings of pressmen depend upon the kind of press operated, the type of printing plant, and the geographical area of employment. A survey of union minimum hourly wage rates for day-work in 69 large cities shows that the average minimum hourly rate in effect on July 1, 1968, for newspaper pressmen-in-charge was \$4.62, for newspaper pressmen (journeymen), \$4.32; for book and job cylinder pressmen, \$4.34; for book and job platen pressmen, \$3.83, and for book and job press assistants and feeders, \$3.69.

Pressrooms are unavoidably noisy—one State, California, now requires newspaper pressmen working in certain areas of the

pressroom to wear ear protectors. There are also the usual occupational hazards associated with machinery. Pressmen often have to lift heavy type forms and printing press plates. At times, they work under pressure to meet deadlines, especially in the printing of newspapers and magazines. Many pressmen work night shifts for which the rate of pay is higher than the basic day rate.

A majority of pressroom workers are covered by union agreements. Practically all of the organized letterpress and gravure pressmen are members of the International Printing Pressmen and Assistants' Union of North America.

Sources of Additional Information

International Printing Pressmen and Assistants' Union of North America, Pressman's Home, Tenn. 37850.

Printing Industries of America, Inc., 5223 River Road, Washington, D.C. 20016.

See page 503 for additional sources of information.

LITHOGRAPHIC OCCUPATIONS

Nature of the Work

Lithography (offset printing) is one of the most rapidly growing methods of printing. Practically all items printed by other processes also are produced by lithography—including books, calendars, maps, posters, labels, office forms, catalogs, folding cartons, and newspapers. Lithography has special advantages when the copy to be reproduced includes photographs, drawings,

or paintings, since the rubber blanket which transfers the image from the plate to the surface to be printed permits greater flexibility in the type of paper that can be used.

Several operations are involved in lithography, and each is performed by a specialized group of workers. The main groups of lithographic workers are cameramen, artists and letterers, strippers, platemakers, and pressmen.

The *cameraman* (D.O.T. 972.-382) starts the process of making a lithographic plate by photographing the copy. He generally is classified as a line cameraman (black and white), halftone cameraman (black and white), or color separation photographer.

After the negatives have been made, they frequently need retouching to lighten or darken certain parts. Thus, it is often necessary for a *lithographic artist* (D.O.T. 972.281) to make corrections by sharpening or reshaping images on the negatives. Highly skilled workers perform this work by hand, using chemicals, dyes, and special tools.

To qualify as journeymen, these artists must be adept in one or more of the various retouching methods. Like cameramen, they are assigned to only one phase of the work and may customarily be known, for example, as dot etchers, retouchers, or letterers, depending on their particular job.

The *stripper* (D.O.T. 971.381) makes layouts on paper, glass, or film. He arranges and pastes film or prints of type, pictures, and other art work on the layout sheets called flats or "stripups," from which photographic impressions are made for the lithographic press plates. The job of the stripper in the lithographic process corresponds to that of the makeup man in the letterpress process.



Camerman adjusts lens before making printing plate.

In lithography, employees in the platemaking department expose press plates to photographic films which are made by the cameramen and corrected by artists. The *platemaker* (D.O.T. 972.781) may cover the surface of the metal plate with a coating of photosensitive chemicals, or the metal plate may come to him with the photosensitive layer applied. The platemaker exposes the sensitized plate through the negative or positive to strong arc lights; this is commonly done in a vacuum printing frame. When a large

number of the same images are to be exposed on a single plate, however, the operation is done in a photocomposing machine. The plate then is developed and chemically treated to bring out the image.

The *lithographic pressman* (D.O.T. 651.782) makes ready and tends the lithographic (off-set) printing presses. He installs the plate on the press, adjusts the pressure for proper printing, cares for and adjusts the rubber blanket which takes the impression from the plate and transfers

it to the paper, adjusts water and ink rollers for correct operation, mixes inks, and operates the presses. Basically, the duties of these workers are similar to those of letterpress and gravure pressmen. Some differences exist, however, because of the chemical means used to separate image and nonimage areas on lithographic presses. In large plants, press feeders and helpers are employed; their duties are similar to those of assistants and helpers to letterpress and gravure pressmen. (See p. 511.)

Training and Other Qualifications

A 4- or 5-year apprenticeship covering the basic lithographic process usually is required to become a well-rounded lithographic craftsman. Training emphasis is on the specific occupation in which journeyman status is being sought, although generally, an attempt is made to make the apprentice familiar with all lithographic operations. At the beginning of 1969, there were about 1,900 registered apprentices in training for skilled lithographic occupations.

Usually, apprenticeship applicants must be in good physical condition, high school graduates, and at least 18 years of age. Aptitude tests are sometimes given to prospective apprentices. Vocational school training and training in photography, mathematics, chemistry, physics, and art are helpful in learning these crafts.

Employment Outlook

A slow rise in the number of lithographic workers is expected through the 1970's. In addition, the need to replace workers who retire, die, or transfer to other fields of work will provide

some job openings. Employment growth and replacement needs together are expected to provide about 1,800 job opportunities for new workers each year on the average through the 1970's.

Offset printing has expanded considerably in recent years, particularly in the commercial printing field, and a large number of letterpress concerns have established offset departments. Offset presses are used increasingly in small and medium size newspaper establishments. In 1968, an estimated 73,000 journeymen lithographic workers were employed. Offset printing employment should show continued growth because of the greater use of photographs, drawings, and illustrations in printed matter, and because of the more widespread use of color in many printed products. However, new technological developments, particularly in the camera, platemaking, and press departments, are expected to slow the increase in lithographic employment.

Earnings and Working Conditions

Union minimum hourly wage rates for lithographic occupations vary within each occupation, depending upon the degree of skill required, the type and size of equipment, and the part of the country in which the worker is employed. For example, according to information on union minimum hourly wage rates in 69 large cities as of July 1, 1968, wage rates for dot etchers or process artists and letterers ranged from \$3.32 an hour in Little Rock, Ark., to \$5.55 an hour in Boston, Mass. Rates for cameramen, which generally are below those for skilled artists, ranged from \$3.13 an hour in San Antonio, Tex., to \$5.35 an hour in the San

Francisco area. In many plants, top grade cameramen earn as much as the highly skilled artists, and cameramen who do multi-color work are paid more than those who do only black and white work. Minimum hourly rates of platemakers ranged from \$2.81 an hour in San Antonio to \$5.14 an hour in Los Angeles and San Diego. The wide range of rates for lithographic pressmen—from \$2.53 an hour for small multilith press operators in Little Rock to \$7.12 an hour for first pressmen on a large eight-plate roll-fed offset press in Chicago—is due largely to the many different types and sizes of presses operated.

A substantial proportion of all lithographic workers are members of the Lithographers and Photoengravers International Union. A considerable number of offset pressmen and other offset workers are members of the International Printing Pressmen and Assistants' Union of North America.

Sources of Additional Information

Lithographers and Photoengravers International Union, 233 West 49th St., New York, N.Y. 10019.

International Printing Pressmen and Assistants' Union of North America, Pressmen's Home, Tenn. 37850.

Graphic Arts Technical Foundation, 4615 Forbes Ave., Pittsburgh, Pa. 15213.

National Association of Photo-Lithographers, 230 West 41st St., New York, N.Y. 10036.

Printing Industries of America, Inc., 5223 River Road, Washington, D.C. 20016.

See page 503 for additional sources of information.

BOOKBINDERS AND RELATED WORKERS

(D.O.T. 977.781)

Nature of the Work

Many printed items, such as books, magazines, pamphlets, business forms, and calendars, must be folded, sewed, stapled, or bound after they leave the printing shops. Much of this work is done by skilled *bookbinders* (D.O.T. 977.781) who numbered about 30,000 in 1968. Many bookbinders are employed in shops whose chief business is bookbinding. However, a considerable number are employed in the bindery departments of large book, periodical, and commercial printing plants and large libraries.

There are several different kinds of binderies. Edition and pamphlet binderies bind books, magazines, and pamphlets printed in large quantities. Trade or job binderies do bindery work on contract for printers, publishers, or other customers. Blankbook and looseleaf binderies bind various types of blank books such as ledgers and bookkeeping and accounting volumes. They also produce looseleaf binders and bind books in looseleaf form.

Edition binding—making books in quantity from big, flat printed sheets of paper—is by far the most complicated. The first step in the process is to fold the printed sheets into one unit or more, known as "signatures," so that the pages will be in the right order. The next steps are to insert any illustrations that have been printed separately, to gather and assemble the signatures in proper order, and to sew them together. The resulting book bodies are shaped with power presses and trimming ma-

chines, and fabric strips are glued to the backs for reinforcement. Covers are glued or pasted onto the book bodies, after which the books undergo a variety of finishing operations and, frequently, are wrapped in paper jackets. Machines are used extensively throughout the process.

Skilled bookbinders seldom perform all the different edition bindery tasks, although many journeymen have had training in all of them. In large shops, skilled bookbinders may be assigned to one or a few operations, most often to the operation of complicated machines.

In many binderies, especially large ones, much of the work is done by workers trained in only one operation or in a small number of relatively simple, related tasks. Most of these workers, often classified as bindery workers or bindery hands, are women (hence the common designation, bindery women). Their work closely resembles assembly line factory work.

Training and Other Qualifications

A 4- or 5-year apprenticeship which includes on-the-job training as well as related classroom instruction generally is required to qualify as a skilled bookbinder. Apprenticeship programs may vary considerably among the various types of bookbinding shops. When large quantities of books are bound on a mass production (edition) basis, emphasis is on the most modern machine methods. In fine hand binding, emphasis is mainly on hand methods, including artistic designing and decorating of leather covers. For many years, hand bookbinding has been declining in importance.



Bookbinder marbles book edges.

Apprenticeship applicants usually must have a high school education and be at least 18 years of age. Mechanical aptitude is helpful to the person entering this trade. In the course of the apprenticeship, trainees learn, among other things, to assemble signatures, renovate old, worn bindings, and use various binding machines such as punches, folders, perforators, stitchers, and power cutters.

For the less skilled bindery occupations, the training period may last from several months to 2 years. In union shops, apprenticeship programs for women bindery workers generally last 2 years. These formal programs include classroom instruction as well as on-the-job training.

Employment Outlook

A few hundred job openings for skilled bookbinders are expected each year during the next decade because of the need to replace experienced workers who retire or die. Many openings are expected

for bindery hands, the majority of whom are women, because of the considerable turnover among this group. However, some decrease in the total number of bookbinders and bindery hands is expected, despite the anticipated growth in the amount of bound printed materials, because of the increasing mechanization of bindery operations.

Earnings and Working Conditions

Wage rates for skilled bookbinders tend to be below the average of other printing crafts. A survey of union minimum hourly wage rates in 69 large cities, as of July 1, 1968, showed that the minimum hourly wage rate for bookbinders in book and job establishments averaged \$4.20 an hour, and rates ranged from \$4.87 in the San Francisco area to \$3.20 in Shreveport, La. The wage rates for bindery women are considerably lower and are among the lowest for printing industry workers. They ranged from \$1.93 an hour in Little Rock to \$3.30 in the San Francisco area.

The majority of bindery workers are union members. Most skilled bookbinders are represented by the International Brotherhood of Bookbinders.

Sources of Additional Information

International Brotherhood of Bookbinders, 1612 K St. NW., Washington, D.C. 20016.

Printing Industries of America, Inc., 5223 River Road, Washington, D.C. 20016.

See page 503 for additional sources of information.

SOME OTHER MANUAL OCCUPATIONS

ASSEMBLERS

Nature of the Work

Many of the products and parts made in factories must be assembled during various steps in the manufacturing process, as well as in the final assembly of the product. For example, television sets, automobiles, and refrigerators are typical of the products which undergo many assembly operations. The workers

who put together parts or finished products, nearly 911 of whom are semiskilled workers, are known as assemblers.

Some assemblers, known as floor assemblers, put together large, heavy machinery or equipment on shop floors, often fastening parts with bolts, screws, or rivets. Others, known as bench assemblers, put together small parts to make subassemblies or small complete units while working at a bench. Many assemblers work on products or parts which

move automatically past their work stations on conveyors. These workers must complete their assembly job within the time period it takes the part or product to pass their work station.

The job duties of assemblers depend upon the product being manufactured, and the manufacturing process being used. In aircraft and missile production, these workers may assemble and install parts into subassemblies. In the automobile industry, one assembler may start nuts on bolts, and the next worker on the assembly line tightens the nuts with power-driven tools. Assemblers in electronic plants may connect parts with electrical wire.

The kinds of tools assemblers use depend upon the work they are doing and the product on which they are working. Pliers, screwdrivers, soldering irons, power drills, and wrenches are among the common tools used by semiskilled assemblers.

Skilled assemblers work on the more complex parts of subassemblies with little or no supervision and are responsible for the final assembly of complex jobs. These skilled workers must know how to read blueprints and other engineering specifications and use a variety of tools and precision measuring instruments. In relatively new fields such as electronics, instrumentation, and missiles, subassembly work may require a high degree of skill.

Places of Employment

Assemblers work in plants that mass-produce products such as automobiles, aircraft, television sets, cameras, refrigerators, watches, and electrical motors. In early 1968, approximately 785,000 assemblers were employed in manufacturing plants; the great majority were in electrical machinery and other metal-working plants. The majority of



Assembler wires safety component in missile.

assemblers were employed in California, New York, Michigan, Illinois, Ohio, Indiana, and Pennsylvania.

About half of all assemblers were women, who worked primarily as bench assemblers. The largest proportion of women assemblers worked in the electrical machinery, equipment, and supply industry. Large numbers of women assemblers also were employed in other industries—fabricated metals; machinery, except electrical; transportation equipment; and instruments and related products.

Training, Other Qualifications, and Advancement

Inexperienced workers who are hired to do assembly work are usually trained on the job in a few days or weeks. The new worker may have his job duties explained to him by his supervisor and then be placed under the supervision of an experienced employee. The trainee observes the experienced employee at work or directly assists him in his work. When the learner develops sufficient speed, he is placed "on his own" and is responsible for the work he does.

Employers generally want applicants for assembly jobs to be physically fit, dependable, and have some aptitude for mechanical work.

High school graduates or workers who have taken vocational school courses, such as blueprint reading, are preferred by many employers although a high school diploma is not usually required. Generally, for production-line assembly jobs, employers look for applicants who can do routine work at a steady and fast pace. For other types of assembly jobs, applicants may have to meet special require-

ments. For example, in plants producing electrical and electronic products, which may contain many different colored wires, applicants often are tested for color blindness.

Many women are employed in bench assembly jobs because such work is relatively light and often requires the ability to work with small and delicate objects. This is particularly true in the electrical and electronic equipment industry. Male workers are usually employed as floor or line assemblers, where the work is physically hard. Final automobile assembly, for example, is generally done by men.

A relatively small number of workers who learn to perform a variety of assembly work and who have a knowledge of blueprint reading and shop mathematics are able to become skilled assemblers. A few workers also may become skilled inspectors or foremen.

Employment Outlook

Employment of assemblers is expected to increase slowly through the 1970's, creating several thousand job openings annually. Most job openings, however, are expected to result from the need to replace workers who retire, die, or transfer to other fields of work. Deaths and retirements alone will account for about 20,000 openings each year.

Most of the industries that employ assemblers, especially the electrical machinery industry, are expected to increase their employment during this period; however, technological changes are expected to limit the growth of this occupation. For example, the increasing use of printed electrical circuits reduces the wiring work required in assembling radio and television sets, thus af-

fecting the employment of assembly workers in plants producing these products. Further increases in the use of automatic assembly processes are expected to slow the growth of assemblers.

Employment in metalworking manufacturing plants, which have many assemblers, is particularly sensitive to changes in business conditions and national defense needs. Therefore, assemblers in those industries will be subject to occasional layoffs.

Earnings and Working Conditions

Earnings of assemblers in manufacturing industries vary widely, depending on their skill, the type of product assembled, and factors such as the size and location of the plant in which they are employed.

Assembly jobs are commonly classified as A, B, and C, to reflect the level of skill and responsibility involved. The following table presents average straight-time hourly earnings of assemblers in the nonelectrical machinery industry:

Average straight-time hourly earnings of class A, B, and C assemblers in nonelectrical machinery, mid-1967

Area	Class A	Class B	Class C
United States ¹	\$3.08	\$2.68	\$2.32
New England ..	2.98	2.60	2.34
Middle Atlantic ..	3.03	2.60	2.17
Border States ..	2.97	2.64	2.23
Southeast	2.45	1.95	1.79
Southwest	2.65	2.16	1.84
Great Lakes	3.18	2.87	2.45
Middle West	3.27	2.71	2.47
Pacific	3.10	2.60	2.23

¹Includes data for Mountain States.

The working conditions of assemblers differ, depending on the particular job performed. Assemblers of electronic equipment may put together small components at a bench in a room which is clean, well lighted, and free from dust. Floor assemblers of industrial machinery, on the other hand, may install and assemble

heavy parts and are often exposed to contact with oil and grease. Assemblers on assembly lines may be under pressure to perform their assignments in the time the conveyor moves the parts or subassemblies past their work stations. Assemblers paid incentive or piecework rates are encouraged to work more rapidly by the prospect of higher earnings.

Many assemblers in manufacturing industries are members of labor unions. These unions include the International Association of Machinists and Aerospace Workers; the International Union of Electrical, Radio and Machine Workers; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; and the International Brotherhood of Electrical Workers. Most labor-management contracts in the manufacturing plants in which assemblers are employed provide for fringe benefits, such as holiday and vacation pay, health insurance, life insurance, and retirement pensions.

AUTOMOBILE PAINTERS

(D.O.T. 845.781)

Nature of the Work

Automobile painters make old and damaged motor vehicles "look like new." These skilled workers repaint vehicles that have lost the luster of their original paint, and the repaired portions of vehicles damaged in traffic accidents. (Production painters who work for motor vehicle manufacturers are discussed elsewhere in the *Handbook*.)

To prepare an automobile for painting, the painter or his helper rough sands the vehicle to re-

move original paint. He then uses a spray gun to apply primer coats to the automobile surface. After the primer dries, he sands the surface until it is smooth enough to be painted. For rough sanding, he usually uses a pneumatic or electric sander and a coarse grade of sandpaper; final sanding may be done by hand using a fine grade of sand paper. Small nicks and scratches that cannot be removed by sanding are filled with automobile-body putty. Masking tape and paper cover areas not to be painted.

Before painting repaired portions of an automobile, the painter may mix paints to match the existing color of the car. Before applying the paint, he adjusts the nozzle of the spray gun according to the kind of lacquer or enamel being used and, if necessary, adjusts the air-pressure regulator to acquire the needed amount of pressure. He must handle the spray gun skillfully so that the paint is applied evenly, rapidly, and thoroughly. To speed drying, he may place the freshly painted automobile under heat lamps or in a special infrared oven. After the paint dries, the painter or his helper may polish the newly

painted surface to bring out its luster.

Places of Employment

Almost two-thirds of an estimated 30,000 automobile painters employed in 1968 worked in repair shops that specialize in automobile-body repairs and painting, and in shops that make general automobile repairs. Most of the others were employed in the service departments of automobile and truck dealers. Some painters were employed by organizations that maintained and repaired their own fleets of motor vehicles, such as trucking companies and bus lines.

Although automobile painters are employed in every section of the country, about half of them work in the eight States with the largest number of motor vehicles: California, New York, Texas, Pennsylvania, Ohio, Illinois, Michigan, and Florida.

Training, Other Qualifications, and Advancement

Most automobile painters start as helpers and acquire their skills informally by working for several years with experienced painters. Usually, beginners remove automobile trim, clean and sand surfaces to be painted, and polish painted surfaces. As helpers gain experience, they progress to more complicated tasks such as using spray guns to apply primer coats and paint small areas. Three to four years of informal on-the-job training are required to become a fully qualified automobile painter.

A small number of automobile painters learn their trade through apprenticeship. Apprenticeship programs for automobile painters, which generally last 3 years,



consist of on-the-job training supplemented by related classroom instruction.

Young men considering this work as a career should have good health, keen eyesight, a discerning color sense, and a steady hand. Courses in automobile-body repair offered by high schools and vocational schools provide helpful experience. Completion of high school generally is an advantage though not a requirement for getting a job as a painter's helper, because too many employers high school graduation indicates that a young man can "complete a job."

An experienced automobile painter with supervisory ability may advance to shop foreman. Many experienced painters who acquire the necessary capital open their own shops.

Employment Outlook

Employment of automobile painters is expected to increase moderately through the 1970's. In addition to the few hundred job openings anticipated annually as a result of employment growth, hundreds of job openings are expected to result each year because of the need to replace experienced painters who retire or die. Opportunities also will occur as some painters transfer to other lines of work.

Employment of automobile painters is expected to increase primarily as a result of the increasing number of motor vehicles damaged in traffic accidents. The accident toll is expected to increase as the number of motor vehicles in use grows, despite new and improved highways, driver training courses, added safety features on new vehicles, and stricter law enforcement that may slow down the rate of increase. Despite the increasingly

durable paint used on new cars, the number of motor vehicles that need to be repainted because the original finish has deteriorated also is expected to increase as a result of the growth in the number of motor vehicles in use.

The employment effect of increasing numbers of motor vehicles and traffic accidents may be offset slightly by improvements that make automobile bodies more resistant to rust, and new developments in painting equipment that should enable painters to complete jobs in less time.

Earnings and Working Conditions

A number of union-management agreements indicate that most automobile painters employed by automobile dealers in 1968 earned between \$3.45 and \$4.60 an hour. Those employed in large metropolitan areas generally earned more than painters employed in small towns.

Many painters employed by automobile dealers and independent repair shops are paid a percentage of the labor cost charged to the customer. Under this method, a painter's earnings depend largely on the amount of work he is assigned and how fast he completes it. Earnings also may be based on other methods of wage payment—for example, a weekly salary plus a commission on jobs completed, or an hourly rate. Painters employed by trucking companies, buslines, and other organizations that repair their own vehicles usually receive an hourly rate. Most painters work 40 to 48 hours a week.

Many employers of automobile painters provide holiday and vacation pay, and additional benefits such as life, health, and accident insurance, and contribute to retirement plans. Some shops

furnish laundered uniforms free of charge.

Automobile painters are exposed to fumes from paint and paint-mixing ingredients. However, in most shops, the painting is performed in special ventilated booths that protect the painters. Shops not having such booths furnish masks that cover the nose and mouth. Painters must be agile because they often bend and stoop while working. Only average physical strength is needed.

Many automobile painters belong to unions, including the International Association of Machinists and Aerospace Workers; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; the Sheet Metal Workers' International Association; and the International Brotherhood of Teamsters, Chauffeurs, Warehousemen and Helpers of America (Ind.). Most painters who are union members are employed by the larger automobile dealers and by trucking companies and buslines.

Sources of Additional Information

For further information regarding work opportunities for automobile painters, inquiries should be directed to local employers, such as automobile-body repair shops and automobile dealers; locals of the unions previously mentioned; or the local office of the State employment service. The State employment service also may be a source of information about the Manpower Development and Training Act of 1962, apprenticeship, and other programs that provide training opportunities.

General information about the work of automobile painters may be obtained from:

Automotive Service Industry Association, 168 North Michigan Ave., Chicago, Ill. 60601.

Independent Garage Owners of America, Inc., 624 South Michigan Ave., Chicago, Ill. 60605.

AUTOMOBILE TRIMMERS AND INSTALLATION MEN (AUTOMOBILE UPHOLSTERERS)

(D.O.T. 780.381 and .884)

Nature of the Work

Automobile trimmers, frequently assisted by installation men, replace and repair upholstery and other automobile fabrics. (Workers who upholster automobiles in factories are not included in this statement.) Trimmers and installation men together are called "automobile upholsterers."

Automobile trimmers (D.O.T. 780.381) are skilled upholsterers who custom make coverings for automobile seats, floors, and door panels; convertible tops; and other items. To make these items, they first determine the dimensions of each piece of vinyl, leatherette, broadcloth, or other material to be used and mark the material for cutting, after allowing for pleats, seams, shrinkage, and stretching. Although trimmers often follow standard designs to make most items, they may follow original designs specified by customers or create original designs. After cutting and fitting, they use heavy-duty sewing machines to stitch the pieces. Finished pieces are stretched and pulled to fit snugly; glued, tacked, stapled, or fastened in other ways; and then trimmed of excess material. In addition to

making automobile upholstery and convertible tops, trimmers may make items such as truck seat cushions and tarpaulins, boat covers, and seats for buses and small airplanes. Automobile upholsterers also repair upholstery that has been torn, cut, burned, or damaged. They may repair power-window and convertible top mechanisms, and cut and install automobile glass.

Automobile trimmers often are assisted by *installation men*, sometimes called seat-cover installers (D.O.T. 780.884), who

remove worn seat covers and convertible tops and install new ones.

Trimmers and installation men use a variety of handtools including shears, knives, screwdrivers, special pliers, various type of wrenches, tack hammers, mallets, and tape measures. They also use heavy-duty sewing machines and power tools such as airpowered staplers and wrenches. In some shops, they use electric steaming machines to shrink fabrics, and special electronic welders to bind synthetic materials.



Places of Employment

An estimated 8,300 automobile trimmers and installation men were employed in 1968. Most worked in shops that specialize in the fabrication and replacement of automobile upholstery and convertible tops. Others worked in automotive repair and accessories sections of department stores, in automobile-body repair shops, and in automobile dealer shops. Most automobile upholstery specialty shops employ from 1 to 5 trimmers. In small shops, the number of installation men generally equals the number of trimmers. However, installation men outnumber trimmers in many of the larger shops, particularly those that specialize in the installation of factory-made seat covers and tops.

Although automobile upholsterers are employed throughout the country, most work in the larger cities.

Training, Other Qualifications, and Advancement

Most trimmers and installation men learn their skills on the job. Beginners usually are hired as installation men trainees. They are first taught to remove seats and upholstery and install seat covers, and gradually learn to do more difficult jobs such as installing convertible tops. After qualifying as installation men, they progress to making seat covers, tops, and other upholstery. Although a capable beginner can become a fully qualified installation man in 3 to 6 months, 3 to 4 years usually are required to become a skilled trimmer.

A small number of automobile trimmers begin as apprentices. Apprenticeship programs for automobile trimmers, generally last 3 or 4 years, and consist of on-

the-job training supplemented by related classroom instruction.

Applicants for entry jobs should be mechanically inclined and in good physical condition. Employers are interested in hiring those who enjoy working creatively with their hands. A high school education is desirable but not essential. High school and vocational school courses in furniture upholstery provide valuable training. Courses in mathematics are useful in laying out and planning automobile upholstery work.

Experienced trimmers who have supervisory ability may advance to foremen in large shops. Many automobile trim shops are owned by trimmers who acquired the necessary experience, skill, and capital to establish their own businesses.

Employment Outlook

Hundreds of job openings for automobile trimmers and installation men are expected to be available through the 1970's. Most openings will result from the need to replace experienced workers who retire, die, or transfer to other lines of work. Moderate growth of the occupations is expected to provide a small number of job opportunities annually, primarily because the operation of more automobiles is expected to increase the demand for custom-made automobile upholstery and other fabric products. However, the demand is not expected to grow as rapidly as the number of automobiles, because of the use of more durable fabrics. Other factors that may stimulate employment growth include an increasing demand for truck cushions and tarpaulins as a result of the anticipated increase in the number of trucks in operation, and an increasing demand for custom-made boat

covers and seat as a result of the growing popularity of boating.

Earnings and Working Conditions

Most trimmers and installation men are paid a weekly salary or hourly wage and work from 44 to 48 hours per week. Many receive commissions or bonuses based on sales, in addition to their regular pay. Some trimmers are paid on a straight commission basis. Information from a limited number of automobile dealers indicated that most installation men and trimmers earned between \$2.75 and \$4.25 an hour in 1968. Individual earnings often depend on experience and geographic location. Trimmers earn more than installation men, and earnings generally are higher in large metropolitan areas than in small towns.

Trimmers and installation men receive holiday and vacation pay and all, or part, of the cost of life, health, and accident insurance. Some employers also contribute to retirement plans.

Trimmers and installation men generally work in shops that are clean, well-lighted, and relatively quiet. Their work often involves being in awkward and uncomfortable positions for short periods. Automobile upholstery work is not hazardous, although these workers are subject to cuts, bruises, and other minor injuries.

A small percentage of these workers are members of the International Brotherhood of Teamsters, Chauffeurs, Warehousemen and Helpers of America (Ind.).

Sources of Additional Information

For further information regarding work opportunities for automobile trimmers and installation men, inquiries should be

directed to local automobile trim shops or the local office of the State employment service. The State employment service also may be a source of information about the Manpower Development and Training Act of 1962, apprenticeship, and other programs that provide training opportunities.

General information about the work of automobile trimmers and installation men may be obtained from:

National Association of Auto Trim Shops, 129 Broadway, Lynbrook, L.I., N.Y. 11563.

BLACKSMITHS

(D.O.T. 356.381 and 610.381)

Nature of the Work

Blacksmiths are skilled craftsmen who make and repair various metal articles such as tools, fixtures, machine and structural parts, and other agricultural and industrial implements. They also sharpen hand and machine tools such as chisels, drills, bits, picks, and similar tools. Blacksmiths join pieces of glowing hot metal by hammering them together, a process called forge or fire welding. They use several basic tools and pieces of metalworking equipment to fabricate or repair metal articles, including a special furnace called a forge to heat the metal, an anvil on which the heated metal is placed to hammer it into shape, presses and power hammers to shape the metal, and a variety of handtools such as hammers, chisels, and tongs.

After a metal article or tool has been fabricated, repaired, or sharpened, a blacksmith may heat-treat (temper or anneal) the forg-

ed metal for certain desired properties. To harden the metal, he first heats the metal to a high temperature in the forge, and then he cools it quickly in an oil or water bath. To temper the metal (to make it more durable and less brittle), he also heats it, but to a lower temperature than is needed for hardening. The metal is kept at this lower temperature for a specified time and then removed to cool gradually at air temperature.

An ancient skill practiced by many blacksmiths is that of shoeing horses; blacksmiths who specialize in this activity often are called farriers. To shoe a horse, a blacksmith removes the old shoe from the horse's hoof and examines the hoof for bruises and defects. He then cleans, trims, and shapes the hoof to receive the new shoe. The blacksmith then heats a metal bar cut to hoof measurements, hammers this bar into the shape of the shoe, punches nail holes, and positions and nails the shoe on the horse's hoof. Finally, he uses a rasp to trim the hoof flush to the new shoe. Today, most blacksmiths or horseshoers use ready-made horse shoes, but they may be required to make minor adjustments to achieve a proper fit.

Job duties of industrial blacksmiths are similar to those of many forge shop workers who operate heavy machinery to shape and form articles from heated metal. For a detailed discussion of jobs and job opportunities in forge shops, see the section on Forge Shop Occupations.

Places of Employment

In 1968, about two-thirds of the 15,000 blacksmiths employed in the United States worked as industrial blacksmiths, primarily performing maintenance and repair duties. Nearly half of the

industrial blacksmiths worked in manufacturing industries, especially in the basic iron and steel industry, and also in the machinery, transportation equipment, and fabricated metal products industries. The railroad, construction, and mining industries also employed relatively large numbers of blacksmiths. Where oil wells are being drilled, for example, blacksmiths sharpen and temper drill bits, repair tools, and assist drillers in the operation and maintenance of drilling equipment.

About one-third of all blacksmiths worked in small shops repairing farm implements, tools, and other mechanical equipment. Blacksmiths in these shops often perform other services such as welding, brazing, or tool sharpening. In addition, a few of these craftsmen specialized in the shoeing of horses. The vast majority of the blacksmiths in these small shops were self-employed.

Blacksmiths work in all parts of the country, in small rural communities as well as in large industrial centers. However, employment is concentrated in Pennsylvania, Texas, California, Illinois, Ohio, and New York. Horseshoers are found in all States and, especially, where there are numerous horses, horse farms, and race tracks.

Training and Other Qualifications

Most workers enter the occupation by obtaining jobs as helpers in blacksmith shops, where they gradually learn the trade through on-the-job experience. Others enter through formal apprenticeship training programs, which generally last 3 or 4 years. Apprenticeship programs customarily provide training in blueprint reading, proper use of tools and equipment, heat-treatment of metal, and forging methods, in-



cluding forge welding. Most apprentices are found in large industrial firms rather than in small repair shops. Vocational school or high school courses in metalworking, blueprint reading, and mathematics are helpful to young persons interested in becoming blacksmiths.

Blacksmiths must have a skilled touch to shape metal parts to specified dimensions. They also must be in good physical condition. Pounding metal into shape and handling heavy tools and metal parts require considerable strength and stamina. The use of power hammers and hoists, however, reduces the physical demands of the work.

Employment Outlook

Employment of blacksmiths is expected to decline slowly through the 1970's. However, a few hundred job openings will arise each year to replace experienced workers who retire, die, or transfer to other fields of work.

The employment of blacksmiths is expected to decline in the years ahead because forge shops are producing a growing variety of small metal articles formerly made by blacksmiths. Metalworking operations once performed only by blacksmiths are being done increasingly by other specialized workers such as welders and forge shop crafts-

men. In addition, it is often cheaper to replace many small parts than to have them repaired by a blacksmith. However, the skills of all-round blacksmiths will continue to be required in the maintenance departments of large industrial establishments, in many small metalworking and repair shops, and to shoe horses.

Earnings and Working Conditions

National earnings data are not available for blacksmiths. However, earnings data are available from union-management contracts in effect in 1968 covering a large number of blacksmiths employed in steel plants, railroad shops, and in the shipbuilding and petroleum industries. Although these contracts show a wide range of earnings for experienced blacksmiths, the majority of the contracts called for straight-time hourly earnings ranging from about \$3.25 to more than \$4.25. Contracts covering blacksmiths in the petroleum industry specified hourly rates ranging from about \$3.60 to slightly more than \$4.00. Industrial blacksmiths generally work the same number of weekly hours and have the same holidays, vacations, and other benefits as other plant workers in those industries in which they work.

Blacksmith shops tend to be hot and noisy because of the closeness of furnaces and hammers, although heat and noise have been decreased in recent years by the introduction of large ventilating fans and the reduction of machine vibration. Blacksmiths are subject to a number of job hazards such as burns from forges and heated metals and cuts, bruises, and other injuries from manual handling of materials. Increased use of per-

sonal protective equipment, such as safety glasses, metal helmets, metal-tip shoes, instep guards, face shields, ear plugs, and leather aprons, has helped to decrease the number of injuries.

Many blacksmiths belong to unions. One important union is the International Brotherhood of Boilermakers, Iron Shipbuilders, Blacksmiths, Forgers and Helpers. Other unions representing blacksmiths include the United Steelworkers of America, the Industrial Union of Marine and Shipbuilding Workers of America, and the International Union of Journeymen Horseshoers.

Sources of Additional Information

General information about the work of blacksmiths may be obtained from:

International Brotherhood of Boilermakers, Iron Shipbuilders, Blacksmiths, Forgers and Helpers, Eighth at State Ave., Kansas City, Kans. 66101.

BOILERMAKING OCCUPATIONS

Nature of the Work

Boilermakers, layout men, and fitup men are skilled craftsmen who specialize in the repairing, fabricating, and assembling and disassembling of boilers, tanks, vats, pressure vessels, heat exchangers, and similar structures made of metal plate. These boilers and other metal vessels are used throughout industry to hold liquids and gases under pressure. Boilermakers are engaged primarily in erecting and repairing boilers and pressure vessels; layout men and fitup men usually

are employed in manufacturing new boilers and heavy tanks. The repair work performed by boilermakers requires these workers to have all-round skills; fitup men and layout men have more specialized duties.

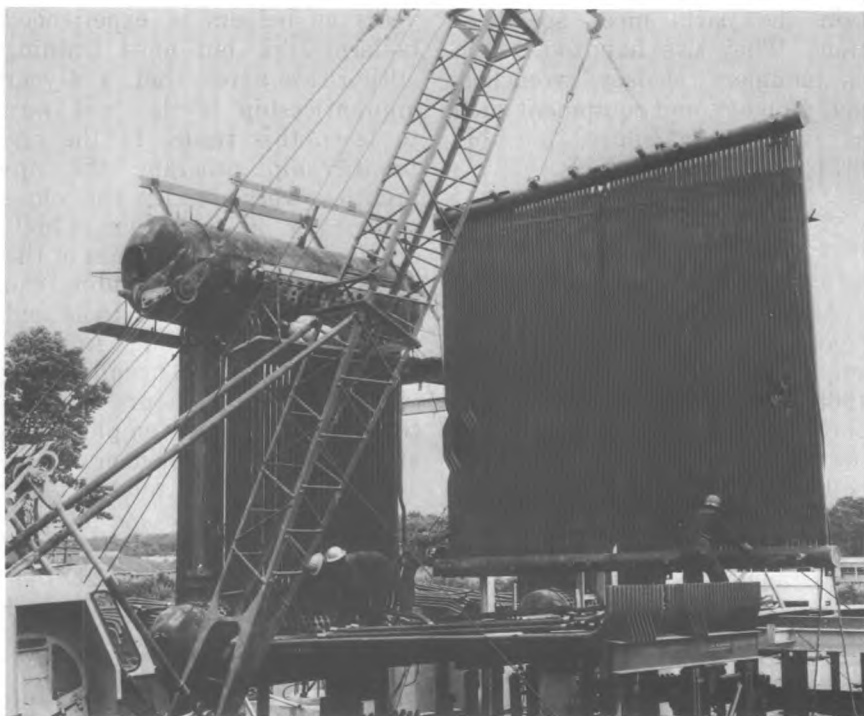
Boilermakers (D. O. T. 805.281). These craftsmen assemble and erect prefabricated parts and fittings at construction sites where boilers or other pressure vessels are used. After installation is completed, they conduct tests to check for defects. Boilermakers also repair all kinds of boilers. After first determining the cause of trouble, they may dismantle the boilers or other units and make repairs, such as patching weak spots with metal stock, replacing defective sections with new parts, or strengthening joints. In addition to those working at construction sites, a large number of boilermakers maintain and repair boiler and other pressure vessels in the powerplants of

industrial firms. Installation and repair work performed by boilermakers often must meet standards set by State and local laws covering boilers and other pressure vessels.

Many large boilers are assembled in manufacturing plants and shipped as complete units. Boilermakers often perform this assembly work, using the same skills for plant work as for field work.

Boilermakers use a variety of tools and equipment in their work. They cut and shape metal plate to size with power shears, power rolls, power presses, or oxyacetylene torches. They also use welding or riveting equipment. When assembling and erecting steel plate units at a construction site, they may use rigging equipment such as, hoists, jacks, and rollers.

Layout Men (D.O.T. 809.381 and .781). Metals used in the manufacture of boilers, tanks, vats, and other pressure



Boilermakers erect steam generating boiler.

vessels initially are prepared for fabricating operations by layout men. These workers mark curves, lines, points, and dimensions on metal plates and tubes that serve as guides to other workers who cut or shape the parts required for fabrication of the pressure vessel. They lay out parts to scale as outlined on blueprints, sketches, or patterns. Layout men use compasses, dividers, scales, surface gages, hammers, and scribes in their work.

Fitup Men (D.O.T. 819.781). Before the various parts of boilers, tanks, vats, and other pressure vessels finally are assembled, fitup men temporarily assemble and fit them together in the shop. They bolt or tack-weld parts together and correct irregularities. Fitup men also fit together nozzles, pipes, fittings, and other parts.

Fitup men read and interpret blueprints and drawings used in the manufacturing process, check parts for accuracy, and make certain the parts meet specifications. They use handtools such as hammers, sledges, wrenches, and punches, and equipment such as welding machines, portable drills, and grinding tools.

Places of Employment

About 25,000 boilermakers, layout men, and fitup men were employed in the United States in 1968. Several thousand were employed in the construction industry, mainly to assemble and erect boilers and other pressure vessels. Boilermakers also were employed in the maintenance and repair departments of industries such as iron and steel manufacturing, petroleum refining, railroad transportation, and electric and gas utilities. Large numbers worked in Federal Government installations, principally in Navy

shipyards and Federal powerplants. Layout men and fitup men were employed mainly in establishments that fabricate fire-tube and water-tube boilers, heat exchangers, heavy tanks, and similar boiler-shop products.

Boilermakers are employed in every State because of the widespread need for their skills in repair and installation work. Large numbers are employed in the Middle Atlantic and East North Central regions where metalworking industries are concentrated. Most layout men and fitup men also work in these two regions. Pennsylvania, California, Texas, Illinois, Ohio, New York, and New Jersey are among the leading States in the employment of boilermaking craftsmen.

Training, Other Qualifications, and Advancement

Many men have become boilermakers by working for several years as helpers to experienced boilermakers, but most training authorities agree that a 4-year apprenticeship is the best way to learn this trade. In the apprenticeship program, the apprentice works under the close supervision of a journeyman boilermaker who instructs him in the skills of the craft, including the proper way to use the tools and machines of the trade. Apprenticeship programs usually provide about 8,000 hours of relatively continuous employment and training, supplemented by about 600 hours of related technical instruction. Some of the technical subjects studied are blueprint reading, shop mathematics, welding techniques, and shop metallurgical science covering stress and strain of metals.

Many layout men and fitup men acquire their skills on the job. They usually are hired as

helpers and learn the craft by working with experienced workers. It generally takes at least 2 years to qualify as an experienced layout or fitup man in a fabricating shop where boilers and other pressure vessels are produced on a mass-production basis. In shops where products are custom made, layout and fitup jobs generally are filled by men who already qualify as skilled boilermakers.

Most employers prefer to hire beginning workers who have a high school education. Prior training in mathematics, blueprint reading, and shopwork is helpful to young men interested in becoming boilermakers, layout men, or fitup men. Most firms require prospective employees to pass a physical examination because good physical health and the capacity to do heavy work are necessary in these occupations. Mechanical aptitude and manual dexterity also are important qualifications.

Some boilermakers may become foremen for contractors specializing in boiler installation and repair work. A few may go into business for themselves.

Employment Outlook

Employment of boilermakers, layout men, and fitup men is expected to increase moderately through the 1970's. Most job openings will arise from the replacement of experienced workers who retire, transfer to other fields of work, or die. Retirements and deaths alone are expected to result in approximately 600 job openings annually.

The expected moderate increase in employment of boilermakers, layout men, and fitup men in the decade ahead will occur mainly because of the expansion in industries that use boiler

products—particularly the electric and gas utilities, chemical, petroleum, steel, and construction industries. In addition to increased demand for boiler products, the trend toward very large, increasingly complex, custom-made boilers is expected to spur employment of skilled boilermakers to erect this equipment on the construction site. For example, development of atomic energy facilities may create a need for many more boilermakers, layout men, and fitup men, either to manufacture or install boilers and related products. In shops that fabricate boiler products, however, growth in the number of boilermakers, layout men, and fitup men may be limited by the increasing use of more efficient production techniques and equipment, including improved materials handling methods and welding equipment.

Earnings and Working Conditions

Wage rates of skilled boilermaking workers compare favorably with those of other craftsmen. Layout men generally are paid more than boilermakers or fitup men, although wages vary widely in each occupation because of differences in factors such as the experience and skill of the worker, the kind of industry in which he is employed, and the geographical region in which he works.

Boilermakers in field assembly and installation (construction) work generally receive higher hourly wage rates than boilermakers, layout men, and fitup men employed in industrial establishments, although they may not be employed as steadily. According to a national survey of building trades workers in the construction industry, union

minimum hourly wage rates for boilermakers in 57 large cities averaged \$5.58, on July 1, 1968. Among individual cities surveyed, the union minimum hourly wage rates for boilermakers ranged from \$4.85 in Atlanta, Ga., Jacksonville and Tampa, Fla., and Knoxville and Memphis, Tenn., to \$6.53 in New York City. Straight-time hourly earnings, excluding fringe benefits or payments to health, insurance, or pension funds, for boilermakers in 12 of the 57 cities selected to show wage information from various areas and regions of the country, on July 1, 1968, appear in the accompanying tabulation.

<u>City</u>	<u>Rate per hour</u>
Baltimore	\$5.30
Boston	5.55
Chicago	6.30
Cleveland	6.51
Denver	5.10
Fresno	6.00
Houston	5.00
Kansas City	5.10
Los Angeles	6.00
New Orleans	5.00
Phoenix	6.00
Syracuse	5.55

Comparable data were not available covering boilermakers employed in industrial establishments. However, information on minimum hourly wage rates was available from union-management agreements, in effect in mid-1968, covering a large number of boilermakers, layout men, and fitup men employed in fabricated plate work, petroleum, and shipbuilding industries. The majority of these agreements called for minimum hourly wage rates ranging from \$4.00 to about \$5.00 for layout men; from about \$3.75 to \$4.75 for boilermakers; and from about \$3.50 to \$4.60 for fitup men.

Boilermakers, layout men, and fitup men in industrial establishments usually work the same number of weekly hours as other

plant workers, generally 40 hours. Most union-management agreements covering these workers provide fringe benefits such as hospitalization, and medical and surgical insurance; paid vacations; life insurance; sickness and accident insurance; and retirement pensions.

When engaged in boiler repair and assembly work, boilermakers often are required to work in cramped quarters or at great heights. Some work also must be done under conditions of dampness, heat, and poor ventilation.

Boilermaking is more hazardous than many other metalworking occupations. Employers and unions attempt to eliminate injuries in boilerships by promoting safety training and the use of protective equipment, such as safety glasses and metal helmets.

Most boilermakers, layout men, and fitup men belong to labor unions. The principal union in these trades is the International Brotherhood of Boilermakers, Iron Shipbuilders, Blacksmiths, Forgers and Helpers. Some boilermaking craftsmen are members of industrial unions, such as the Industrial Union of Marine and Shipbuilding Workers of America; the Oil, Chemical and Atomic Workers International Union; and the United Steelworkers of America.

Sources of Additional Information

General information about the work of boilermakers may be obtained from:

International Brotherhood of Boilermakers, Iron Shipbuilders, Blacksmiths, Forgers and Helpers, Eighth at State Ave., Kansas City, Kansas 66101.

DISPENSING OPTICIANS AND OPTICAL MECHANICS

(D.O.T. 713.251, .381, .884, and 299.884)

Nature of the Work

Dispensing opticians and optical mechanics (also called optical laboratory technicians) make and fit eyeglasses prescribed by eye physicians (oculists or ophthalmologists) and optometrists to convert defective vision. Optical mechanics grind and polish lenses to the specifications of prescriptions and assemble lenses in frames. Dispensing opticians then fit and adjust the finished glasses to the customer's facial features. In some States, dispensing opticians also fit contact lenses. These lenses are worn in contact with the eyes and are used as a substitute for or supplement to conventional eyeglasses. Occasionally, both the fabricating and fitting of glasses are performed by the same person.

The *dispensing optician* works in a retail optical establishment. He makes certain that the glasses follow the prescription and fit the customer properly. The optician determines exactly where the lenses should be placed in relation to the pupils of the eyes by measuring the distance between the centers of the pupils. He also assists the customer in selecting the proper eyeglass frame by measuring the customer's facial features and giving consideration to the various styles and colors of the eyeglass frames.

Before prescription eyeglasses are fitted, the dispensing optician prepares a work order which gives the optical mechanic the information he needs to interpret the prescription properly, grind the lenses, and insert them in a

frame. The work order consists of the lens prescription; information on the size, tint (where appropriate), optical centering of the lens, and other optical requirements; and the size, color, style, and shape of the frame. After the eyeglasses are made, the optician adjusts the frame to the contours of the customer's face and head to make sure they fit properly and comfortably. He uses small handtools, such as optical pliers, files, and screwdrivers, and also uses a precision instrument to check the power and surface quality of the lenses. In some shops, he may do lense grinding and finishing, and sell other optical goods such as binoculars, magnifying glasses, and nonprescription sunglasses.

In fitting contact lenses, the dispensing optician, following the physician's or optometrist's prescription, measures the cornea of the customer's eye and then prepares specifications to be followed by a firm specializing in fin-

ishing such lenses. The dispenser uses precision instruments to measure the power and curvature of the lenses and the curvature of the cornea of the eye. Contact lens fitting requires considerably more skill, care, and patience than conventional eyeglass fitting. The dispensing optician instructs the customers in the insertion, removal, and care of the contact lenses during the initial period of adjustment, which may last several weeks. The physician or optometrist rechecks their fit, as needed. If minor adjustments are necessary, the dispensing optician makes them; if major changes are needed, he returns the lenses to the contact lens manufacturer.

The *optical mechanic* performs the shop or laboratory work required to make prescription eyeglasses; but he does not make contact lenses, which involve somewhat different operations. The two principal types of optical mechanics are the *surfacers* (or



Dispensing optician fits glasses for proper functioning and attractive appearance.

prescription lens grinder) and the *benchman* (or finisher). The sur-facer, starting with standard or stock size lens blanks, lays out the work, grinds and polishes the surfaces of the lenses, and makes sure that the ground lenses conform to the prescription requirements. In small laboratories, one man may perform all of these operations and benchwork too. In large laboratories, the work is divided into separate operations which are performed mainly by workers who operate power grinding and polishing machines. The sur-facer uses precision instruments to measure the power of the lenses.

The benchman marks and cuts the ground and polished lenses to fit the frame, bevels or smooths the edges of the lenses, and assembles the lenses and frame parts into the finished eyeglasses. In large laboratories, these duties are divided into several operations which are performed mainly by semiskilled workers. The benchman uses small handtools, such as lens cutters, chippers, pliers, files, protractors, and diamond point glass drills. He also uses precision instruments to determine, for example, if there are any imperfections in the lenses.

Places of Employment

An estimated 7,000 dispensing opticians and 15,000 optical mechanics were employed throughout the country in 1968. A few thousand women are employed in these trades—most as dispensing opticians.

About 70 percent of all dispensing opticians were employed by retail optical shops or the optical departments of department stores and other retail establishments; about 20 percent were employed by eye physicians or optometrists who sell eyeglasses directly to their patients. Most



Optical laboratory mechanic surface grinds.

of the remainder worked in the prescription departments of wholesale optical laboratories that did work for retail optical firms; in special prescription shops in large ophthalmic goods factories; or were employed by hospitals. Nearly 70 percent of the mechanics worked in wholesale optical laboratories, and about 25 percent worked in retail optical shops; the rest worked for the same types of employers as did opticians.

In addition to the dispensing opticians and optical mechanics mentioned above, many others are proprietors of retail optical establishments.

Although opticians and mechanics are found in all States, more than half are located in the following States; New York, Massachusetts, Pennsylvania, Texas, California, and Illinois.

Training, Other Qualifications, and Advancement

Most optical mechanics and dispensing opticians learn their skills through informal, on-the-job training. On-the-job training in dispensing work may last several years and usually includes instruction in optical mathematics, optical physics, the use of precision measuring instruments, and other related subjects.

Trainees start in jobs requiring simple skill and dexterity and gradually work into the more difficult jobs. For example, they may begin by processing lenses through a lens grinding machine. After they have become skilled in this operation, the trainees perform other production operations, such as polishing, edging, lens cutting, and eyeglass assembly. Their training may include instruction in the measurement and curvature of lens surfaces, the measurement of lenses, and other subjects related to their work. When the trainees have acquired experience in all types of eyeglass production work, which usually takes about 3 years, they are considered all-round optical mechanics. Some trainees become specialists on one type of work performed by optical mechanics, such as surfacing or bench work. The training time required to become a specialist generally is less than that needed to become an all-round mechanic.

High school graduates also can prepare for both optical dispensing and mechanical work through formal apprenticeship programs. Some optical firms have 4- or 5-year apprenticeship programs. Apprentices having exceptional ability may complete their training in a shorter period. Most training authorities agree that optical mechanics and dispensing opticians who learn as appren-

tices have more job opportunities, improved job security, and more opportunities for advancement than those without such training.

Formal institutional training for the dispensing optician is becoming increasingly common. As of 1968, five schools offered 2-year full-time courses in optical fabricating and dispensing work leading to an associate degree. In addition, a number of vocational schools offered full-time courses lasting nine months in optical mechanics. Graduates from such schools often go to work for retail optical stores where they receive additional on-the-job training. Large manufacturers of contact lenses offer nondegree courses of instruction in contact lens fitting that usually last a few weeks.

Employers prefer applicants for entry jobs as dispensing opticians and optical mechanics to be high school graduates who have had courses in the basic sciences. A knowledge of physics, algebra, geometry, and mechanical drawing is particularly valuable. Interest in, and ability to do, precision work are essential. Because dispensing opticians deal directly with the public, they must be tactful and have a pleasing personality.

In 1968, 17 States had licensing requirements governing dispensing opticians: Arizona, California, Connecticut, Florida, Georgia, Hawaii, Kentucky, Massachusetts, Nevada, New Jersey, New York, North Carolina, Rhode Island, South Carolina, Tennessee, Virginia, and Washington. Some of these States also require licenses for optical mechanics in retail optical shops or for the retail optical shop itself. Some States permit dispensing opticians to fit contact lenses whereas others prohibit them from doing so. To obtain a license, the applicant generally

must meet certain minimum standards of education and training and also pass a written or practical examination, or both. For specific requirements, the licensing boards of individual States should be consulted.

Optical mechanics can become supervisors, foremen, and managers. Many of them have become dispensing opticians, although there is a trend to train specifically for dispensing optician jobs. There are opportunities for workers in both occupations to go into business for themselves, especially for those having all-round training in both shop and dispensing work. Dispensing opticians also may become managers of retail optical stores. Some dispensing opticians may become salesmen for wholesale optical goods companies or for manufacturers of conventional eyeglasses or contact lenses.

Employment Outlook

Employment of dispensing opticians is expected to increase moderately through the 1970's. In addition to the opportunities resulting from employment growth, about 200 job openings will result annually from the need to replace experienced workers who retire or die. Some additional job openings will become available as workers transfer to other occupations.

Little or no change in the number of optical mechanics is expected during the 1970's. Several hundred job openings, however, will be available annually because of the need to replace experienced mechanics who retire, die, or transfer to other occupations.

The production of prescription lenses is expected to increase considerably during the period. Factors that will contribute to this growth include the increasing size, and the rising literacy

and educational level of the population; a large increase in the number of older persons (a group most likely to need eyeglasses); and the growing emphasis on good vision (more than half the population over 6 years of age now wear eyeglasses). In addition, the many different styles and colors of eyeglass frames now available have increased the number of pairs of eyeglasses purchased by individuals and encouraged the wearing of eyeglasses.

The increase in production of prescription lenses will result in the growing employment of dispensing opticians. However, principally as a result of more efficient methods of production and improved equipment, employment of optical mechanics is not expected to increase.

Earnings and Working Conditions

According to information obtained from union-management contracts covering optical laboratory mechanics in 1968, minimum hourly rates ranged from \$2.40 to \$3.80 an hour. Foremen earned up to 20 percent more than optical mechanics, depending on their experience, skill, and responsibilities.

Dispensing opticians usually earn about 10 to 20 percent more than optical mechanics. Opticians who have their own businesses may earn much more.

Apprentices start at about 60 percent of the skilled worker's rate; their wages are increased periodically so that upon completion of the apprenticeship program, they receive the beginning rate for journeymen.

Optical laboratory mechanics at wholesale establishments usually have a 5-day, 40-hour workweek. Dispensing opticians and optical mechanics at retail shops

generally work a 5½- or 6-day week.

Workers in these occupations usually have year round employment.

The work of the dispensing optician requires little exertion and is generally performed in pleasant, well-lighted, and well-ventilated surroundings. Optical mechanics may work under fairly noisy conditions because power grinding and polishing machines are used. New machines are much quieter, however.

Physically handicapped persons who have full use of their eyes and hands and can do sedentary work can perform some of the more specialized jobs in the larger laboratories.

Some optical mechanics and dispensing opticians are members of unions. One of these unions is the International Union of Electrical, Radio and Machine Workers.

Sources of Additional Information

Optical Wholesalers Association,
222 West Adams St., Chicago,
Ill. 60606.

International Union of Electrical,
Radio and Machine Workers,
1126 16th St. NW., Washington,
D.C. 20036.

Guild of Prescription Opticians of
America, 1250 Connecticut Ave.
NW., Washington, D.C. 20036.

American Board of Opticianry,
821 Eggert Rd., Buffalo, N.Y.
14226.

ELECTROPLATERS

(D.O.T. 500.380, .782, and .884)

Nature of the Work

Electroplaters (platers) use plating solutions and electric cur-

rent (electrolysis) to coat metal articles with a layer of chromium, nickel, silver, gold, or other metal to give them a protective surface or a more attractive appearance. Metal products that often are electroplated include items as widely different as automobile bumpers, cigarette lighters, silverware, costume jewelry, plumbing fixtures, electrical appliances, bearings, electronic components and jet engine parts. Electroplaters also form objects by a process known as electroforming. These include items such as spray paint masks, search light reflectors, and a variety of molds used in the manufacture of plastic items.

Platers' skills vary broadly among plating shops. All-round platers who work in job shops that do small lot plating of great variety may mix and analyze plating solutions, calculate the time and electric current needed for various types of plating, and perform other duties requiring a technical knowledge of the plating process. Platers who work in production shops, where large lots of metal parts of the same type are plated, usually carry out less difficult, more specialized assignments that require only limited technical knowledge.

An article to be electroplated is scoured or dipped into a cleansing solution. Any surface not to be plated is covered with lacquer, rubber, or plastic tape. The plater or his foreman determines the amount of current needed, time required, and the best type of solution to assure a good finish. The article may be removed from the solution at intervals to make sure the work is progressing satisfactorily. Platers must be observant because unnoticed errors can be costly.

Many types of plating require inspection for visible defects. On jobs that require close tolerance,

the plater may use micrometers, calipers, and electronic devices to determine the quality of the work. Helpers frequently assist electroplaters by placing objects on racks before plating, removing them afterwards, and then cleaning tanks and racks. In some shops, platers order chemicals and other supplies for their work.

Places of Employment

An estimated 13,000 electroplaters were employed in 1968. About 3 out of 5 worked in independent job shops specializing in metal plating and polishing for other manufacturing firms and for individuals. The remaining platers were employed in plants primarily engaged in the manufacture of plumbing fixtures, heating and cooking utensils, lighting fixtures, wire products, electric control apparatus, electric appliances, radio and television products, motor vehicles and parts, mechanical measuring instruments, miscellaneous hardware items, and other metal products.

Electroplaters are employed in almost every part of the country, although most work in the Northeast and Midwest near the centers of the metalworking industry. Large numbers of electroplaters work in Los Angeles, San Francisco, Chicago, New York, Detroit, Cleveland, Providence and Newark (New Jersey).

Training, Other Qualifications, and Advancement

Most electroplaters learn the trade on the job as helpers by working with experienced platers. Three years or longer are required to become an all-round plater in this way. Platers employed in production shops who



Electroplater inspects batch of plastic items immersed in nickel solution.

are not required to have an all-round knowledge of plating can learn their jobs in much less time. A small percentage of electroplaters have received all-round preparation by working 3 or 4 years as an apprentice.

The program for apprentices combines on-the-job training and related classroom instruction in the properties of metals, chemistry, and electricity as applied to plating. The apprentice does progressively more difficult work as his skill and knowledge increase. By the third or fourth year, he determines cleaning methods, does plating without

supervision, makes solutions, examines plating results, and supervises helpers. Qualified journeymen may advance to foremen.

High school and vocational school courses in chemistry, electricity, physics, mathematics, and blueprint reading will prove valuable to young persons interested in becoming electroplaters. Some colleges, technical institutes, and vocational high schools offer 1- or 2-year courses in electroplating. In addition, many branches of the American Electroplaters Society conduct basic courses in electroplating.

Employment Outlook

Employment of electroplaters is expected to increase moderately through the 1970's. Most openings however, will result from the need to replace experienced workers who retire, die, or transfer to other fields of work.

Continuing mechanization of the electroplating process and the assigning of some of the plater's technical responsibilities to chemists and foremen will limit employment growth in this occupation. However, these factors will be more than offset by the long-run expansion in the machinery and metalworking industries and the application of the electroplating processes to a broadening group of metals and plastics.

Earnings and Working Conditions

Wage rates of electroplaters ranged from \$1.75 to \$3.50 an hour in 1968, according to the National Association of Metal Finishers. All-round platers, generally earned more than \$2.50 an hour. During apprenticeship or on-the-job training, a worker's wage rate starts at 60 to 70 percent of an experienced worker's rate and progresses to the full rate by the end of his training period. Almost all plants, pay shift premiums for night work. Many employers provide paid holidays and vacations and pay part or all of additional benefits such as life, health, and accident insurance.

Plating work involves some hazards because acid, alkaline, or poisonous solutions are used. Humidity and odor also are problems in electroplating plants. However, most plants have installed systems of ventilation and other safety devices which have considerably reduced the occupa-

tional hazards. Protective clothing and boots provide additional protection. Mechanical devices generally are used to handle most of the lifting required, but at times the worker must lift and carry objects weighing up to 100 pounds.

Some platers are members of the Metal Polishers, Buffers, Platers and Helpers International Union. Other platers have been organized by the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America, and the International Association of Machinists and Aerospace Workers. Some of the labor-management contracts covering electroplating provide health insurance and other benefits.

Sources of Additional Information

For educational information concerning electroplating and other metal finishing methods, write to:

American Electroplaters Society,
Inc., 56 Melmore Gardens, East
Orange, N.J. 07017.

For information on job opportunities, training, and other questions, write to:

National Association of Metal Finishers, 248 Lorraine Ave., Upper
Montclair, N.J. 07043.

FURNITURE UPHOLSTERERS

(D.O.T. 780.381)

Nature of the Work

Upholstered furniture that has become old and worn is reconditioned by furniture upholsterers.

These craftsmen replace worn furniture fabric, repair broken frames, or replace or repair bent springs, webbing, and other worn parts of furniture. The upholsterer usually places the piece of furniture on padded wooden horses so that he may work at a convenient level. Using a tack puller or chisel and mallet, he pulls out the tacks that hold the fabric in place and removes the fabric. He also may remove padding and burlap that cover the springs. He examines the springs and removes the broken or bent ones. If the webbing that holds the springs in place is worn, all of the springs and the webbing may be ripped out. The upholsterer then repairs the frame by regluing loose sections and refinishing worn wooden arms.

To reupholster the furniture, the upholsterer first tacks strips of webbing to the frames. Next, he sews new springs to the webbing and ties each spring to the adjoining ones, securing the outside springs to the frame. He then uses burlap, filling, and padding to cover the springs, and sews the padding to the burlap. Finally, after covering the padding with muslin and new fabric, he attaches these materials to the frame and makes sure that they are smooth and tight. He completes the job by sewing or tacking on fringe, buttons, or other ornaments ordered by the customer.

Upholsterers use a variety of handtools in their work, including tack and staple removers, pliers, hammers, and shears. They also use special tools such as webbing stretchers and upholstery needles. Upholsterers who work in small shops lay out patterns and use hand shears or machines to cut the upholstery fabric. They also operate sewing machines to form new upholstery covers. In large shops, however,

seamstresses usually perform these tasks. Sometimes upholsterers pick up and deliver furniture. These who own their shops order supplies and equipment, keep business records, and perform other managerial and administrative tasks. (This statement does not include furniture upholsterers who manufacture upholstered furniture.)

Places of Employment

More than one-half of the estimated 32,000 furniture upholsterers employed in 1968 worked in small upholstery shops, frequently having fewer than eight employees. Many upholsterers also were employed by furniture stores, and a few worked for organizations—movie theatres, hotels, motels, and others—that maintain their own furniture.

Employment of furniture upholsterers is distributed geographically in much the same way as the Nation's population. Thus, they are employed mainly in major metropolitan areas and in the more populated States. Almost one-half of the upholsterers employed in 1968 worked in New York, California, Pennsylvania, Texas, Illinois, and Ohio.

Training, Other Qualifications, and Advancement

The most common way to learn this trade is to complete an informal on-the-job training program in an upholstery shop. Prospective upholsterers are hired as helpers to perform simple jobs, such as removing old fabric, padding, and springs from furniture. As they gain experience, they perform more complex tasks, such as installing webbing and springs and sewing on upholstery fabric and trimming. Inexperi-



Employment Outlook

Overall employment of upholsterers is expected to show little or no change through the 1970's. Most job openings will result from the replacement of experienced workers who die, retire, or transfer to other fields of work. Deaths and retirements alone are expected to provide more than 600 job openings annually. There have been many unfilled job openings in this trade in recent years because the supply of qualified workers has been insufficient to meet the demand. Moreover, this shortage may continue for several years, because the number of people currently being trained is still insufficient to meet anticipated future requirements.

Among the factors tending to increase requirements for furniture upholsterers are the growing expenditures for furniture, the growth in family formation, and the higher levels of personal incomes. However, these factors will be offset by the rising cost of reupholstering furniture relative to replacing it.

enced helpers who have initiative may become skilled upholsterers after about 3 years of on-the-job training.

Upholsterers can learn their skills while employed as plant workers in furniture factories by performing a variety of plant jobs that are closely related to furniture upholstery. They also may learn upholstery through vocational or high school courses that include chair caning, furniture making, textile fabrics, and upholstery repair. However, on-the-job training usually is required before these workers qualify as journeymen upholsterers.

A few people acquire the skills of the trade through formal ap-

prenticeship programs that last from 3 to 4 years and include related classroom instruction.

Young people interested in becoming furniture upholsterers should have good manual and finger dexterity and be able to do occasional heavy lifting. An eye for detail, ability to distinguish between colors, and a flair for creative work are helpful.

Furniture upholsterers usually purchase their handtools but employers provide power tools.

Almost 1 out of every 3 upholsterers is self employed—a higher proportion than in most other trades. Opening an upholstery shop usually requires a moderate investment.

Earnings and Working Conditions

Earnings data for furniture upholsterers are not available on a national basis. However, limited information obtained in 1968 generally indicated that throughout the country rates for helpers ranged from \$1.60 to \$2.25 an hour, and for experienced upholsterers, from \$3 to \$5 an hour. A few upholsterers were paid on a piecework basis. The hourly rates for upholsterers depended on factors such as their level of skill, the length of time they had been employed, and the type and geographic location of the establishment in which they worked. Hourly rates for upholsterers in

the South were generally lower than those in the North and West.

Furniture upholsterers usually receive little direct supervision. They generally work 40 hours a week, although overtime is common during the weeks before major holidays. Many upholsterers receive paid vacations and sick leave, and some are covered by health insurance plans.

Upholstery shops often are spacious, adequately lighted, and well ventilated and heated. However, dust from padding and stuffing sometimes is present. Upholsterers stand while they work and do a considerable amount of stooping and bending. They may work from awkward positions for short periods of time. Upholstery work generally is safe, although minor cuts from sharp tools and back strain from lifting and moving heavy furniture are not uncommon.

Sources of Additional Information

Upholsterers International Union
of North America, 1500 North
Broad St., Philadelphia, Pa.
19121.

GASOLINE SERVICE STATION ATTENDANTS

(D.O.T. 915.867)

Nature of the Work

Almost all of the more than 95 million motor vehicles in the United States are serviced at one time or another in a gasoline service station. When a car or truck is driven into a station, the service station attendant (also called gasoline station salesman or serviceman) greets

the customer and inquires about his needs. The attendant may perform a variety of services for the customer, ranging from directing the customer to a street address to making a minor repair.

When servicing a car, he dispenses gasoline, cleans the windshield, and, with the customer's permission, checks the water level in the radiator and battery, the oil level in the crankcase and automatic transmission, and the air pressure in the tires. He also may check the tires, fan belt, and other parts of the car for excessive wear.

The attendant also has other responsibilities besides servicing cars. He sells and installs items such as tires, batteries, fan belts, and windshield wiper blades. When a customer pays his bill, he makes change or prepares a charge slip if the customer uses a credit card. He also may dispense trading stamps. In small stations, particularly, he may perform minor maintenance and repair work, such as lubrication, changing the engine oil, rotating tires, repairing tires, or replacing a muffler. Some attendants, called mechanic-attendants, perform more difficult repairs. Before and after doing maintenance and repair work, the attendant may drive the customer's car between a convenient parking place and the service area. He also may keep the service areas, building, and restrooms clean and neat. In some stations, he helps the station manager take inventory, set up displays, and perform other duties associated with the operation of a small business.

If a gasoline service station provides emergency road service, the attendant may drive a tow truck to a stalled car and change a flat tire or perform other minor repairs needed to fix the customer's vehicle. If more extensive repairs are needed, he tows the



vehicle back to the service station.

In doing maintenance and repair work, gasoline service station attendants may use simple handtools such as screwdrivers, pliers, and wrenches; and power tools such as pneumatic wrenches. Mechanic-attendants frequently use more complex equipment such as motor analyzers and wheel alignment machines.

Places of Employment

An estimated 410,000 service station attendants, more than one-third of whom were part-time workers, were employed in gasoline service stations in 1968. In addition to attendants, about 220,000 gasoline service station managers and owners did similar work.

Gasoline service station attendants are employed in every

section of the country, in the largest cities, the smallest towns, and outlying areas. About 40 percent, however, are employed in the seven States that have the largest number of motor vehicles: California, Texas, New York, Ohio, Illinois, Pennsylvania, and Michigan.

Training, Other Qualifications, and Advancement

An applicant for a job as gasoline service station attendant should have a driver's license, a general understanding of how an automobile works, and some sales ability. He should be friendly and able to speak well, present a generally neat appearance, and have self-confidence. He should know simple arithmetic so that he can make change quickly and accurately and help keep business records. An applicant should be familiar with local roads, highways, and points of interest in order to give directions to strangers and to locate vehicles whose owners have called for road service.

Although completion of high school is not generally a requirement for getting an entry job, it is an advantage because it indicates to many employers that a young man can "finish a job." A high school education generally is required for attendants to qualify for service station management training programs conducted by oil companies, and to advance to the position of service station manager.

Gasoline service station attendants usually are trained on the job, although there are some formal training programs. Attendants, who are trained on the job first are given relatively simple work assignments. They may

be required to keep the station clean, wash cars, dispense gasoline, clean windshields, and otherwise make themselves useful. Gradually, they progress to more advanced work such as making sales, writing credit charge slips, doing simple maintenance work, installing accessories on cars, and helping to keep the station records. It usually takes from several months to a year for a gasoline service station attendant to become fully qualified.

Formal training programs for young people who want to do gasoline service station work are offered in many high schools around the country. In this curriculum, known as distributive education, students in their last 2 years of high school take business education courses and work part-time in a gasoline service station where they receive instruction and supervision in all phases of service station work.

Some attendants are enrolled in formal training programs for service station managers, which are conducted by most major oil companies. These programs usually last from 2 to 8 weeks and emphasize subjects such as simple automobile maintenance, salesmanship, and business management.

Several avenues of advancement are open to gasoline service station attendants. Additional training qualifies attendants to become automobile mechanics; those having business management capabilities may advance to station manager. Many experienced station managers and automobile mechanics go into business for themselves by leasing a station from an oil company, the most common means, or by buying their own service station. Some service station attendants are hired by oil companies as salesmen or district managers.

Employment Outlook

Employment of gasoline service station attendants is expected to increase moderately through the 1970's, creating several thousand full-time and part-time job openings annually. An even greater number of job openings will result from the need to replace attendants who transfer to other fields of work, are promoted, retire, or die. Deaths and retirements alone are expected to provide an estimated 4,700 full-time job opportunities annually.

Employment of service station attendants is expected to increase as a result of the growing consumption of gasoline and other service station products. The number of motor vehicles registered is expected to rise because of growing population, income, multiple car ownership, and the continuing movement to the suburbs. Also, greater use of cars as families have more leisure time is expected and as the highway systems continue to be improved.

More attendants also may be needed to perform additional maintenance on newer, more complex cars. For example, more cars will have devices that reduce exhaust fumes, and these devices must be serviced periodically. On the other hand, more cars that require oil changes and lubrication less frequently will offset partially the servicing requirements of additional, more complex vehicles.

Earnings and Working Conditions

Hourly earnings of gasoline service station attendants vary considerably. According to information from 30 gasoline dealer associations across the country, average straight time hourly earnings in 1968 ranged from \$1.25 to \$1.50 in Tuscon, Ari-

zona, to \$2.85 in Chicago, Illinois. More than one half of the gasoline dealer associations reported average weekly earnings of at least \$100 for full-time gasoline service station attendants. The remainder of the associations reported average weekly earnings of between \$65 and \$98.

In many stations, employers provide fringe benefits such as accident and health insurance and paid vacations. Some employers furnish uniforms and pay for their cleaning; others require the attendants to pay for these expenses. More than one-half of the attendants work over 40 hours a week; many work more than 48 hours. Attendants frequently work at night and on weekends and holidays.

A gasoline service station attendant works outdoors in all kinds of weather. He must be in good physical condition because he does considerable lifting and stooping and spends much time on his feet. Possible injuries include cuts from sharp tools and burns from hot engines. The attendant frequently gets dirty because he dispenses gasoline, handles oil and grease, and works with tools and around cars. For many attendants, however, the opportunity to meet new people and the possibility of someday managing their own service stations more than offset these disadvantages. For others, the opportunity to get part-time employment is important.

Some high school and college students have been able to work their way through school by working as gasoline service station attendants after school, and on vacations and holidays. Some workers also supplement their income from regular jobs by working part time as attendants.

Sources of Additional Information

For further information regarding work opportunities for gasoline service station attendants, inquiries should be directed to local gasoline service stations or the local office of the State employment service.

INSPECTORS (MANUFACTURING)

Nature of the Work

Almost everything manufactured must be carefully inspected during the manufacturing process. The millions of automobiles, sewing machines, television sets, production machines, and other mass-produced items must be tested and inspected to make sure they operate properly. The workers who see that the size and quality of raw materials, parts, assemblies, and finished products meet specifications are known as inspectors.

Inspectors use a variety of methods in order to be certain that the products they examine conform to specifications. They may merely look for scratches and other defects in products or parts; or they may use gages, micrometers, and other measuring devices to check the accuracy of the parts. Semiskilled inspectors may be required to read simple work orders, and do arithmetic involving decimals and fractions when reading measuring instruments. Inspectors often keep records of the number of parts they have accepted, and rejected. When they find a large number of faulty pieces, they notify their supervisors so that corrections can be made on the production

line. Some inspectors use hand-tools, such as screwdrivers or pliers, in their work. In some industries, inspectors may make minor repairs and adjustments, and grade products for quality.

The kinds of products that inspectors check vary widely by industry. For example, in radio and television manufacturing plants, many inspectors test tubes and circuits to determine if they meet specifications. In the automobile industry, they examine raw materials and parts during the various stages of manufacturing, as well as the complete automobile.

Skilled inspectors work under general supervision, whereas semiskilled inspectors usually work under close supervision. Skilled inspectors often use a much wider variety of testing instruments. In the metalworking industries they are often required to read blueprints and interpret complex specifications. They generally have greater discretion in accepting or rejecting products and usually are responsible for inspecting the most critical parts of mass-produced goods.

Places of Employment

In early 1968, approximately 585,000 inspectors (most of whom were semiskilled) were employed in a wide variety of manufacturing industries. Most of these inspectors worked in plants producing durable goods such as electrical and nonelectrical machinery, fabricated metal products, transportation equipment, and aerospace products. Others were employed in plants producing non-durable goods such as chemicals, textiles, apparel, and food products. Large numbers of inspectors were employed in Ohio, New York, Michigan, Illinois, Pennsylvania, California, and New Jersey.



Inspector checks precision drilling.

About one-half of all inspectors were women. Many of these women were employed in the food, textile, and apparel industries. Others were employed throughout the metalworking industries, especially in plants that produce small electrical and electronic components.

Training, Other Qualifications, and Advancement

Inspectors generally are trained on the job for a brief period—from a few hours or days to several months, depending upon the skill required.

Many employers look for applicants who have good health and eyesight, can follow directions, and are dependable. Some

employers prefer experienced production workers for inspection jobs. A few large companies give aptitude tests in selecting new employees for inspection work. For example, in the electronics industry, new workers may be given tests to determine their ability to work with numbers. Employers also look for employees who can do work requiring constant attention. Employers may hire applicants who do not have a high school diploma if they have qualifying aptitudes or related job experience.

Some semiskilled inspectors in the metal products industries who supplement their work experience with formal educational courses, such as blueprint reading, shop mathematics, and electrical theory, may advance to

skilled inspectors. A few inspectors, after acquiring sufficient experience and knowledge, may advance to foremen jobs.

Employment Outlook

The employment of inspectors is expected to increase slowly through the 1970's, creating several thousand job openings annually. However, most opportunities will result as workers retire, die, or transfer to other fields of work, and as women leave their jobs to marry or rear a family. Deaths and retirements alone will account for about 15,000 openings each year.

Most of the industries that employ these workers, especially the electrical machinery industry, are expected to increase their employment in the long run. The growing complexity of the products manufactured in our factories, and rising quality standards, should also result in a need for more inspectors. These factors will be partially offset, however, by the increasing use of mechanized and automatic inspection equipment.

Earnings and Working Conditions

Inspectors' earnings vary considerably, depending on their skill, the type of product inspected, the method of wage payment, and the size and location of the plant in which they are employed. Inspector jobs are commonly classified as A, B, and C, to reflect the level of skill and responsibility involved. The following tabulation presents average straight-time hourly earnings of inspectors in the nonelectrical machinery industry:

Average straight-time hourly earnings of class A, B and C inspectors in nonelectrical machinery, mid-1967

Area	Class A	Class B	Class C
United States ¹	\$3.20	\$2.87	\$2.44
New England ..	2.97	2.76	2.23
Middle Atlantic	3.12	2.82	2.39
Border States ..	3.20	2.77	2.24
Southeast	2.79	2.13	1.77
Southwest	2.97	2.65	2.09
Great Lakes	3.28	2.99	2.65
Middle West	3.20	2.80	2.48
Pacific	3.47	2.80	2.51

¹Includes data for Mountain States.

Working conditions also vary considerably for inspectors. For example, some may work in well-lighted, air-conditioned workplaces in an aircraft or missile plant; others, who may work on the production floor of a machinery or metal fabricating plant, often are exposed to high temperatures, oil, grease, and noise.

Many inspectors employed in manufacturing industries are members of labor unions. The International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; the International Association of Machinists and Aerospace Workers; the International Union of Electrical, Radio and Machine Workers; and the International Brotherhood of Electrical Workers are among the large unions to which these workers belong. Most of the labor-management contracts in manufacturing plants employing inspectors provide for fringe benefits, such as paid holidays and vacations, health insurance, life insurance, and retirement pensions.

necklaces, bracelets, and other precious jewelry. They create jewelry from metal such as gold, silver, and platinum, and set precious or semiprecious stones. To repair jewelry, they solder broken parts, make new parts, enlarge or reduce the size of rings, reset stones, and restyle old jewelry. The jewelers' work is very delicate and must be done with care and precision, as the materials used usually are expensive. An eye "loupe," or magnifying glass held over the eye, often is used when working to close tolerances. To make jewelry, jewelers may follow their own design or one prepared by a design specialist. The metal is formed to follow the design in one of several ways. Special-order work may involve shaping metal stock with hand and machine tools or melting and casting metal in a mold. When jewelry is produced in volume, the metal usually is formed either by the casting or the stamping process.

Shaping metal stock by hand may involve the following metal-working operations: outlining, cutting, drilling, sawing, filing, shaping, engraving, and electroplating. Individual parts are polished and then joined by soldering. After the article has been assembled, surface decorations are made and jewels or stones are mounted. When jewelry is made in this manner, tools such as files, saws, drills, dapping, carving, and chasing tools; jewelers' lathes; soldering irons; and polishing machines are used.

To cast gold and platinum jewelry, a model is made by a jewelry modelmaker, a craftsman who has a thorough knowledge of the casting process. A rubber mold is produced from the model, and into this mold wax or plastic is injected under pressure. The pattern produced is placed in a plasterlike material and burned out, leaving a cavity in the material. The precious metal then is cast into this cavity by cen-

JEWELERS AND JEWELRY REPAIRMEN

(D.O.T. 700.281 and .381)

Nature of the Work

Jewelers are skilled craftsmen who make or repair rings, pins,



Jeweler uses a ring size gage.

trifugal force. After cooling, the cast piece is removed. Articles produced by the process require a minimum of finishing. Jewels or stones then may be set in the cast piece and it may be engraved.

Cast costume jewelry is produced similarly, except that the metal is cast directly into a rubber or metal mold, and either tumbled and plated or finished on a polishing machine.

In the stamping process, which is used to make costume and some precious jewelry, the metal piece is formed in a stamping machine that brings together, under tremendous force, a die and metal from which the piece is to be made. The die has a cavity shaped to the exact contour and dimension of the desired article.

As a rule, jewelers specialize in making a particular kind of jewelry, or in a particular operation, such as making models and tools, engraving, polishing, or setting diamonds and other stones. After years of experience, some become all-round jewelers capable of making and repairing any kind of jewelry. Costume jewelry and some kinds of precious jewelry are mass produced by factory workers using assembly line methods. However, skilled jewelers are needed to make the models and tools for this large-scale production. They also may perform finishing operations, such as stone setting and engraving, on stamped or cast pieces.

Many jewelers make and repair jewelry in their own stores where they also may sell jewelry, watches, and other merchandise, such as silverware, china, and glassware, and repair watches. Other jewelers operate trade shops that specialize in making jewelry and in doing repair work for jewelry stores owned or operated by merchants who are not jewelry craftsmen or who take in

more repair work than they can handle.

Places of Employment

About 25,000 jewelers and jewelry repairmen were employed in 1968. Most of those who were self-employed owned either retail jewelry stores or trade shops. More than half of those who were not self-employed worked in jewelry manufacturing establishments; others worked in retail jewelry stores.

The Nation's 20,000 retail jewelry stores are located throughout the country. The heaviest concentration of these stores, as well as the thousands of small trade shops that service them, is located in large commercial centers, such as New York City, Chicago, Los Angeles, and San Francisco.

Nearly three-fourths of all precious jewelry manufacturing plants are located in New York, New Jersey, Rhode Island, and California. The New York City metropolitan area is the center of precious jewelry manufacturing.

Training, Other Qualifications, and Advancement

Young persons generally learn the jewelry trade either by serving a formal apprenticeship or through informal on-the-job training while working for an experienced jeweler. Jewelry repair, which usually is less complicated than jewelry making, can be learned in a short time by individuals already trained in filing, sawing, drilling, and other basic mechanical skills. Courses in jewelry repair are given in several trade schools. Other trade schools offer courses in specific types of jewelry work, such as

diamond setting, jewelry design, and engraving.

Formal apprenticeship in this trade, depending on the type of training, takes from 3 to 4 years. For example, 3 years are required to become a colored-stone setter and 4 years to qualify as a diamond setter. Throughout the apprenticeship, training on the job is supplemented by trade school instruction in design, quality of precious stones, chemistry of metals, and other related subjects. Initial work assignments may be to set up work for soldering or to do simple soldering or rough polishing. As an apprentice gains experience, he advances to more difficult work. After completion of the apprenticeship, he becomes a qualified journeyman jeweler.

A high school education is desirable for young people seeking to enter the trade. Courses in chemistry, physics, mechanical drawing, and art are particularly useful. Personal qualifications include aptitude, finger and hand dexterity, and good eye-hand coordination. Artistic ability is necessary for work in jewelry design. For those planning to become retail jewelers or to open trade shops on manufacturing establishments, the ability to deal with people and manage a business is a necessity. Because people in this trade work with precious stones and metals they must be bonded. Bonding requires an investigation of one's personal background for honesty, trustworthiness, and respect for the law.

Jewelry manufacturing establishments in the major production centers offer the best opportunities for a young person to acquire all-round skills, even though the number of trainees accepted is small. Trade shops also offer training opportunities, but their small-size—many are

one- or two-man shops—limits the number of trainees.

Jewelry workers may advance in several ways. In manufacturing, they can advance from production jewelers to shop foremen. In retail stores, jewelers may become heads of sales departments or store managers. Those craftsmen employed in jewelry making and repair departments operated by large retail establishments may advance to department managers. Some jewelry workers establish their own retail stores or trade shops.

A substantial financial investment is required to open a retail jewelry store and the field is highly competitive in most parts of the country. Jewelers interested in going into business for themselves will find it advantageous to work first in an established retail jewelry store, trade shop, or jewelry manufacturing plant. Persons planning to open their own jewelry stores should have experience in selling jewelry. Those craftsmen who can repair watches have an advantage over those who can repair jewelry only, since watch repair work is a substantial part of the business in many small jewelry stores. Talented and experienced jewelers of recognized integrity can establish their own trade shops or small manufacturing shops with a more moderate financial investment. The location of these shops is limited to areas that have a large volume of jewelry business. For manufacturing, this means the major production centers. Trade shops have best chances for success in moderate or large cities where there are many retail jewelry stores.

Employment Outlook

Employment requirements for jewelers and jewelry repairmen

are expected to show little or no change though the 1970's. However, hundreds of job openings will arise annually because of retirements and deaths among experienced workers. Most job openings are expected to be filled by people trained in only one or two specialties of the trade such as stone setting, engraving, modelmaking, casting, or polishing. Nevertheless, all-round jewelers will continue to be in demand, and have been in short supply in recent years.

Rising levels of personal incomes are expected to result in a substantial increase in the demand for precious and costume jewelry, and an expected increase in family formations will spur demand for engagement and wedding rings. However, the employment effect of an increased demand for jewelry will be offset by more efficient means of producing and repairing jewelry.

The demand for jewelry craftsmen during the 1970's is expected to differ by place of employment. In jewelry manufacturing, most job openings will be filled by specialized craftsmen as mass-production techniques are adopted increasingly. In trade shops, where a large volume of repair work permits job specialization, job openings also will be filled mainly by specialized

craftsmen. In retail jewelry stores, however, there will be job opportunities for both all-round jewelers and specialized craftsmen.

Earnings and Working Conditions

Beginning pay for jewelry repairmen employed in retail stores and trade shops ranged from \$90 to \$125 a week in 1968; experienced workers in these establishments earned up to \$225 weekly. Wages were highest for jewelry repairmen who worked in large metropolitan areas. Jewelers who own retail stores or trade shops earn considerably more than jewelers working as employees in these establishments.

One union-management agreement, covering about 2,600 jewelry workers employed in plants manufacturing precious jewelry in New York City, provides the minimum hourly rates shown in the accompanying tabulation for inexperienced workers (including apprentices) and for journeymen in selected crafts, in 1968. Average hourly earnings for journeymen covered by this agreement in 1968 also are shown in the tabulation.

Under this agreement, all inexperienced workers, including

Occupation	Average hourly earnings 1968	Minimum hourly job rate 1968
Starting rate—all inexperienced workers		\$1.66
Journeyman's rate:		
Production jewelers	\$3.65	2.80
Jewelers—handmade work	4.12	3.30
Modelmakers	4.66	3.35
Stone setting:		
Diamond	4.39	3.30
Colored stones	3.92	3.00
Handmade work		3.55
Chasers	3.82	2.80
Engravers	3.42	2.80
Polishers	3.30	2.80
Casters	3.66	2.60
Lappers	4.09	2.75
Toolmakers	4.71	3.05
Hub Cutters	5.55	3.50

apprentices, receive increases of 15 cents an hour after 30 days of employment and 15 cents an hour every 3 months until they reach the minimum journeyman rate for their particular job, which is considerably lower than average hourly earnings in the trades.

Skilled workers in the precious jewelry manufacturing union shops in the New York City area have a 35-hour workweek and are paid time and one-half for all work done before or after the regular workday. Retail jewelers and jewelry repairmen work 40 to 48 hours a week, and may work longer hours during the holiday seasons.

Sources of Additional Information

Information on employment opportunities for jewelers and jewelry repairmen in retail jewelry stores may be obtained from:

Retail Jewelers of America, Inc.,
1025 Vermont Ave. NW., Wash-
ington, D.C. 20005.

Information on employment opportunities in manufacturing establishments may be obtained from:

Manufacturing Jewelers and Sil-
versmiths of America, Inc.,
Sheraton-Biltmore Hotel, Room
S-75, Providence, R.I. 02902.

International Jewelry Workers'
Union, Local No. 1, 133 West
44th St., New York, N.Y. 10036.

MEAT CUTTERS

(D.O.T. 316.781, 316.884)

Nature of the Work

Meat cutters prepare meat, fish, and poultry for sale in supermarkets or wholesale food outlets. Their primary duty is to

divide animal carcasses, from which the hide, head, and entrails have been removed, into steaks, roasts, chops, and other serving sized portions. They also prepare meat products such as sausage, corned beef, and meat loaf. Meat cutters who work in retail food stores may set up attractive counter displays and wait on customers.

In cutting a beef carcass, the meat cutter divides it into halves with a band saw, and then quarters it by cutting each half between the ribs with a knife and sawing through the backbone. He uses special meat cutting saws to divide the quarters into major (primal) cuts, such as rib or chuck, and then uses a butcher knife and a smaller boning knife to divide the primal cuts into retail cuts such as T-bone steak or rib roast.

The meat cutter may divide the retail cuts into individually sized portions. He uses a butcher knife or slicer to divide boneless cuts, and a band saw or cleaver to divide cuts containing bones. He removes any chips that may remain on the meat either by scraping it with his butcher knife or placing the meat on a machine that has a small revolving brush. Meat trimmings and some less expensive cuts are ground into hamburger.

In addition to cutting meat, the meat cutter may pickle or "corn" meat by pumping a brine solution into the arteries. He may place some of the cuts on a tenderizer machine which increases tenderness by injecting an enzyme into the meat.

Places of Employment

The 200,000 meat cutters employed in 1968 were located in almost every city and town in the Nation. Only a small proportion

were women. Most meat cutters worked in retail food stores. A large number also worked in wholesale food outlets; a few worked in restaurants, hotels, hospitals, and other institutions.

Training, Other Qualifications, and Advancement

Meat cutters acquire their skills either through apprenticeship programs or by means of on-the-job experience. Under the guidance of skilled journeymen meat cutters, trainees learn the identity of various cuts and grades of fresh meats and cold cuts and the proper use of tools and equipment. They learn to use scales, make counter displays, slice luncheon meats and cheese, wrap meat, and wait on customers.

Carcass breaking, boning, and portion cutting are a major part of the meat cutter's training. To perform carcass breaking—the successive division of the carcass into halves, quarters, and primal cuts—trainees learn to use the band saw, rotary saw, and butcher knife. During the boning operation, in which the excess skin, bones, and fat are removed and the primal cuts are divided into retail cuts, they learn to use the boning knife and to increase their skill with the butcher knife. Generally, the last cutting function trainees learn is portion cutting. During this phase, they learn to operate the slicer, grinder, and small band saw, and to use the revolving brush that removes bone chips.

In addition to cutting operations, beginning meat cutters learn to dress fish and poultry, roll and tie roasts, grind hamburger, prepare sausage, cure and corn meat, and may learn to use the vacuum and tenderizer machines. During the latter



Meat cutter uses band saw to cut chuck.

stages of training, they may learn marketing operations such as inventory control, meat buying and grading, and record keeping.

Meat cutters who learn the trade through apprenticeship generally complete 2 to 3 years of supervised on-the-job training which may be supplemented by some classroom work. A meat cutting test is given at the end of the training period that is ob-

served by the employer, and if the shop is unionized, usually by a union member. If the apprentice passes the test, he becomes a fully qualified journeyman meat cutter. In many areas of the country, the apprentice may become a journeyman in less than the usual training time if he is able to pass his meat cutting test at an earlier date.

The most common method of entering this occupation is to be

hired and trained by an individual retail or wholesale outlet. A few meat cutters have gained entry by attending training programs sponsored under the Manpower Development and Training Act or by attending vocational schools that offer courses in meat cutting.

Employers prefer entrants who have a high school diploma and also have the potential to develop into meat department or retail store managers. Employers look for applicants who have had training in mathematics, since the meat cutter may be called on to weigh and price meats and to make change; in English, since many outlets want their meat cutters to wait on and advise customers; and in the use of power tools, since power tools are used frequently in the daily work of the occupation.

Manual dexterity, good form and depth perception, color discrimination, and good eye-hand coordination are important in cutting meat. Better than average strength is necessary since meat cutters often must lift heavy loads and stand on their feet much of the day. In some communities, a health certificate may be required for employment.

Meat cutters may progress from journeyman to first cutter and then to meat department manager of a retail food store. Some become meat buyers, and those who learn the operation of the grocery section of a retail outlet can become retail store managers. In a few instances, experienced meat cutters have opened their own meat markets or retail food stores.

Employment Outlook

Demand for meat is expected to increase substantially in the future due to population growth

and increased personal income. However, little or no increase in the total number of meat cutters is anticipated through the 1970's, since increasing worker productivity is expected to offset larger output. Nevertheless, thousands of entry jobs for meat cutters will be available during the next decade to replace meat cutters who retire, die, or transfer to other occupations. Deaths and retirements alone are expected to create about 4,000 job openings each year.

A number of technological advances are expected to limit the growth of the total number of meat cutters employed in future years. Technological advances that are now available and expected to be used more widely include a greater use of power tools, such as electric saws, electronic scales, and wrapping machines that can weigh, package, and stamp prices automatically; and machines that tie strings on roasts or other boneless cuts. In the future, power assisted knives may be used for boning and portion cutting, and processes that separate meat from bones by means of centrifugal force or other means are being tested.

Central cutting, which establishes one point from which meat for a given area is cut and wrapped, may limit the employment growth of meat cutters. As a result of central cutting, fewer meat cutters will be needed in individual retail stores to cut or package meat. Central cutting also permits meat cutters to specialize in both the type of meat cut and the type of cut performed. Thus, the job content of many meat cutters may change from that of a generalist capable of performing all meat cutting operations to that of a specialist who performs a few cuts on one kind of meat. Central cutting also tends to reduce the amount of

training necessary to achieve a sufficient degree of cutting skill.

In many wholesale outlets, a significant degree of specialization similar to central cutting is already in effect. Many wholesale outlets perform "portion cutting" for restaurants, hotels, and other institutions. Rather than keeping a meat cutter on the premises, the hotel or restaurant orders a desired number of serving-size portions from the wholesaler. The effect has been to displace some meat cutters formerly employed by hotels, restaurants, and other institutions.

Earnings and Working Conditions

In 1968, average weekly earnings of journeymen meat cutters working a standard workweek in selected cities were as follows:

Boston	\$143
Chicago	144
Kansas City	139
Philadelphia	149
St. Louis	160
Cleveland	143
Houston	124
New York	138
San Diego	153
Washington, D.C.	144

Beginning apprentices usually receive between 60 and 70 percent of journeymen wages and generally receive increases every 6 to 8 months until they achieve the journeyman level. Most meat cutters are union members of the Amalgamated Meat Cutters and Butcher Workmen of North America.

Meat cutters generally work in a well-lighted and well-ventilated environment. They must exercise care since sharp instruments, such as knives, grinders, saws, cleavers, scrapers, and shears, are used. To prevent accidents, most machinery is equipped with protective devices, and safety gloves often are worn.

Meat cutters often are exposed to sudden temperature changes when entering and leaving refrigerated areas and may be exposed to unpleasant odors.

Sources of Additional Information

Information on training and other aspects of the trade may be obtained from:

American Meat Institute, 59 East Van Buren Street, Chicago, Illinois 60605.

Amalgamated Meat Cutters and Butcher Workmen of North America, 2800 North Sheridan Road, Chicago, Illinois 60657.

Further information about local work opportunities and manpower development and training programs can be obtained from local employers or by contacting local offices of the State employment service.

MOTION PICTURE PROJECTIONISTS

(D.O.T. 960.382)

Nature of the Work

The projectionist is an important man behind the scenes in the motion picture theater. From an elevated room at the back of the theater, he operates the projection machines and audio equipment, assuring high quality screen and sound presentation for the audience.

In showing a feature length movie, the projectionist uses two projectors, audio equipment, a film rewinding machine, and seven reels or more of film. Before

the first feature is scheduled to begin, he checks the equipment to see that it operates properly and loads the two projectors with the first and second reels to be shown. To load a projector he threads the film through a series of sprockets and guide rollers, and attaches it to a take-up reel. Most projectors burn a carbon rod to provide light for the screen. After igniting and adjusting the carbon rod, the projectionist starts the projector containing the first reel. When the reel has reached proper running speed, he opens a shutter and the picture appears on the screen. If the picture is out of focus or unsteady, he makes the necessary adjustments on the projector.

A film reel lasts approximately 20 minutes. When the first reel is near completion, the projectionist; watches for cue marks (small circles in the upper right hand corner of the screen) which indicate that it is time to start the second projector. When a second series of cue marks appears, he simultaneously closes the shutter on the first projector and opens the shutter on the second projector. This changeover happens so quickly that the viewer in the audience does not notice an interruption on the screen. Next, the projectionist removes the used reel, and rewinds it on the rewinding machine. The projectionist repeats the process described above until all the rods have been used. If the film breaks the projectionist must work rapidly to rethread it so that the show may continue.

In addition to operating the equipment, the projectionist cleans and lubricates it, checks for defective parts and damaged film, and makes minor repairs and adjustments. By keeping his equipment in good operating condition, the projectionist reduces the possibility of malfunctions



and breakdowns. For example, he may replace a badly worn projector sprocket which could eventually cause film damage or an unsteady picture. Major repairs are made by servicemen who specialize in projection and audio equipment.

Places of Employment

An estimated 16,000 full-time motion picture projectionists—nearly all of them males—were employed in 1968. More than three-fourths of them were employed in indoor theaters; most of the remainder were employed in drive-in theaters. Other employers of projectionists included large manufacturers, television studios, and Federal, State, and local governments. Most theaters employ one projectionist per shift; few employ more than two.

Projectionists work in cities and towns of all sizes throughout the country. In a theater located in a small town, the theater owner or a member of his family may

perform the duties of the projectionist.

Training and Other Qualifications

Most motion picture theaters in urban areas are unionized, and young people who aspire to work as motion picture projectionists in these theaters must complete a period of apprenticeship. Apprenticeship applicants must be at least 18 years of age, and high school graduates usually are preferred.

The length of time a person must serve as an apprentice before taking an examination for union membership may vary from 1 to 2 years, depending on the policies of union locals. However, if he is capable of performing the work, an apprentice may be assigned to a full- or part-time job at journeyman's pay before becoming a member. In a few cities and States, projectionists must be licensed.

An apprentice learns the trade by working full- or part-time with experienced projectionists. He first learns simple tasks, such as threading and rewinding film, and, as he gains experience, progresses to more difficult assignments such as adjusting and repairing equipment. He may work in several theaters to become familiar with different types of equipment. Many apprentices receive no pay while being trained. In a non-union theater, a young man may start as an usher or helper and learn the trade by working with an experienced projectionist.

Young men interested in becoming projectionists should have good eyesight, including normal color perception and good hearing. They should be temperamentally suited to working alone in close quarters. Manual dexterity and mechanical aptitude

are also important personal qualifications. Practical experience gained from operating small movie projectors at home, at school, or in the Armed Forces also is helpful.

Employment Outlook

Employment of motion picture projectionists is expected to increase slowly through the 1970's. Most job opportunities will arise as experienced workers retire, die, or transfer to other fields of work. Retirements and deaths alone may result in several hundred job openings annually, but competition for the available openings is likely to continue to be keen. Some of these openings will be filled by experienced projectionists who are unemployed or underemployed.

Employment of projectionists is closely related to the number of motion picture theaters. Following a rapid decline in the 1950's and early 1960's, the number of theaters has leveled off in recent years but is expected to increase slightly during the 1970's. Among the factors which may contribute to this increase are the growing population, rising personal incomes, increased leisure time, and the continued movement of people to suburban areas.

Earnings and Working Conditions

Motion picture projectionists had average straight-time hourly earnings of more than \$3.00 in 1968. In some large cities, average hourly earnings of these workers were \$5.00 or more. Generally, downtown theaters pay higher hourly rates than suburban or drive-in theaters.

Most projectionists work evenings. Generally, those employed

on a full-time basis work 4 to 6 hours, 6 evenings per week. They may work more than 6 hours on Saturday in a theater which features Saturday matinees. Some projectionists work at several theatres. For example, a projectionist's weekly schedule may call for 2 evenings in each of three theaters. Projectionists employed in drive-in theaters, particularly those in Northern States, may be laid off for several months during the winter.

Many projectionists receive 2 or 3 weeks of paid vacation and premium pay for weekend or holiday work. Some projectionists are covered by hospitalization and pension plans.

The motion picture projectionist works in a room called a projection booth. In most theaters, these booths have adequate lighting, ventilation, and work space. Many booths are air conditioned. The work is relatively free of hazards, but there is danger of electrical shocks and burns if proper safety precautions are not taken. The motion picture projectionist's work is not physically strenuous. He frequently lifts and handles film reels, but most of these weigh no more than 35 pounds. Although he must be on his feet much of the time, he can sit for short periods while the equipment is in operation. Most projectionists work without direct supervision and have infrequent contact with other theater employees.

Sources of Additional Information

Further information about apprenticeship programs and employment opportunities may be obtained from any local union of the International Alliance of Theatrical Stage Employees and Moving Picture Machine Opera-

tors of the United States and Canada.

PHOTOGRAPHIC LABORATORY OCCUPATIONS

(D.O.T. 970.281; and 976.381, .687, .782, .884, .855, .886, and .887)

Nature of the Work

Photographs, such as those contained in books, magazines, and newspapers and amateur snapshots and home movies, require the skills of thousands of people employed in photographic laboratories. These workers develop film, make prints and slides, and perform related tasks such as enlarging photographs. (This chapter does not discuss employees of laboratories that specialize in processing professional motion picture film.)

All-round darkroom technicians (D.O.T. 976.381) perform all tasks necessary to develop and print film. Although these workers may use some mechanized processing equipment, they rely chiefly on manual methods. The darkroom technician develops film in tanks and trays containing chemical solutions. He varies the developing process according to the type of film—black and white negative, color negative, or color positive. For example, a developing process for black and white negative film covers five steps: developer, stop bath, fixing bath, washing, and drying. The first three steps are performed in darkness. After unwinding a roll of film, the darkroom technician places it in the developer, a chemical solution that brings out the image on exposed film. After the film has

remained in the developer for a specified period of time, the darkroom technician transfers it to a stop bath to prevent over-development. Next, he places the film in a fixing bath that makes it insensitive to light, thus preventing further exposure. He then washes the film to remove the fixing solution and places it in a drying cabinet. If a developed negative has flaws, such as scratches or bare spots, the darkroom technician may retouch these areas using an ink-like substance. Developing processes for color negative and color positive films are more complex than those used in black and white negative film. Thus, some laboratories employ *color technicians* (D.O.T. 976.381)—highly skilled workers who specialize in processing color film.

The darkroom technician makes a photograph by transferring the image from a negative to photographic paper. Printing frequently is performed on a projection printer, which consists of a fixture for holding negatives and photographic paper, an electric lamp, and a magnifying lens. The darkroom technician places the negative between the lamp and lens, and the paper below the lens. When he turns on the lamp, light passes through the negative and lens and records a magnified image of the negative on the paper. During printing, the darkroom technician may vary the contrast of the image or remove unwanted background by using his hand or paper patterns to shade parts of the photographic paper from the lamp light. After removing the exposed photographic paper from the printer, he develops it in much the same way as the negative. If the customer desires, the darkroom technician mounts the finished print in a frame or on a paper or cardboard back, using cement or a hand-operated press.

In addition to working in the laboratory, darkroom technicians may set up lights and cameras or otherwise assist experienced photographers. Many darkroom technicians, particularly those employed in portrait studios, divide their time between taking pictures and processing them. In some laboratories, helpers assist darkroom technicians. They also may be assisted by workers who specialize in a particular activity, such as *developers* (D.O.T. 976.381), *printers* (D.O.T. 976.381), and *photograph retouchers* (D.O.T. 970.281).

In large, mechanized photographic laboratories, darkroom

technicians may be employed to supervise semiskilled workers. Most semiskilled workers perform specialized assignments that require only a limited knowledge of developing and printing processes. Included are *film numberers* (D.O.T. 976.887), who sort film according to the type of processing needed and number each roll for identification purposes; *film strippers* (D.O.T. 976.887), who unwind rolls of film and place them in developing machines; *printer operators* (D.O.T. 976.782), who operate machines that expose rolls of photographic paper to negatives; *print developers*, *machine* (D.O.T. 976.885),



Darkroom technician examines finished print.

who operate machines that develop these rolls of exposed photographic paper; *chemical mixers* (D.O.T. 976.884), who measure and combine the various chemicals that make up developing solutions; *slide mounters* (D.O.T. 976.885), who operate machines that cut, insert, and seal film in cardboard mounts; and *photocheckers and assemblers* (D.O.T. 976.687), who inspect the finished slides and prints and package them for customers.

Places of Employment

In 1968, an estimated 30,000 workers were employed in photographic laboratory occupations. Almost half of them were darkroom technicians; the remainder worked in semiskilled photofinishing occupations. Although most darkroom technicians are men, women predominate in many of the semiskilled occupations. For example, most printer operators, slide mounters, photocheckers, and assemblers are women.

A large proportion of darkroom technicians are employed in photographic laboratories operated by portrait and commercial studios and by business and government organizations. The latter include manufacturers, newspaper and magazine publishers, advertising agencies, and Federal, State, and local governments. Darkroom technicians also are employed in small commercial laboratories that specialize in processing the work of free-lance photographers, advertising agencies, magazine publishers, and others. Most semiskilled workers are employed by large commercial photographic laboratories that specialize in processing film for amateur photographers.

Training, Other Qualifications, and Advancement

Most darkroom technicians learn their skills through informal on-the-job training. Beginners start as helpers and gradually learn to develop and print film by assisting experienced technicians. It generally takes 3 or 4 years to become a fully qualified darkroom technician. Some helpers become specialists in a particular activity such as printing or developing. Generally, the training time required to become a specialist is less than is needed to become an all-round darkroom technician.

Employers prefer to hire darkroom technicians' helpers who have a high school education. Courses in chemistry, physics, and mathematics are helpful to young people interested in this trade. Some high schools and trade schools offer courses in photography that include training in film processing. Experience gained through processing film as a hobby also is helpful. Some darkroom technicians have received training and experience in the Armed Forces.

Two-year curriculums leading to an associate degree in photographic technology are offered by a few colleges. Completion of college level courses in this field is helpful to people aspiring to supervisory and managerial jobs in photographic laboratories.

Many darkroom technicians eventually become professional photographers. Others advance to supervisory positions in laboratories. Darkroom technicians who acquire their experience in small laboratories need additional training before they can qualify for supervisory positions in large laboratories where mechanized equipment is used.

Training requirements for workers in semiskilled occupa-

tions range from a few weeks to several months of on-the-job training. For example, film numberers and slide mounters usually can learn their jobs in less than a month, but printer operators and chemical mixers need several months or longer. For many semiskilled jobs, manual dexterity, good vision including normal color preception, and good eye-hand coordination are important qualifications. However, some laboratories employ blind workers as film numberers and film strip-pers, since these jobs may be performed in the dark to prevent damage to exposed film. Completion of high school generally is not required for semiskilled jobs, but it frequently is needed for advancement to supervisory jobs.

Employment Outlook

Employment in photographic laboratory occupations is expected to increase moderately throughout the 1970's. Most job opportunities, however, will result from the need to replace experienced workers who retire, die, or transfer to other fields of work. Retirements and deaths alone will create an estimated 850 job openings annually.

The need for semiskilled workers is tied closely to the growth of amateur photography. Film purchases by amateur photographers are expected to increase rapidly through the 1970's as a result of rising population and personal income, more leisure time, and increased travel. Improvements in still and movie cameras that make them easier to load, unload, and operate also should contribute to increases in the use of film. However, the more widespread use of mechanized film processing equipment and improvements in this type of equipment will tend to increase

the efficiency of laboratory workers, thus keeping employment from growing as fast as the volume of film processed.

The need for all-round darkroom technicians is expected to increase as a result of the growing demand for photography in business and government. A major factor contributing to this demand will be the increasing variety of printed matter, such as sales brochures, catalogues, and public relations literature that is illustrated with photographs. The growing use of photography in research and development activities also will contribute to the demand for darkroom technicians. However, the generally favorable employment effects of these factors will be partially offset by the greater use of mechanized film processing equipment in small laboratories.

Earnings and Working Conditions

Information obtained from several employers in 1968, indicates that earnings of workers in photographic laboratory occupations vary greatly, depending on factors such as skill level, experience, and geographic location. Beginning pay for inexperienced darkroom technician's helpers generally ranged from \$1.65 to \$2.25 an hour. Most of the experienced all-round darkroom technicians earned between \$2.50 and \$5.00 an hour. In addition to all-round darkroom technicians, color technicians and printers generally had the highest earnings.

Workers in semiskilled occupations earned from \$1.60 to \$3.50 an hour. Among these workers, printer operators and chemical mixers generally had the highest earnings.

In the Federal Government, photographic laboratory techni-

cians earned between \$5,100 and \$9,100 annually.

Many photographic laboratories provide paid holidays, vacations, and other benefits such as medical-surgical insurance. Workers in photofinishing laboratories operated by business and government organizations receive the same fringe benefits as their fellow employees.

The majority of photographic laboratory employees have a standard workweek of 40 hours and receive premium pay for overtime. In laboratories that specialize in processing film for amateur photographers, employees may work a considerable amount of overtime during the summer and for several weeks after Christmas. Many laboratories employ additional workers temporarily during these seasonal peaks.

Most photographic laboratory jobs are not physically strenuous. In many semiskilled occupations, workers perform their jobs while sitting, but the work is repetitious and the pace is rapid. Some of these workers (for example, printer operators and photocheckers and assemblers) are subject to eye fatigue. Photofinishing laboratories are generally clean, well lighted, and air conditioned.

Sources of Additional Information

Additional information about employment opportunities in photographic laboratories and schools that offer degrees in photographic technology may be obtained from:

Master Photo Dealers' and Finishers' Association, 603 Lansing Ave., Jackson, Mich. 49202.

POWER TRUCK OPERATORS

(D.O.T. 892.883; 921.782 and .883; and 922.782 and .883)

Nature of the Work

In the past, manual workers in factories usually did the hard physical labor of moving raw materials and products. Today, many heavy materials are moved by workers who operate various types of self-powered trucks, which can easily carry tons of material and lift it to heights of many feet.

A typical truck operated by these workers has a hydraulic or electric lifting mechanism with attachments, such as forks to lift piles of cartons or other containers, and scoops to lift coal or other loose material. Some power trucks are equipped with tow bars used to pull small trailers.

Power truck operators start the truck, drive it forward or backward, stop the truck, and control the lifting mechanism and attachments by moving pedals and levers. Power truck operators may be required to keep records of materials moved, do some manual loading and unloading of materials, and maintain their trucks in good working condition by cleaning, oiling, checking the water in batteries, and making simple adjustments.

The driver must use care and skill in driving his truck. For example, in driving through aisles where materials are stored, or when loading or removing materials from stock, which may be stacked from floor to ceiling, he must be able to judge distance so that no damage occurs. The operator also must know how much the truck can lift and carry and the kinds of jobs it can do.



Places of Employment

In 1968, more than 100,000 power truck operators were employed in manufacturing plants throughout the country. About half of these operators worked in the North Central States. Although semiskilled power truck operators were employed in all types of manufacturing industries, many were employed in metalworking plants that manufactured automobiles and automobile parts, machinery, fabricated metal products, and iron and steel. In addition to working in factories, large numbers of power truck operators were employed in warehouses, depots, dock terminals, mines, and other places where great quantities of materials must be moved.

Training, Other Qualifications, and Advancement

Most workers can learn to operate a power truck in a few days. It takes several weeks, however, to learn the physical layout and operation of a plant or other establishment, and the most efficient way of handling the materials to be moved.

Large companies generally require applicants for a power truck operator job to pass a physical examination. Many large companies also have formal training programs for new employees. In these training programs, the employee learns to operate the power truck, to do simple maintenance work, principles of loading and handling materials, plant layout and plant operation, and safe driving practices and rules.

There are some opportunities for advancement. A few operators may become materials movement foremen or supervisors.

Employment Outlook

Employment of power truck operators is expected to increase slowly through the 1970's. Most job openings will result from the need to replace workers who will retire, die, or transfer to other jobs.

Because of the need to move the increasingly huge amounts of manufactured goods demanded by the Nation's growing population and rising standard of living, most of the industries which employ large numbers of these workers are expected to have a long-range upward trend in employment. In addition, the increasing use of containers and pallets for moving goods will increase the need for power truck operators. The favorable effects of these two factors on employment, however, will be partially offset by the continued development of more efficient power trucks and

other mechanized materials-handling equipment.

Earnings and Working Conditions

Power truck operators employed in manufacturing industries generally are paid an hourly rate. The following table presents average straight-time hourly earnings for such workers:

Average straight-time hourly earnings of power truck operators in manufacturing, 1968

Area	Hourly rate
United States	\$2.92
Northeast	2.88
South	2.48
North Central	3.06
West	3.08

Power truck operators are subject to several hazards—such as falling objects and collisions between vehicles. Safety instruction is an important part of the job training in power trucking work.

The driver may operate his truck inside buildings or outdoors where he is exposed to various weather conditions. Some operators may handle loose material that may be dirty or dusty.

Power truck operators have somewhat varied work in moving materials throughout a plant. Their work is likely to be less repetitive and routine than that of workers who do semiskilled machine operator work.

Many power truck operators are members of labor unions. Most labor-management contracts in manufacturing plants employing power truck operators provide for fringe benefits such as paid holidays and vacations, health insurance, life insurance, and retirement pensions.

PRODUCTION PAINTERS

Nature of the Work

Almost every metal or wood product manufactured by Ameri-

can industry is given a coating of paint or other protective material. In mass-production industries, this painting is done by workers known as production painters. Most of these workers use spray guns to apply paint, lacquer, varnish, or other finishes to parts or finished manufactured products. Some production painters use brushes to apply paint and others operate semiautomatic paint spraying machines, dipping tanks, or tumbling barrels. The work done by production painters in factories is different from that performed by skilled painters who are employed in construction and maintenance work. (See statement on Painters.)

Production painters who operate spray guns pour paints into a spray gun container that is attached to an air-compressor unit. They adjust the nozzle of the spray gun and the air-compressor so that the paint will be applied uniformly. The objects being sprayed may be stationary or attached to a moving conveyor. Production painters who operate semiautomatic painting machines may load items into the machine or onto conveyors before applying paint. When working on objects requiring more than one color, production painters may apply masking tape to prevent overlapping of colors.

Although the duties of most production painters are simple and repetitive, the jobs of some may be varied. These production painters may make decisions involving the application of finishes, thinning of paint, and the adjustment of paint spray equipment. Production painters also may clean the surface to be painted before painting. When production painters are required to mix paints and figure the size of the area to be painted, they use simple arithmetic involving

decimals and fractions. Production painters may replace nozzles and clean guns and other paint equipment when necessary. Some production painters may operate specialized spray guns such as those operated at high temperatures and used to spray powdered plastics. In addition to their painting equipment, production painters use tools, such as mixing paddles, pliers, wrenches, rules, and gages, that indicate the consistency of liquid paint.

Places of Employment

About 160,000 production painters were employed in 1968, nearly three-quarters in manufacturing. Approximately 1 out of 8 production painters was a

woman. Two-thirds of all production painters were in industries making durable items such as automobiles, refrigerators, furniture, electrical measuring meters, and transformers. About half of all production painters were employed in New York, Michigan, Ohio, California, Illinois, Pennsylvania, Indiana, North Carolina, and New Jersey.

Training, Other Qualifications, and Advancement

Most production painters learn their jobs through on-the-job training. The length of training may vary from 2 weeks to several months.

The new worker may have his job duties explained to him by



Production painters apply acrylic enamel to automobile body.

his supervisor and then work under the guidance of an experienced employee. The trainee may observe the experienced employee at work or assist him in his work.

A person going into this work should be in good health, be able to stand for long periods of time, have a steady hand, and have good eyesight so that he can distinguish between colors and see whether the paint is applied evenly. High school graduation is not generally required of applicants for these jobs.

There are some opportunities for advancement in this field of work. A small number of workers have become inspectors or foremen.

Employment Outlook

Employment of production painters is expected to show little or no change through the 1970's. However, several thousand job opportunities are expected to arise annually as workers retire, die, or transfer to other lines of work. Deaths and retirements alone will result in almost 3,000 openings each year.

Employment of production painters is expected to remain relatively stable, primarily because of the increasing development and use of mechanized and automatic painting equipment. For example, even though the number of automobiles produced is expected to increase substantially, the greater use of automatic sprayers will very likely offset any need for additional production painters.

Earnings and Working Conditions

Production painters generally are paid on an hourly basis. An examination of selected 1968 labor-management contracts in the

machinery industries indicates that production painters earned from about \$2 to \$4 an hour.

Production painters are exposed to fumes from paint and paint-mixing ingredients. Some painters wear protective goggles and masks which cover the nose and mouth. When working on large objects, they may work in awkward and cramped positions.

Many production painters are members of unions. Among the labor organizations to which they belong are the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; the United Furniture Workers of America; and the United Steelworkers of America. Many labor-management contracts in the plants in which these workers are employed provide for fringe benefits, such as holiday and vacation pay, health insurance, life insurance, and retirement pensions.

SHOE REPAIRMEN

(D.O.T. 365.381)

Nature of the Work

Shoe repairmen repair worn heels and soles, broken straps, and torn seams of all types of shoes. These craftsmen also re-style shoes by attaching ornaments such as buckles and bows. Highly skilled shoe repairmen may design, make, or repair orthopedic shoes in accordance with the prescription of orthopedists and podiatrists. They also may mend handbags, luggage, tents, boat covers, and other items made of leather, rubber, or canvas.

The most frequent tasks performed by shoe repairmen are re-

placing worn heels and soles. To resole a shoe, the repairman prepares the shoe by removing the worn sole and old stitching, and roughing the bottom of the shoe on a sanding wheel. Next, he selects a new sole or cuts one from a piece of leather and cements, nails, or sews it to the shoe. Finally, he trims the sole. To reheel a shoe, the repairman first pries off the old heel. He then selects a replacement heel or cuts one to the required shape, and cements and nails the new heel in place. The heel is then trimmed. After the heels and soles have been replaced, the shoe repairman stains and buffs them so that they match the color of the shoes. Sometimes he cements leather tips or nails metal heels and toe plates to the new heels and soles to increase their durability. Before completing the job, the repairman may replace the insoles, restitch any loose seams, and polish and buff the shoes.

In large shops, shoe repair work often is divided into a number of specialized tasks. For example, some shoe repairmen may remove and replace heels and soles only; others only restitch torn seams.

Shoe repairmen use handtools and power and manually operated machines in their work. For example, they may use power operated sole stitchers and heel nailing machines, and manually operated sewing machines, cement presses, and shoe stretchers. Among the handtools they use are hammers, awls, and nippers.

Self-employed shoe repairmen have managerial, sales, and other responsibilities in addition to their regular duties. They make estimates of repair costs, prepare sales slips, keep records, and receive payments for work performed. They also may supervise the work of other repairmen.



Places of Employment

Over 60 percent of the estimated 30,000 shoe repairmen employed in 1968 were proprietors of small, one-man shoe repair shops. Most of the remaining craftsmen were employed in large shoe repair establishments. Many of these large shops offered cleaning and laundering services in addition to shoe repairing. A few shoe repairmen worked in shoe repair departments of department stores, variety chain stores, shoe stores, and cleaning establishments.

Almost every community in the United States has at least one shoe repairman. However, most repairmen work in urban areas. States having large numbers of shoe repairmen include New York, California, Pennsylvania, Illinois, and Texas.

Training, Other Qualifications, and Advancement

Most shoe repairmen are hired as helpers and receive on-the-job training in large shoe repair shops. Helpers begin by assisting exper-

ienced repairmen with simple tasks, such as staining, brushing, and shining shoes, and progress to more difficult duties as they gain experience. Helpers having an aptitude for the work and initiative can become qualified shoe repairmen after 2 years of on-the-job training.

Some repairmen learn how to repair shoes in vocational schools that offer such training. Others receive their training under the provisions of the Manpower Development and Training Act; still others enter the occupation through apprenticeship training programs.

Skilled shoe repairmen who work in large shops can become foremen or managers. Those who have the necessary funds can open their own shops.

Employment Outlook

Employment of shoe repairmen is expected to show little or no change through the 1970's. However, hundreds of job openings will arise each year from the need to replace experienced workers who retire, die, or transfer to other fields of work. Retirements and deaths alone are expected to provide nearly 1,500 job openings annually. In addition, many jobs currently are unfilled because of a shortage of qualified shoe repairmen. Moreover, the number of repairmen currently being trained is insufficient to fill present or prospective job openings.

Several factors will tend to limit the growth in requirements for shoe repairmen. In recent years, the popularity of canvas footwear, loafers, sandals, and cushion-soled shoes has increased. Because of the construction of these types of shoes, they often cannot be repaired. In addition, many shoes are being made of more durable, long-wearing materials and

need repair less frequently. Also, as personal income rises, many people buy new shoes rather than repair old ones.

Earnings and Working Conditions

In 1968, shoe repairmen in metropolitan areas generally earned between \$90 and \$100 for a 40 hour week. Some skilled repairmen earned up to \$150. Those who were managers of shoe repair shops earned more than \$150 a week and trainees generally earned about \$65 a week.

Earnings of self-employed shoe repairmen varied considerably, depending on the size and location of the shop and the owner's managerial ability. Shoe repairmen who operated clean, modern shops often earned more than \$7,500 a year. On the other hand, those who owned shops in small communities often earned less.

Shoe repairmen generally work 8 hours a day, 5 or 6 days a week. The workweek for the self-employed, however, is often longer, sometimes 10 hours a day, 6 days a week. Although shoe repair establishments are busiest during the spring and fall, work is steady with no seasonal layoffs. Employees in large shops receive from 1 to 4 weeks' paid vacation, depending on the length of time employed. Usually, at least 6 paid holidays a year are provided.

Working conditions in large repair shops, shoe repair departments of shoe stores and department stores, and in the more modern shoe service stores are generally good. However, some repair shops may be crowded and noisy and have poor light or ventilation. Strong odors from leather goods, dyes, and stains may be present.

Shoe repair work is not strenuous, but does require physical stamina, since shoe repairmen must stand a good deal of the time.

Sources of Additional Information

Information on training and other aspects of the trade may be obtained from:

Shoe Service Institute of America,
222 West Adams St., Chicago,
Ill. 60606.

Information about local work opportunities and manpower development and training programs can be obtained from local offices of the State employment service.

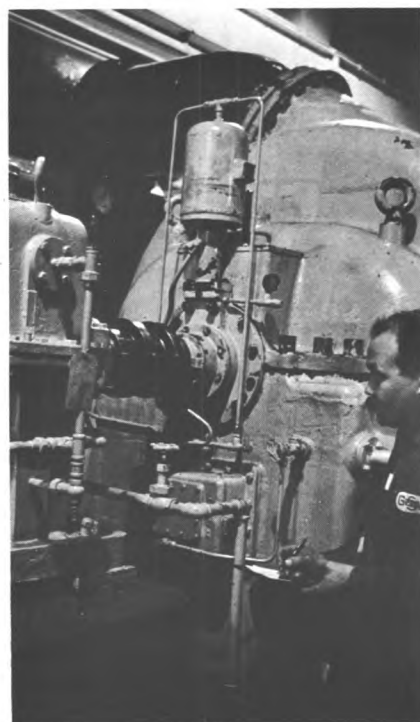
STATIONARY ENGINEERS

(D.O.T. 950.782)

Nature of the Work

Stationary engineers operate and maintain equipment in industrial plants and other buildings that is essential to power generation, heating, ventilation, humidity control, and air conditioning. These workers are needed wherever steam boilers, diesel and steam engines, refrigeration and air-conditioning machines, generators, motors, turbines, pumps, compressors, and similar equipment are used. They must operate and maintain the equipment according to State and local laws, since the safety of many people depends upon its proper functioning.

The most important duty of stationary engineers is to make certain that the equipment for which they are responsible is operating properly. They must detect and identify any trouble that develops by analyzing their readings of meters, gages, and other monitoring instruments, and by watching and listening to the machinery. They operate levers, throttles, switches, valves, and



Stationary engineer takes reading.

other devices to regulate and control the machinery so that it works efficiently. They also record such information as the amount of fuel used, the temperature and pressure of boilers, the number and pieces of equipment in use, and any repairs that are made.

Stationary engineers usually repair the equipment they operate, using handtools of all kinds, including precision tools. Common repairs involve reseating valves; replacing gaskets, pumps, packings, bearings, and belting; and adjusting piston clearance. Occasionally, stationary engineers make mechanical changes so that the equipment will operate more efficiently or conform to the requirements of a different process.

The duties of stationary engineers depend on the size of the establishment in which they work and the type and capacity of the machinery for which they are responsible. However, their primary

responsibilities are very much the same for all kinds of plants—safe and efficient operation of their equipment. In a large plant, the chief stationary engineer may have charge of the entire operation of the boilerroom and direct the work of assistant stationary engineers and other employees, including turbine operators, boiler operators, and air-conditioning and refrigeration mechanics. Assistant stationary engineers may be responsible for the operation of all the equipment during a shift or they may be in charge of a specific type of machinery such as air-conditioning equipment. In relatively small establishments, stationary engineers may be responsible for the operation and maintenance of all mechanical and electrical equipment.

Places of Employment

In 1968, more than 260,000 stationary engineers were employed in a wide variety of establishments, such as power stations, factories, breweries, food-processing plants, steel mills, sewage and water-treatment plants, office and apartment buildings, hotels and hospitals. Federal, State, and local governments also employed large numbers of these workers. The size of establishments in which the engineers worked ranged from giant hydroelectric plants and large public buildings to small industrial plants. Most plants which operate on three shifts employ from 4 to 8 stationary engineers, but some have as many as 60. In many establishments, only one engineer works on each shift.

Because stationary engineers work in so many different kinds of establishments and industries, they are employed in all parts of the country. Although some are employed in small towns and in rural areas, most work in the more

heavily populated areas where large industrial and commercial establishments are located. New York, Texas, California, Illinois, Pennsylvania, Ohio, New Jersey, and Michigan employ well over half of these workers.

Training, Other Qualifications, and Advancement

Many stationary engineers start as helpers or craftsmen in other trades and acquire their skills largely through informal on-the-job experience. However, most training authorities recommend formal apprenticeship as the best way to learn this trade because of the increasing complexity of the machines and systems.

In selecting apprentices, most joint labor-management apprenticeship committees prefer high school or trade school graduates between 18 and 25 years of age who have received instruction in such subjects as algebra, geometry, trigonometry, shop mathematics, mechanical drawing, machine-shop practice, physics, and chemistry. Mechanical aptitude, manual dexterity, and good physical condition also are important qualifications.

A stationary engineer apprenticeship customarily lasts 3 to 4 years. Through on-the-job training, the apprentice learns to operate, maintain, and repair stationary equipment, such as blowers, generators, compressors, boilers, motors, and air-conditioning and refrigeration machinery. He is taught how to use a variety of hand and machine tools, such as chisels, hammers, electric grinders, lathes, and drill presses. He also learns to use precision-measuring instruments, such as calipers and micrometers. In addition, he may be taught how to move machinery by the use of blocks, chain hoists, or other equipment.

This on-the-job training is supplemented by classroom instruction and home study in such related technical subjects as practical chemistry, elementary physics, blueprint reading, applied electricity, and theories of refrigeration, air conditioning, ventilation, and heating.

Persons who become stationary engineers without going through a formal apprenticeship program usually do so only after many years of experience as assistants to licensed stationary engineers in such occupations as boiler, refrigeration, or turbine operator. This practical experience usually is supplemented by technical or other school training or home study.

Eight States, the District of Columbia, and more than 50 large and medium-size cities have licensing requirements for stationary engineers. Although requirements for obtaining a license differ from place to place, the following are typical: (1) The applicant must be over 21 years of age; (2) he must have resided in the State or locality in which the examination is given for a specified period of time; and (3) he must demonstrate that he meets the experience requirements for the class of license requested. A license is issued to applicants who meet these requirements and pass an examination which may be written, oral, or a combination of both types.

Generally, there are several classes of stationary engineer licenses, which specify the steam pressure or horsepower of the equipment the engineer may operate. The first-class license permits the stationary engineer to operate equipment of all types and capacities without restriction. The lower class licenses limit the capacity of the equipment the engineer may operate. However, engineers having lower class licenses may

operate equipment other than their license class, provided they are under the supervision of a higher rated engineer—usually one having a first-class license.

Stationary engineers advance to more responsible jobs by being placed in charge of larger, more powerful, or more varied equipment. Generally, the engineer advances to these jobs as he obtains higher grade licenses. Advancement, however, is not automatic. For example, an engineer having a first-class license may work for some time as an assistant to another first-class engineer before a vacancy requiring a first-class licensed engineer occurs. In general, the broader his knowledge of the operation, maintenance, and repair of various types of equipment, the better are his chances for advancement. Stationary engineers also may advance to jobs as plant engineers and as building and plant superintendents.

Employment Outlook

Employment of stationary engineers is expected to grow slowly through the 1970's. In addition, an average of about 6,000 new workers will be required each year to replace workers who retire or die. Promotions and transfers to other fields of work also will create job openings.

A rise in employment of stationary engineers is expected mainly because of the continuing increase in the use of large stationary boilers and refrigeration and air-conditioning equipment in factories, powerplants, and other buildings. Job opportunities may arise because of the continued growth of pipeline transportation and saline water conversion. However, improved efficiency from more powerful, automatic, and more centralized equipment and better utilization of workers may

limit the growth in the employment of these workers.

Earnings and Working Conditions

According to a number of union-management contracts in effect in 1969 covering brewery, laundry, hotel, bakery, printing and other industries located in 20 States and the District of Columbia, the average straight-time hourly rate for stationary engineers was approximately \$3.90. Stationary engineers in charge of large boiler-room operations often earn considerably more than the average straight-time hourly rate; some earn more than \$200 a week.

Stationary engineers generally have steady year-round employment. They usually work a straight 8-hour day and 40 hours a week. In plants or institutions that operate around the clock, they may be assigned to any one of three shifts—often on a rotating basis—and to Sunday and holiday work.

Many stationary engineers are employed in plants which have union-employer contracts. Most of these contracts provide fringe benefits, which may include hospitalization, medical and surgical insurance; life insurance; sickness and accident insurance; and retirement pensions. Similar benefits also may be provided in plants which do not have union-employer contracts. Among the unions to which these workers belong are the International Union of Operating Engineers and the International Union; United Automobile, Aerospace and Agricultural Implement Workers of America.

Most engine rooms, powerplants, or boilerrooms where stationary engineers work are clean and well-lighted. However, even under the most favorable conditions, some stationary engineers are exposed to high temperatures,

dust, dirt, contact with oil and grease, and odors from oil, gas, coal, or smoke. In repair or maintenance work, they may have to crawl inside a boiler and work in a crouching or kneeling position to clean or repair the interior.

Because stationary engineers often work around boilers and electrical and mechanical equipment, they must be alert to avoid burns, electric shock, and injury from moving machinery. If the equipment is defective or is not operated correctly, it may be hazardous to them and to other persons in the vicinity.

Sources of Additional Information

Information about training or work opportunities in this trade may be obtained from local offices of State employment services, locals of the International Union of Operating Engineers, and from State and local licensing agencies.

Information about the occupation also may be obtained from:

International Union of Operating Engineers, 1125 17th St., NW., Washington, D.C. 20036.

National Association of Power Engineers, Inc., 176 West Adam St., Chicago, Ill. 60603.

STATIONARY FIREMEN (BOILER)

(D.O.T. 951.885)

Nature of the Work

Stationary firemen are semi-skilled workers who operate and maintain steam boilers used to power industrial machinery, and to heat factories. Some experienced stationary firemen may be responsible for inspecting boiler

equipment, for lighting boilers, and building up steam pressure. On the other hand, the responsibilities of some stationary firemen may be limited to maintaining equipment in good working order by cleaning, oiling, and greasing moving machinery parts.

In most plants, stationary firemen operate mechanical devices that control the flow of air, gas, oil, or powdered coal into the firebox in order to keep proper steam pressures in the boilers. Duties of these workers may include reading meters and other instruments to be certain that the boilers are operating efficiently and according to safety regulations.

Fully qualified stationary firemen should be able to detect malfunctions without relying entirely on safety devices. In some plants, stationary firemen may be expected to know how to make minor repairs. Stationary firemen often are supervised by stationary engineers. (The stationary engineer is a skilled worker who is responsible for the operation and main-

tenance of a variety of equipment, including boilers, diesel and steam engines, and refrigeration and air-conditioning equipment. See statement on Stationary Engineers.)

Places of Employment

About 73,000 stationary firemen were employed in 1968, more than one-half in manufacturing. Generally, these workers are employed in industries which are large users of power generating equipment. Leading industries in the employment of stationary firemen are lumber, food, iron and steel, paper, chemicals, and transportation equipment.

Because stationary firemen work in so many different industries, they are employed in all parts of the country. Although some are employed in small towns and even rural areas, most work in the more heavily populated areas where large manufacturing plants are located. The States of Ohio, New York, Pennsylvania, Illinois, Michigan, New Jersey, and California accounted for about 45 percent of the total number of firemen.

Training, Other Qualifications, and Advancement

Some large cities and a few States require stationary firemen to be licensed. Applicants can obtain the knowledge and experience to pass the license examination by first working as a helper in a boilerroom, or working as a stationary fireman under a conditional license.

License requirements differ from city to city and from State to State. However, the applicant usually must prove that he meets the experience requirements for the license and pass an examina-

tion testing his knowledge of the job. For specific information on licensing requirements, consult your State or local licensing authorities.

There are two types of stationary firemen licenses—for low and high pressure boilers. Low pressure firemen operate low pressure boilers generally used for heating. High pressure firemen operate the more powerful high pressure boilers and auxiliary boiler equipment used to power machinery and equipment in addition to heating buildings. Both high and low pressure operators, however, may operate equipment of any pressure class, provided a stationary engineer is on duty.

Stationary firemen should understand the operation of machinery and must have normal vision and good hearing. (Because of the mechanization of equipment, physical strength is no longer a major requirement for this type of work.)

Stationary firemen may advance to jobs as stationary engineers. To become stationary engineers, firemen sometimes supplement their on-the-job training by taking courses in subjects such as practical chemistry; elementary physics; blueprint reading; applied electricity; and theory of refrigeration, air conditioning, ventilation, and heating. Stationary firemen also may advance to jobs as maintenance mechanics.

Employment Outlook

Employment of stationary firemen is expected to decline moderately through the 1970's. Many hundreds of openings for new workers, however, will result each year from the need to replace workers who transfer to other fields of work, retire, or die.

Although an increase in the use of stationary boilers and auxili-



Stationary fireman opens valve in gas line to burner.

any equipment is expected during the next 10 to 15 years, the trend to automatic, more powerful, and more centralized equipment is expected to result in a decline in employment of stationary firemen. In large plants, however, where turbines and engines are housed under a separate roof and where there is a need for constant surveillance of boilers, firemen will continue to be needed.

Earnings and Working Conditions

In 1967, stationary firemen in manufacturing plants located in 85 metropolitan areas across the country had average straight-time hourly earnings of \$2.90. Average hourly earnings in these areas ranged from about \$1.71 in Little Rock, Ark., to \$3.68 in Detroit, Mich.

Most stationary firemen, even under the most favorable conditions, are at times exposed to noise, high temperatures, dirt, dust, contact with oil and grease, odors and fumes from oil, gas, coal, or smoke. In repair or maintenance work, these workers may have to crawl inside a boiler and work in a crouching or kneeling position.

Stationary firemen are subject to burns, falls, and injury from moving machinery. Boilers and auxiliary equipment that are not operated correctly, or are defective, may be dangerous to these workers and to other persons in the work vicinity. However, modern equipment and safety procedures have reduced accidents considerably in recent years.

Many stationary firemen are employed in plants that have labor-management contracts, most of which provide benefits that may include paid holidays and vacations, hospitalization, medical and surgical insurance, sickness and accident insurance, and

retirement pensions. Among the unions to which these workers belong are the International Brotherhood of Firemen and Oilers and the International Union of Operating Engineers.

WASTE WATER TREATMENT PLANT OPERATORS (SEWAGE-PLANT OPERATOR)

(D.O.T. 955.782)

Nature of the Work

Clean water is essential for the health and recreational enjoyment of the population and for the existence of fish and other wildlife. Waste water treatment plant operators work to secure America's water resources by eliminating water pollution through the removal of domestic and industrial waste from water.

Domestic and industrial waste is carried by water through sewers and arrives at treatment plants in a diluted state. Where storm sewers flow through waste water treatment plants, nonorganic matter in the form of sticks, boards, sand, rags, and grit also is present. The primary task of waste water treatment plant operators is to supervise the operation and control of equipment and facilities designed to remove these materials or render them harmless to human, animal, and fish life. Operators test and correct the level of chlorine and oxygen in the water to assure maximum efficiency in the elimination of harmful bacteria that is responsible for most water pollution. Operators also must prevent the concentration of sludge (solid waste) at the bottom of water treatment tanks (sedimen-

tation tanks). By operating pumps and opening and closing valves that connect a system of pipes to the sedimentation tanks, operators remove excess sludge.

Operators perform routine tasks according to a regular schedule. These routine tasks include reading meters and gages and entering the information on log sheets. For example, an operator may monitor meters that record the volume of flow of waste water (sewage) into a plant or he may read gages that measure the level of water in a well and provide information needed to ascertain normal pump action. Other tasks may include operating screening devices for removing sand, gravel, and larger objects; making minor repairs on valves, pumps, and other equipment; opening and closing of valves; and sampling waste water at various stages of treatment for laboratory analysis. Operators also may paint pipes and equipment and hose down walls and tanks to breakup scum and sludge. In the performance of their duties, operators may be required to use wrenches, pliers, hammers, and other hand tools.

Operators occasionally must work under emergency conditions—for example, a pump may breakdown due to a violent storm and suddenly increase the flow of sewage and storm water into a plant. Under these circumstances, an operator may have to make emergency repairs or, at the very least, be able to locate the source of trouble, disengage the defective mechanism, and report the malfunction to a foreman or supervisor.

The range of duties of an operator depend largely on the size of the treatment plant. In smaller plants, the operator may have sole responsibility for the entire system, including making repairs on equipment, filling out forms,



Waste water treatment plant operator enters readings on record sheet.

and handling complaints, as well as patrolling and housekeeping duties such as cleaning the plant and cutting grass. Since many small plants are semiautomatic, frequently a single or part-time operator only is required. In larger plants, the staff may include helpers, foremen, and chief operators. The responsibilities of these workers range from those of helpers, who perform primarily housekeeping duties, to those of chief operators who supervise the entire operation.

Places of Employment

There were approximately 23,500 waste water treatment plant operators in 1968—about 3,500 of these operators worked in industrial waste liquid treatment

plants, and 20,000 were employed in municipal plants throughout the Nation.

The geographical distribution of treatment plants parallels the population pattern of the United States. About one-half of all waste water treatment plant operators worked in the following 8 states: California, New York, Illinois, Ohio, Pennsylvania, Texas, Florida, and New Jersey.

Training, Other Qualifications, and Advancement

Entry jobs generally do not require specific training, and most operators learn their skills through informal on-the-job experience. New workers usually start as helpers and are assigned

to work under the direction of an operator. They learn by helping in routine tasks, such as recording meter readings; taking samples of waste water and sludge; and doing simple maintenance and repair work on pumps, electric motors, valves, and pipes. They also are expected to perform housekeeping tasks such as cleaning and maintaining plant equipment and property.

Young people who are interested in obtaining an entry position in the field should have some mechanical aptitude and be able to perform simple arithmetic calculations. Most municipalities accept men with less than a high school education, however, in a number of large municipalities—particularly those having formal civil service structures—applicants generally must have a high school diploma or its equivalent. Some treatment operators, particularly in larger municipalities, are covered by civil service regulations, and applicants may be required to pass written examinations covering elementary mathematics, mechanical aptitude, and general intelligence. Operators must be agile, since they have to be able to climb up and down ladders and move easily around heavy machinery and equipment.

Most State water pollution control agencies offer some short term course training to improve the skills of water treatment plant operators. These courses cover subjects such as principles of digestion, odors and their control, chlorination, sedimentation, biological oxidation, and flow measurements. In some cases, operators take advantage of correspondence courses on subjects related to waste water treatment. Some large municipalities will pay part of the tuition for courses leading to a college degree in science or engineering.

Operators having experience and on-the-job training may be promoted to levels of more responsibility such as foremen and chief operators. The extent of educational and on-the-job experience required for advancement varies considerably, depending primarily on the size of the waste water treatment plant. Chief operators of large and complex plants, for example, may be expected to have a bachelor's degree in science or engineering. On the other hand, a high school diploma or its equivalent, and successively responsible experience is usually sufficient to qualify as chief operator of a small or medium-sized plant. A limited number of operators may become technicians employed by local or State water pollution control agencies or consulting engineers. These technicians are employed in a variety of tasks, including the collection and preparation of water and biological samples for laboratory examinations. Some technical-vocational school or junior college training is generally preferred for technician jobs.

All but 5 of the 50 States have certification programs that issue qualification standards for operators. By certifying operators on the basis of demonstrated proficiency, these programs are designed to improve treatment plant operations and raise employee stature. Sixteen States (Delaware, Illinois, Indiana, Iowa, Kentucky, Maryland, Michigan, Montana, New Hampshire, New Jersey, New York, Ohio, Oklahoma, Texas, West Virginia, and Wisconsin) have adopted mandatory certification laws providing for the examination of operators and certification of their competence to supervise the operation of treatment plants. In addition to requiring the certification of supervisory operators, these States en-

courage other operators to become certified. Voluntary certification programs are in effect in 29 States, and municipalities in these States are urged to employ certified operators.

Under a typical licensing program, there are four classes of certification that relate as nearly as possible to corresponding classifications for waste water treatment plants. For example, to be certified a Class I operator (corresponding to a Class I plant-serving a population of less than 2,000), an applicant may be required to demonstrate general knowledge of treatment operations by passing a written examination, be a high school graduate, and have completed 1 year of acceptable employment at a treatment plant. Requirements for certification as a Class IV operator (corresponding to a Class IV plant-serving a population in excess of 40,000) may be a college degree or completion of 2 years of college in science or engineering; 5 years of treatment plant experience at a Class III plant or higher, 2 years of which were in a position of major responsibility; and specific knowledge of the entire field of waste water treatment as demonstrated through a written examination.

Employment Outlook

Employment of operators is expected to rise rapidly through the 1970's, mainly as a result of the construction of new treatment plants to manage the increasing amount of domestic and industry waste water. Employment growth also should result from expansion of existing plants to include secondary treatment operators to cope more effectively with water pollution. In addition to the new jobs that will result from growth, approximate-

ly 1,100 job openings are expected each year due to death and retirement of experienced workers.

The construction of larger and more complex municipal and industrial treatment plants and the consolidation of smaller plants is expected to increase through the 1970's. In 1968, about 4 out of 5 communities having sewer systems had waste water treatment plants. By 1980, it is expected that almost all communities will provide for the treatment of waste water. A larger proportion of small plants are expected to use full-time operators as a result of increases in the quantity of waste water from population and industrial growth.

Earnings and Working Conditions

Earnings of operators in small plants ranged from \$3,600 to \$8,500 per year in 1968; in large treatment plants earnings were higher. Foremen earned up to \$9,000 per year and chief operators as much as \$14,000. Salaries for trainees were roughly 80 percent of the operators' salaries in most cities. These data reflect information collected from a number of municipalities in various parts of the United States.

Fringe benefits provided for plant operators usually are similar to those received by other municipal civil service employees. Many operators receive paid vacations and holidays, overtime, shift differential pay, sick leave, paid life insurance, paid hospitalization, and retirement benefits.

Because pollution control is a continuous operation, operators work in different shifts and in event of an emergency may have to work overtime. When working outdoors, operators are exposed to all kinds of weather. Operators

also may be exposed to unpleasant odors and toxic conditions, dust, and fumes in the atmosphere, as well as noise from the operation of electrical motors, pumps, and gas engines. However, odor is kept to a minimum by the use of chlorine. Many plants are modern buildings that have good lighting, clean washrooms equipped with showers, and a room set aside for the comfort of the operator. The site is usually landscaped with well groomed lawns and shrubbery. For the most part, the pipes and sludge digestion tanks are beneath the ground or covered.

Young people interested in a career in water treatment should contact their local or State water pollution control agencies. Additional information may be obtained from:

Water Pollution Control Federation,
3900 Wisconsin Ave., NW.,
Washington, D.C. 20016

Office of Manpower and Training
Federal Water Pollution Control
Administration, Department of
the Interior, 633 Indiana Ave.,
NW., Washington, D.C. 20242.

Consumer Protection and Environmental
Health Services, Department of
Health, Education, and Welfare,
200 C St., SW., Washington, D.C. 20204.

WELDERS AND OXYGEN AND ARC CUTTERS

(D.O.T. 810. through 819.887)

Nature of the Work

Welding is one of the most common and dependable methods of joining metal parts. Many of the parts used in the manufacture of automobiles, missiles and spacecrafts, airplanes, household appliances, and thousands of

other products are joined by this process. Structural metal used in the construction of bridges, buildings, storage tanks, and other structures is often welded. Welding also is used widely to repair broken metal parts.

Welding is a method of joining pieces of metal by applying heat, pressure, or both, with or without filler metal, to produce a permanent bond. Although there are more than 40 different welding processes, most of the processes fall under three basic categories: arc, gas, and resistance welding. Arc and gas welding can be performed manually or by machine. Resistance welding is mainly a machine process.

Closely related to welding is oxygen and arc cutting (often referred to as flame cutting). Oxygen and arc cutters cut or trim metal objects to a desired size or shape. They also remove excess metal from castings and cut scrap metal into pieces of manageable size.

Most manual welding is done by *arc welders*, *gas welders*, and *combination welders* who do both arc and gas welding. Manual welders may be either skilled or semiskilled. The skilled, all-round manual welder is able to plan and lay out work from drawings, blueprints, or other written specifications. He has a knowledge of the welding properties of steel, stainless steel, cast iron, bronze, aluminum, nickel, and other metals and alloys with which he may be required to work. He also is able to determine the proper sequence of work operations for each job and to weld all types of joints held in various positions (flat, vertical, horizontal, and overhead). The semiskilled manual welder usually performs repetitive work; that is, production work which, more often than not, does not involve critical safety and strength requirements. The surfaces welded by him are primarily in only one position.



Welder strikes arc with electrode.

The principal duty of the welder using the manual technique is to control the melting of the metal edges by directing heat to the edges, either from an electric arc or from a gas-welding torch, and to add filler metal where necessary to complete the joint. In one of the most commonly used manual arc welding processes, the welder obtains a suitable electrode and adjusts the electric current. The welder first "strikes" an arc (creates an electric circuit) by touching the metal with the electrode. After the arc is made, the welder guides the electrode at a suitable distance from the edges to be welded. The intense heat caused by the arc melts the edges and the electrode tip. The molten metal from the electrode is deposited in the joint and, with the molten metal edges, solidifies to form a solid connection. During the past two decades, there has been a considerable increase in the use of arc-welding processes that employ inert gas for shielding the weld area. This type of welding was developed for joining hard-to-weld metals, such as aluminum, magnesium, stainless steel, and titanium, and is now usable with plain carbon steel. Many welders now specialize in this process.

In the late 1950's, the semiautomatic CO₂ gas shielded welding processes were developed. These processes feed a continuous electrode wire into the arc and the gun may be guided by the operator or may be fully automated. The fine wire CO₂ process has almost no spatter or slag and is an all position method. The large wire CO₂ process has a high deposition rate and is very good for fully automatic applications. In addition, the flux cored arc welding procedure has the double advantage of special flux compounds in the center of the wire

and also the CO₂ gas shielding. Flux cored wire is also available which requires no external shielding gas. All the necessary fluxing ingredients are contained inside the center core. Before considering himself up-to-date, a welder should be able to use the semi-automatic welding processes.

In gas welding, the welder uses a gas welding torch to apply an intensely hot flame (obtained from the combustion of a mixture of fuel gas—most commonly acetylene and oxygen) to the metal edges. After the welder obtains the proper types of welding rods and welding torch tips and adjusts the regulators on the oxygen and acetylene cylinders, he lights his welding torch. He then adjusts the oxygen and acetylene valves on the torch to obtain the proper size and quality of flame. The kind of flame selected depends on the type of metal to be joined and the type of joint to be made. The welder heats the metal by directing the flame against the metal until it begins to melt. He then applies the welding rod to the molten metal to supply additional metal for the weld.

In production processes, especially where the work is repetitive and the items to be welded are relatively uniform, the welding may be done by semi-skilled workers who operate welding machines. In resistance welding, the most common type of machine welding, *resistance welding operators* (D.O.T. 813-885) feed and align the work and remove it after the welding operation is completed. Occasionally, they may adjust the controls of the machine for the desired electric current and pressure.

Workers other than welders frequently use welding in their work. In the construction industry, for example, the structural steel worker, plumber and pipe-

fitter, and sheet-metal worker may at times do manual arc and gas welding. Also, maintenance and repair work provide many welding opportunities for other metalworking and related occupations. (See Index for individual statements on these occupations.)

Semiskilled oxygen cutters (D.O.T. 816.782 and .884) and *arc cutters* (D.O.T. 816.884), sometimes called flame or thermal cutters, usually use hand-guided torches to cut or trim metals. In the oxygen-cutting process, for example, the oxygen cutter directs a flame of fuel gas burning with oxygen on the area to be cut until the metal begins to melt. He then releases an additional stream of oxygen which cuts the metal. The oxygen cutter prepares for the cutting job by attaching the proper torch tip for the particular job, connecting the torch to the gas and oxygen hoses, and regulating the flow of gases into the torch for the desired cutting flame. He then cuts through the metal, manually guiding the torch along previously marked lines or following a pattern. He may mark guidelines on the metal by following blueprints or other instructions. Arc cutting differs from oxygen cutting because an electric arc is used as the source of heat. However, as in oxygen cutting, an additional stream of gas may be released in cutting the metal. An arc with a hollow electrode through which oxygen passes is used in underwater cutting. Other special forms of the arc, such as the plasma arc, are used for cutting ferrous and nonferrous metals.

Oxygen and arc cutters also may operate a torch or torches mounted on an electrically or mechanically controlled machine

which by electrical or mechanical control automatically follows the proper guideline.

Places of Employment

In 1968, an estimated 480,000 welders and oxygen and arc cutters were employed throughout the country. About 360,000 of these workers were employed in manufacturing industries. Their main employers were firms manufacturing durable goods, such as transportation equipment, fabricated metal products, machinery, primary metals, and electrical machinery. Of the approximately 120,000 welders and cutters employed in other industries, the greatest number were found in construction firms and establishments performing miscellaneous repair services; the remainder were widely scattered among other nonmanufacturing industries.

The widespread use of the welding and cutting processes in industry enables welders and cutters to find jobs in every State. Most of these jobs, however, are found in the major metalworking areas. Slightly more than 50 percent of the jobs were concentrated in seven States—Pennsylvania, California, Ohio, Michigan, Illinois, Texas, and New York. Large numbers of welders and cutters are employed in Detroit, Chicago, Philadelphia, Los Angeles, and other important metalworking centers.

Training, Other Qualifications, and Advancement

Generally, it takes several years of training to become a skilled manual arc or gas welder, and somewhat longer to become

a combination welder (an individual skilled in both arc and gas welding). Some skilled jobs may require a knowledge of blueprint reading, welding symbols, metal properties, and electricity. Some of the less skilled jobs, however, can be learned after a few months of on-the-job training.

Training requirements for the resistance-welding machine operator's job depend upon the particular type of equipment used; most of these operators learn their work in a few weeks. Little skill is required for most oxygen and arc-cutting jobs; generally, they can be learned in a few weeks of on-the-job training. However, the cutting of some of the newer alloys requires a knowledge of the properties of metals as well as greater skill in cutting.

Welding and oxygen- and arc-cutting work require manual dexterity, a steady hand, good eye-hand coordination, and good eyesight. For entry in manual welding jobs, most employers prefer to hire young men who have high school or vocational school training in welding methods. Courses in mathematics, physics, mechanical drawing, and blueprint reading also are valuable.

A formal apprenticeship generally is not required for manual welders. However, a few large companies (for example, automobile manufacturers) offer apprenticeship programs that run as long as 8,000 hours for the welding occupations. Also, the U.S. Department of the Navy, at several of its installations, conducts 4-year welding apprenticeship programs for its civilian employees.

Programs to train unemployed and underemployed workers for entry level welding jobs or to upgrade welding skill requirements

have been operating in many cities throughout the United States since 1962, under the provisions of the Manpower Development and Training Act. The training, which may be in the classroom or on-the-job and last from several weeks up to 1 year, stresses the fundamentals of welding. Additional work experience and further on-the-job training may qualify graduates of MDTA projects as skilled welders in a relatively short time.

Young persons entering the welding trade often start in simple manual welding production jobs where the type and thickness of metal, as well as the position of the welding operation, rarely change. Occasionally, they are first given jobs as oxygen or arc cutters; they later move into manual welding jobs. Some large companies employ general helpers in maintenance jobs who, if they show promise, may be given opportunities to become welders by serving as helpers to experienced welders and learning the skills of the trade on the job.

Before being assigned to work where the strength of the weld is a highly critical factor, welders may be required to pass a qualifying examination. The test may be given by an employer, a municipal agency, a private agency designated by local government inspection authorities, or a naval facility. Certification tests also are given to welders on some construction jobs or to those who may be engaged in the fabrication or repair of steam or other pressure vessels where critical safety factors are involved. In addition to certification, some localities require welders to obtain a license before they can do certain types of outside construction work. New developments in some manufacturing industries are in-

creasing the skill requirements of welders. This is particularly true in fields such as atomic energy or missile manufacture, which have high standards for the reliability of welds and require more precise work.

After 2 years' training at a vocational school or technical institute, the skilled welder may qualify as a welding technician. Generally, workers in this small but growing occupation interpret the engineers' plans and instructions. Occasionally, welders may be promoted to jobs as inspectors, where they check welds for general conformance with specifications and for quality of workmanship. Welders also may become foremen who supervise the work of other welders. A small number of experienced welders establish their own welding and repair shops.

Employment Outlook

The number of welding jobs is expected to increase rapidly through the 1970's as a result of the generally favorable longrun outlook for metalworking industries and the wider use of the welding process. In addition to jobs created by employment growth, about 7,000 job openings will occur each year because of vacancies resulting from retirements and deaths. Opportunities also will result as some welders transfer to other lines of work.

Many more manual welders will be needed for maintenance and repair work in the growing metalworking industries. The number of manual welders engaged in production work is expected to increase in plants manufacturing structural-metal products, such as metal doors, boilers, storage tanks, and sheet-metal



Welder operates CO₂ gas shielded welding equipment.

products. The construction industry will need an increasing number of welders as the use of welded steel structure expands.

Employment prospects for resistance welders are expected to continue to be favorable because of the increased use of the machine resistance-welding process in activities such as the manufacture of motor vehicles, aircraft and missiles, and the production of light, streamlined railroad cars. The use of faster and more highly automatic welding machines, however, will slow down the growth in the number of these welders.

The number of jobs for oxygen and arc cutters is expected to rise somewhat during the years ahead as the result of the general expansion of metalworking activity. The increased use of oxygen- and arc-cutting machines, however, will tend to restrict the growth of this occupation.

Earnings and Working Conditions

The earnings a welder can expect depend to a great extent on the skill requirements of his job and on the industry or activity in which he is employed. Earnings

of highly skilled manual welders generally compare favorably with those of other skilled metalworking occupations. Machine welders, such as resistance welders, who require little training, generally earn less than skilled manual welders.

Average straight-time hourly earnings for skilled and semi-skilled welders in machinery manufacturing industries in 21 cities and metropolitan areas in late-1968 appear in the accompanying tabulation. In about three-fourths of the cities, average hourly earnings for skilled welders were \$3.50 or more. Welders who are covered by union contracts may earn considerably more than these average earnings.

City	Rate per hour	
	Skilled welder	Semiskilled welder
Baltimore	\$3.50	\$3.00
Boston	3.21	
Buffalo	3.64	3.25
Chicago	3.75	3.81
Cleveland	3.39	3.38
Dallas	2.98	2.59
Denver	3.43	3.11
Detroit	3.92	3.43
Hartford-New Britain-Bristol	3.74	2.88
Houston	3.54	3.04
Los Angeles-Long Beach and Anaheim-Santa Ana-Garden Grove	3.63	3.08
Milwaukee	3.70	3.51
Minneapolis-St. Paul	3.44	3.01
Newark and Jersey City	3.72	3.34
New York	3.69	2.74
Philadelphia	3.55	3.15
Pittsburgh	3.57	2.97
Portland	3.99	3.50
St. Louis	3.98	3.24
San Francisco-Oakland	4.17	
Worcester	3.55	

Many welders and cutters are union members. Among the labor organizations which include welders and cutters in their mem-

bership are the International Association of Machinists and Aerospace Workers; the International Brotherhood of Boilermakers, Iron Shipbuilders, Blacksmiths, Forgers and Helpers; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; the United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada; and the United Electrical, Radio and Machine Workers of America (Ind.). Only one labor organization—the International Union, United Weldors (Ind.), is known to be composed entirely of welders, employed largely in the aircraft industry on the west coast.

Labor-management contracts covering welders and oxygen and arc cutters provide employees with benefit programs which may include paid holidays and vacations, hospitalization, medical and surgical insurance, life insurance, sickness and accident insurance, and retirement pensions.

Safety precautions and protective devices are extremely important for welders because of the many hazards associated with welding. Welders and cutters use protective clothing, goggles, helmets with protective lenses, and other devices to prevent burns and eye injuries. Although lighting and ventilation are usually adequate, welders occasionally work in the presence of toxic gases and fumes generated by the melting of some metals. Welders are often in contact with rust, grease, paint, and other elements found on the surface of the metal parts to be welded. Operators of resistance-welding machines are

largely free from the hazards associated with hand welding. A clear eyeshield or clear goggles generally offer adequate protection to these operators.

Sources of Additional Information

For further information regarding work opportunities for welders, inquiries should be directed to local employers or the local office of the State employment service. The State employment service also may be a source of information about the Manpower Development and Training Act, apprenticeship, and other programs that provide training opportunities. General information about welders may be obtained from:

The American Welding Society,
345 East 47th St., New York,
N.Y. 10017.

International Brotherhood of Boilermakers, Iron Shipbuilders, Blacksmiths, Forgers and Helpers, 8th at State Ave., Kansas City, Kans. 66101.

International Association of Machinists and Aerospace Workers, 1300 Connecticut Ave. NW., Washington, D.C. 20036.

International Union, United Automobile, Aerospace and Agricultural Implement Workers of America, 8000 East Jefferson Ave., Detroit, Mich. 48214.

United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada, 901 Massachusetts Ave. NW., Washington, D.C. 20001.

State Supervisor of Trade and Industrial Education or the local Director of Vocational Education in the State or city in which a person wishes to receive training.

SOME MAJOR INDUSTRIES AND THEIR OCCUPATIONS

AGRICULTURE

The United States is in the midst of an agricultural revolution that is having a tremendous impact on the employment outlook in agriculture.

In brief, fewer and fewer farmers are producing more and more of America's farm products. Employment on U.S. farms has declined from 9.9 million in 1950 to 4.9 million in 1967. Agricultural economists predict that by 1980, U.S. farms will employ only 3 million to 3½ million persons.

The reason is simply that each

farmer today can produce far more than his predecessors. A modern corn farmer, for instance, will use 6-row or 8-row field equipment, including tractors, costing a total of about \$20,000, trucks and field implements costing about \$15,000; a self-propelled combine harvester worth \$15,000, and grain drying equipment valued at about \$15,000. To make this high-capacity equipment profitable, he may need to grow 600 to 1,000 acres of corn. His father, using 2-row equipment, probably earned a

good living from 320 acres. His grandfather, using horsedrawn equipment, could work only about 120 acres.

There has been a vast reduction in the man-hours needed to produce most of the major farm commodities. It used to take 135 man-hours to produce 100 bushels of corn in 1910; today it takes 9. Man-hours needed to produce 100 bushels of wheat dropped from 106 to 11 in the same period. It took 31 hours to produce 100 pounds of turkey in 1910 but takes only 1.6 today.

OPPORTUNITIES ON FARMS

Since the demand for farm products is growing much more slowly than productivity, the number of opportunities in farming declining steadily.

The county that once had 1,000 320-acre farms now may have only 500 640-acre farms. Tomorrow, with ever-larger and faster machinery, there will be even fewer farms and farmers.

The increasing productivity of our farmers has been a boon to consumers and the nonfarm economy—but today farmers find themselves in an industry that requires ever-larger farms, more investment, and better management to stay in business.

Management is the key to success in modern farming. Today's farmer needs a much higher level of knowledge and skills than his predecessor. For example, the dairy farmer used to feed each cow an amount of grain based on the amount of milk she *had* produced the previous day or week. The modern dairyman feeds his cows on the basis of their *potential*—"pushing" potential high-performance cows to their limits, cutting back on expensive feed for cows that already have peaked out. Figuring the potential is a much more difficult technique than weighing milk.

Similar management problems face the modern farmer in most areas—which is why college training is becoming the rule rather than the exception for the young commercial farmer. It gives him the technical basis he needs to keep up with research and technology and to apply them intelligently on his own farm. Biology, engineering, soil science, and agronomy—not to mention economics and account-

ing—are part of the necessary kit of tools for a successful farmer today.

Capital requirements are another barrier the beginning farmer must overcome. The average commercial farm in 1967 had 550 acres, with a value of more than \$100,000 in land and buildings alone. Regionally, the value of commercial farms vary from an average of \$46,000 in Appalachia to nearly \$300,000 in the Pacific region.

For the person who has the training, the capital, and the management ability, the modern farm can offer much higher incomes than the old-style farm ever did.

About 180,000 farms in the United States sold \$4,000 worth of farm products or more during 1967. These large farms averaged \$23,754 in net income. Another 320,000 farms sold an average of \$20,000 to \$39,999 worth of farm products in 1967. These medium-sized farms averaged \$9,792 in net income.

Together, these two groups make up nearly 16 percent of U.S. farms and accounted for nearly 68 percent of U.S. farm sales in 1967. These two groups represent the expanding sector of U.S. agriculture.

Although an additional one-half million farms had gross sales of \$10,000 to \$19,999 in 1967, these farms averaged only \$6,266 in net income. Most of these farmers would need to expand their operations or supplement their incomes with off-farm work to equal the income they could get in some other type of employment.

Agriculture still offers challenging and rewarding careers, with

larger incomes and better living conditions than it used to—but it offers them to fewer and fewer people.

Many people, of course, prefer living in the country, and modern transportation and communications, public services, and household and farming appliances have eliminated most of the disadvantages that attended rural living a generation or two ago.

Although the number of opportunities in farming is shrinking, the number of jobs in farm-related industries is not. There are many industries that supply products and services to the farmer and which handle marketing activities for farm products. They have a continuing need for young people who have a farming background—plus training for their specialized functions.

Training Opportunities Available for Farming

A good initial background in farming is obtained by growing up on a farm. Necessary experience also may be gained by working as a closely supervised tenant or hired worker on a successful farm. College training in agriculture and in agricultural business management are of substantial value to the modern farmer.

Several types of vocational training are available under federally assisted programs of vocational education. Training is offered in the following ways:

1. High school courses in agriculture are taught by teachers who are agricultural college graduates.

2. Short courses for young farmers at schools of agriculture, including intensive training in farm planning, farm structures, construction, welding and related shop and repair work, as well as construction in crop production,

livestock feeding and management, record keeping, and other aspects of farming.

3. Adult farmer programs in evening classes (or day classes in off-seasons) providing intensive instruction in subjects such as land and soil management, crop and livestock production, new technology and equipment, and financial management.

The most significant general sources of information and guidance available to farmers are the services provided by the land-grant colleges and universities and the U. S. Department of Agriculture. These services include research, publications, teaching, and extension work. The county agricultural agent is often the best contact for the

young person seeking advice and assistance in farming. The Farmers Home Administration system of supervised credit is one example of credit facilities combined with a form of extension teaching. Organized groups, such as the Future Farmers of America and the 4-H Clubs, also furnish valuable training to young farm people.

OPPORTUNITIES ON SPECIFIC TYPES OF FARMS

Dairy Farms

Although the number of farms and farm jobs are decreasing, desirable and rewarding opportunities occur from time to time. The decision to enter farming may be made simply because an opening exists on the family farm or on a farm nearby. To be successful, a young man should appraise carefully the requirements in specific types of farm operations, and the prospects for success in them, taking into consideration his aptitude, interests, preferences, experience, knowledge, and skills in directing labor and handling livestock and machinery. He also must consider his family labor supply and his financial resources, as the labor and capital requirements for an operation of adequate size vary widely from one type of farm to another.

A realistic decision to go into farming can be made only in terms of a particular area or community. This section evaluates from an occupational standpoint some of the more common farm types. The accompanying table gives illustrative data on size of farm, labor and capital requirements, and net farm incomes received by operators of typical or representative farms in various parts of the country. Many farms are larger than these and offer more return than is shown here. Some are smaller and offer the operator little income or opportunity to improve his status without major changes. On most of the farms, the major part of the work is done by the farm operator and his family. Whereas, some of the smaller farms hire workers only during the peak labor season, large ones often use hired labor the whole year.

The figures in the table on capital invested mean that the operator controls or uses resources valued at that amount. Many farmers supplement their own capital with borrowed funds; others rent part or all of the land they use, thus allowing more of their funds for the purchase of livestock, feed, machinery, and equipment. Still others have partners who provide most of the working capital. For example, many farmers who raise broilers are in partnership with a feed dealer.

No brief general statement can be made about specialization versus diversification in farm operations that would apply in all parts of the country. The general trend is for more specialized farming. Farms that produced many products a generation ago now may produce only two or three. Efficient production of most farm products requires a substantial investment in specialized equipment. If the farm operator is to receive the full benefit from his investment, he must produce on a large scale. Two other factors contributing to specialization are the increased emphasis on quality of farm products, and the greater knowledge and skill required for effective production. Few farmers, however, find it advantageous to produce only one product. The main reasons for producing more than one product are the desirability of spreading price and production risks, the more effective use of labor (particularly family labor), and the fuller utilization of other resources than can be realized in a one-product system.

Dairy farms are located in most parts of the country. Despite modern methods of processing and transporting milk, production is still concentrated near the large population centers particularly in the Northeast and the Great Lakes States. However, many areas in the Far West and the South are becoming large producers of dairy products. Many of the newer type large dairy farms are "drylot" or barn operations with little or no pasture land. However, on typical dairy farms in the Lake States, and to a lesser extent in the Northeast, crops are important, often requiring operators to hire or exchange labor at harvest time. There is work every day throughout the year on dairy farms, so that effective use can be made of labor, and a regular force can be occupied most of the time.

Although most people do not like to be "tied down" 7 days a week, this obstacle presents no great hardship for the man who enjoys working with cattle. Dairying is also a good choice for the man who likes to work with mechanical equipment. Dairy farmers who produce much of their own feed find variety in the many different jobs that must be done.

The dairyman's sales and income are distributed evenly throughout the year. Moreover, the prices he receives are less subject to year-to-year fluctuations than are prices received by operators in most other types of farming. The accompanying table shows the average net farm income on dairy farms in the Central Northeast and Eastern Wisconsin from 1964 to 1966.

Compared with farmers in most other areas, dairy farmers in the more concentrated milksheds of the Northeast (such as the dairy farms in the Central Northeast shown in the table)

generally have larger herds, purchase a larger proportion of their feed, and buy rather than raise their herd replacements. In the most highly specialized producing area near Los Angeles, dairy farms are drylot operations. They are quite small in acreage but large in milk production and number of cows milked. No crops are produced; these dairy operators buy their entire feed requirements from outside the area. Most of the cows are bought at freshening time and are replaced when their lactation period is completed.

Net farm income represents the return to the farm operator and his family for their labor and the capital invested in the farm business—provided the operator owns his land and is free from debt. If he rents part or all of his farm, not all of net farm income is available for family living; part of it must be used for rent. Similarly, the farmer who is in debt must deduct interest costs and payments on the principal.

Livestock Farms and Ranches

A general livestock farm is a good choice for the farmer who is interested and skilled in working with livestock and mechanical equipment. Many farmers prefer general livestock farms—such as the hog-fattening or beef-raising farms, and hog-beef fattening farms in the Corn Belt—because much the year they require fewer chores than dairy farms. (See table.) The timing of daily hog and beef cattle chores also is more flexible than the milking schedule on dairy farms. Practically all of the regular labor on most general livestock farms is provided by the operator and his family. During some seasons of the year, there is full-time or part-time work for several mem-



Rancher shears sheep.

bers of the family, but there are usually slack labor periods when there is time for leisure or non-farm activities.

The livestock farmer's income is not as well distributed throughout the year as the dairyman's, and it is less likely to be uniform from year to year. Financial and management problems result, increasing the risks of operation. Moreover, on farms of limited acreages—often found in the Eastern States—the level of income from general livestock farming is usually lower than from a dairy herd on similar acreage.

Most hog producers have their own breeding stock and raise the pigs they fatten for market. Some farmers who fatten cattle and sheep also raise their calves and lambs. But most of the cattle and sheep fattened and marketed by the livestock farmer are bred and

raised originally by someone else—usually the livestock rancher of the West. The accompanying table includes data for five types of Western livestock operations: Northern Plains and Northern Rocky Mountain cattle ranches, sheep ranches in Utah and Nevada, and sheep and cattle ranches in the Southwest. In these areas of low rainfall, the main source of feed is range grass, and several acres are required to support one animal. Except where irrigation is available, feed crops usually are not grown. Some ranchers, particularly those in the Northern Plains, own only a small part of the land on which they graze their livestock. Most of the land on which they buy grazing rights is public. Large acreages are required to provide enough pasture for their stock; ranchers spend much of their time in the saddle, truck, or jeep managing their herds.

Poultry Farms

One-third of the farmers in the United States raise some poultry, but in 1964, fewer than 3 percent were classified as poultry farmers. Many poultry farms concentrate on egg production. Most of the larger and more specialized of these farms are in the Northeast and in California; others produce broilers. Many highly concentrated centers of broiler production are east of the Mississippi River, and a few are on the West Coast. Turkey producers also are specialized. A concentration of specialized producers of ducks is located in Suffolk County, Long Island, New York.

A few poultrymen produce some crops for sale and purchase special poultry feeds and laying mash. Crops are not grown by most specialized poultry produc-

Size of Farm, Labor Used, Capital Invested, and Net Farm Income on Commercial Farms, by Type, Size, and Location, 1964-66 Average

Type of farm and location	Size of farm in 1966 as measured by —	Total labor used (hours)	Capital invested in —					Net farm income ¹
			Land and buildings	Machinery and equipment	Livestock	Crops	Total	
Dairy farms:								
Central Northeast	34 milk cows	4,570	\$26,900	\$ 8,600	\$ 9,500	\$ 3,000	\$48,000	5,004
Eastern Wisconsin	33 milk cows	4,630	44,460	13,580	11,810	6,520	76,370	3,138
Egg-producing farms, New Jersey	5,300 layers	4,960	37,100	2,310	7,370	0	46,780	3,022
Broiler farms, Georgia	37,160 produced annually	1,660	14,220	4,180	700	160	19,260	1,383
Corn Belt farms:								
Hog-beef raising	168 acres of cropland	3,570	52,830	7,390	7,970	3,600	71,790	6,773
Hog-beef fattening	227 acres of cropland	4,140	94,550	11,460	17,600	12,880	136,490	13,089
Cash grain	289 acres of cropland	2,400	159,950	16,150	370	360	176,830	14,155
Cotton farms:								
Nonirrigated:								
Mississippi Delta	640 acres of cropland	22,750	269,330	45,940	7,500	1,830	324,600	34,554
High Plains, Texas	501 acres of cropland	3,620	82,600	11,000	680	310	94,590	8,554
Irrigated:								
High Plains, Texas	444 acres of cropland	5,220	134,950	18,080	740	430	154,200	15,913
Tobacco farms:								
North Carolina Coastal Plain	50 acres of cropland	5,100	37,380	4,660	520	560	43,120	5,962
Kentucky bluegrass:								
Tobacco-livestock, inner area	63 acres of cropland	4,250	100,130	5,570	7,550	2,300	115,550	8,232
Tobacco-dairy, outer area	44 acres of cropland	4,800	38,140	6,490	4,710	1,990	51,330	5,991
Penhroyal area, Kentucky-Tennessee:								
Tobacco-beef	242 acres of cropland	4,390	77,450	7,960	9,660	3,800	98,870	5,945
Tobacco-dairy	180 acres of cropland	5,030	56,530	7,620	6,260	2,770	73,180	6,496
Wheat farms:								
Wheat-fallow, Northern Plains	656 acres of cropland	2,780	55,150	10,490	4,370	1,650	71,660	9,993
Wheat, Southern Plains	616 acres of cropland	3,150	103,830	10,210	8,250	2,710	125,000	10,113
Wheat-fallow, Pacific Northwest	1,114 acres of cropland	3,850	156,600	20,530	4,690	1,200	183,020	16,711
Cattle ranches:								
Northern Plains	113 cows	4,560	57,160	7,930	25,170	3,560	93,820	7,064
Northern Rocky Mountain	303 cows	6,660	187,580	15,400	57,790	9,190	269,960	13,857
Southwest	148 cows	3,690	157,530	5,710	28,390	2,050	193,680	4,916
Sheep ranches:								
Utah-Nevada	2,420 sheep	11,300	124,420	11,810	61,440	2,050	199,720	13,869
Southwest	1,278 sheep	5,230	208,450	5,280	23,000	970	237,700	8,281

¹ The information presented here is on an owner-operated basis, primarily for comparability between types of farms. Net farm income is the return to operator and unpaid members of the family for their labor and management on the farm and return to total capital. No

allowances has been made for payment of rent, interest, or mortgage.

NOTE. Prepared in the Farm Production Economics Division, Economic Research Service, U.S. Department of Agriculture.

ers, particularly those who produce broilers or large laying flocks. Commercial poultry farmers in New Jersey, for example, buy all their feed. The typical broiler producer in Maine, the Delmarva (Delaware, Maryland, Virginia) peninsula, and Georgia devotes almost all of his capital and labor to the production of broilers.

Poultry farming requires specialized skill in handling birds, chiefly on the part of the operator. Bulk handling of feed and mechanical feeding is widespread and requires little physical strength. For these reasons, poultry farms can use available family help.

Data on average capital investment and net farm income for representative egg producers in New Jersey and broiler operators in Georgia from 1964 to 1966 are

given in the table. These averages do not reveal the sharp year-to-year fluctuations in income that occur. Because they have a high proportion of cash costs and a thin margin of profit, relatively small changes in prices of feed, broilers, and eggs can produce sizable fluctuations in net farm income.

The incomes of most broiler producers, however, are fairly stable because they produce "under contract." Contract production is more widespread in broiler production than in any other major type of farming. Under these arrangements, the financing agency (usually a feed dealer) furnishes the feed, chicks, and technical supervision—almost everything except the buildings, equipment, and direct production labor. The grower receives a stipulated amount per 1,000 birds marketed,

and often a bonus for superior efficiency. Many turkey producers operate under similar contracts, but these arrangements are not nearly so universal for the production of turkeys as for broilers.

Corn and Wheat Farms

For the man who likes working with crops and farm machinery, cash grain farming (growing soybeans, corn or wheat) has much to offer. Many people dislike being tied down with daily responsibilities the year around such as with livestock chores. They prefer, instead to work long days with large laborsaving equipment during the busy seasons, such as in soil preparation, planting, and harvesting, and then having some free time in slack periods.

The table shows the investment required and the recent income experience of some representative cash grain farms. Farms of this type include cash grain farms in the Corn Belt, spring wheat farms in the Northern Plains, winter wheat farms in the Southern Plains, and wheat-pea and wheat-fallow farms in the Pacific Northwest. Some of these farms—particularly in the Northern Plains—raise some beef cattle for sale as feeders, and a small number keep a few milk cows. However, this livestock production is usually of secondary importance. Many of these cash crop farmers do not raise any livestock.

Two of the main risks faced by the commercial wheat grower are unfavorable weather and low prices. However, crop insurance has reduced the risk of low yields, and Government price support programs have lessened the risk of low prices.

Cotton, Tobacco, and Peanut Farms

In terms of numbers of farmers, the production of cotton, tobacco, and peanuts makes up a large part of the agriculture in the Southeastern and South Central States. These products are grown on farms that range from very small operating units to comparatively large ones. Market competition in these crops has been keen, and many growers have been forced to diversify and enlarge their farms—adjustments which require capital investment. Competition from cotton growers in the irrigated areas of the West and Southwest have forced many farmers in the Southeast to discontinue cotton production. Some of them have diversified their operations, and others have found better opportunities in Southern Industrial expansion.



Farm worker harvests apricots.

Crop Specialty Farms

Many farmers throughout the country have unique background, skills, resources, or other advantages for particular kinds of farming chiefly because of their location, home training, or neighborhood practices. They may specialize in the production of a single crop—such as grapes, oranges, potatoes, sugarcane, or melons—or a combination of related specialty crops.

Operators of these enterprises usually employ many seasonal workers and require relatively expensive specialized equipment. They need specific skills, many of which can be obtained only through experience. Enterprises of this kind should be undertaken only by persons with considerable experience and some of the special skills and techniques required. An individual having an aptitude for these skills usually can earn them by working a few years as a hired hand on such a specialty farm or as a tenant for a landlord who can give direction and assistance.

Annual returns from these specialty farms usually vary greatly from year to year because of the vagaries of nature and the changes in prices. Operators of these farms who keep abreast of production and marketing conditions are usually well rewarded for their ability to manage, produce, and market their products.

Private Outdoor Recreation Farms

Public demand for outdoor recreation is far in excess of the existing and projected supply of public facilities. The public sector is not flexible enough to supply the specialized types of recreation or services demanded by smaller groups. The privately owned outdoor recreation enterprise, particularly the farm-base type, is in a unique position to supply these types of recreation services and activities to the public.

The 1964 Census of Agriculture reported over 3 million farms in the United States. Of this total, about 28,000 earned money from some type of recreation activity.

Many farm operators in the vicinity of national, State, and local parks, or near wildlife reservations have taken advantage of the location in establishing recreation businesses. The average amount received from this activity was about \$1,500 per farm reporting.

These farmers sell hunting or fishing rights to individuals, form hunting clubs, or establish private campgrounds. They absorb the overflow from public campgrounds or cater to the individuals who want more privacy in their camping. Vacation farms cater to family groups during the summer and allow hunting later in the year when children are in

school. Many farmers enlarge and improve their ponds or irrigation reservoirs. They stock ponds for fishing and have swimming areas in the summer and skating areas in the winter. Old farm buildings, sheds, and barns are converted into riding stables or horse boarding stables, or a combination of both. Shore and backwater areas are used to dock privately owned craft. In so doing, many farmers have converted a liability into an asset. Farmers become guides for hunters during the game season and mechanics and service

engineers for watercraft. Guides are also in demand for nature trails and scenic tours.

Other Specialties

Other highly specialized operations, such as fur farms, apiaries, greenhouses, nurseries, and flower farms, require special knowledge and skilled management. Special skills and equipment are required, and risks are high. Even with the high risk, from the standpoint of capital in-

vested and income, the venture is often rewarding to individuals who have the ability and the resources.

Sources of Additional Information

Additional information may be obtained from the U.S. Department of Agriculture, Washington, D.C. 20250; the Department of Commerce, Washington, D.C. 20230; and from State Land Grant Colleges and Universities.

OCCUPATIONS RELATED TO AGRICULTURE

Because of the increased scale and complexity of modern farming, farmers are buying a greater range and volume of production inputs and services from off-farm sources. Thus, larger numbers of people are needed in occupations related to agriculture. These occupations are many and diverse and offer a wide range of choice to the person who is interested in agriculture but does not have the opportunity, resources, or desire to enter agriculture directly. The salary range in occupations related to agriculture vary widely, depending on education, experience and type of job. Salaries of \$10,000 a year or more are not uncommon. The professional and technical vocations usually require college training; however, other vocations may be learned on the job. Some of these occupations are discussed below.

COOPERATIVE EXTENSION SERVICE WORKERS

(D.O.T. 096.128)

Nature of the Work

Extension Service workers are engaged in educational work in agriculture, home economics, youth activities, and community resource development. They are employed jointly by State land-grant universities and the U.S. Department of Agriculture. Extension workers must be proficient in both subject matter and teaching methods.

County Agricultural agents are interested in improving the efficiency of agricultural produc-

tion and marketing, including the development of new market outlets. County home economics agents work closely with women in home management, nutrition, and other phases of family living. There are 4-H extension agents who work with youth. In some counties, special agents concentrate on community resource development.

Extension workers help people analyze and solve their farm and home problems and aid in community improvement. Much of this educational work is carried on in groups, through meetings, tours, demonstrations, and local voluntary leaders. Individual assistance is given on problems that cannot be solved satisfactorily by group methods. Extension workers rely heavily on mass communication media such as newspapers, radio, and television.

The county extension staff is supported by State extension specialists in subject-matter fields such as agronomy, livestock, marketing, agricultural economics, home economics, horticulture, and entomology. Each of these specialists keeps abreast of the latest research in his particular field and works with agents in applying this information to local needs and problems.

Places of Employment

Extension agents are located in nearly every county in the United States. Counties having many farmers who produce a variety of crops may have as many as 10 agents or more, each specializing in a particular field such as dairying, poultry production, crop production, or livestock. There is

an increasing number of area agents who work on specialized problems in several counties.

Training and Other Qualifications

Extension agents must have a bachelor's degree in agriculture, home economics, sociology, or other training that equips them for the particular type of audiences with whom they work. In most States, the Extension Service maintains an in-service training program to keep agents informed of the latest developments in agricultural research, of new programs and policies that affect agriculture and of new teaching techniques. To be successful, extension workers must like to work with people.

In most instances, specialists on the State staff are expected to have a master's degree and special training in their particular lines of work.

Employment Outlook

Employment of Extension Service workers had grown to 15,000 in 1968. The demand for additional workers is expected to continue, especially in depressed rural areas. As agricultural technology becomes more complicated, and as farm people become more aware of the need for organized activity, more help will be sought from trained Extension Service personnel. The Extension Service also is being extended to new segments of the population, as residents recognize the value of their assistance, particularly in helping the disadvantaged.

Counterparts of the Cooperative Extension Service are being established in many countries, and Extension Service personnel often are recruited to help initiate and organize these programs.



County agricultural agent and farmer discuss methods for improving pasture.

U.S. Department of Agriculture, Washington, D.C. 20250. (Also see statement on Home Economists.)

SOIL SCIENTISTS

(D.O.T. 040.081)

Nature of the Work

Soil scientists study the physical, chemical, and biological characteristics and behavior of soils. They investigate the soils both in the field and the laboratory and grade them according to a national system of soil classification. From their research, scientists can classify soils in terms of response to management practices and capability for producing crops, grasses, and trees, as well as their utility as engineering materials. Soil scientists prepare maps, usually based on aerial photographs, on which they plot the individual kinds of soil and other landscape features significant to soil use and management in relation to land lines, field boundaries, roads, and other conspicuous features.

Soil scientists also conduct research to determine the physical and chemical properties of soils and their water relationships, in order to understand their behavior and origin. They predict the yields of cultivated crops, grasses, and trees, under alternative combinations of management practices.

Soil science offers opportunities for those who wish to specialize in soil classification and mapping, soil geography, soil chemistry, soil physics, soil microbiology, and soil management. Training and experience in soil science also will prepare persons for positions as

Earnings and Working Conditions

The salaries of extension agents vary from State to State and county to county. In 1968, starting salaries for new agents averaged about \$7,200.

Ordinarily, the assistant agent is promoted rapidly to a more responsible job, either in the county where he works or in another county in the State. In 1968, salaries for experienced agents av-

eraged about \$10,500. Extension specialists' salaries averaged about \$12,500.

Sources of Additional Information

Additional information may be obtained from County Extension Offices; State Director of the Cooperative Extension work located at each Land-Grant University; or the Federal Extension Service,



Soil scientist conducts test on barley roots with aid of ionization detector.

farm managers, land appraisers, and many other professional positions.

Places of Employment

Most soil scientists are employed by agencies of the Federal Government, State experiment stations, and colleges of agricul-

ture. However, many are employed in a wide range of other public and private institutions, including fertilizer companies, private research laboratories, insurance companies, banks and other lending agencies, real estate firms, land appraisal boards, State highway departments, State and city park departments, State conservation departments, and farm

management agencies. A few are independent consultants, and others work for consulting firms. An increasing number are employed in foreign countries as research leaders, consultants, and agricultural managers.

Training and Advancement

Training in a college or university of recognized standing is important in obtaining employment, as a soil scientist. For Federal employment, the minimum qualification for entrance is a B.S. degree with a major in Soil Science or in a closely related field of study, and having 30 semester hours of course work in the biological, physical, and earth sciences, including a minimum of 15 semester hours in soils. Those having graduate training—especially those with the doctor's degree—can be expected to advance rapidly into a responsible and high paying position. This is particularly true in soil research, including the more responsible positions in soil classification, and in teaching. Soil scientists who are qualified for work with both field and laboratory data have a special advantage.

Many colleges and universities offer fellowships and assistantships for graduate training or employ graduate students for part-time teaching or research.

Employment Outlook

The demand is increasing for soil scientists to help complete the scientific classification and evaluation of the soil resources in the United States. One of the major program objectives of the Soil Conservation Service of the U.S. Department of Agriculture is to complete the soil survey of all rural lands in the United States.

This program includes research, soil classification and correlation, interpretation of results for use by agriculturists and engineers, and training of other workers to use these results. Also, demand is increasing for both basic and applied research to increase the efficiency of soil use.

Earnings

The incomes of soil scientists depend upon their education, professional experience, and individual abilities. The entrance salary in the Federal service for graduates having a B.S. degree was \$5,732 since July 1968. They may expect advancement to \$6,981 after 1 year of satisfactory performance. Further promotion depends upon the individual's ability to do high-quality work and to accept responsibility. Earnings of well-qualified Federal soil scientists with several years' experience range from \$10,203 to \$16,946 per year.

Sources of Additional Information

Additional information may be obtained from the U.S. Civil Service Commission, Washington, D.C. 20415; Office of Personnel, U.S. Department of Agriculture, Washington, D.C. 20250; or any office of the Department's Soil Conservation Service.

Also see statements on Chemists and Biologists.

SOIL CONSERVATIONISTS

(D.O.T. 040.081)

Nature of the Work

Soil conservationists supply farmers, ranchers, and others with

technical assistance in planning, applying, and maintaining measures and structural improvements for soil and water conservation on individual holdings, groups of holdings, or on watersheds. Farmers and other land managers use this technical assistance in making adjustments in land use; protecting land against soil deterioration; rebuilding eroded and depleted soils; stabilizing runoff and sediment-producing areas; improving cover on crop, forest, pasture, range, and wildlife lands; conserving water for farm and ranch use and reducing damage from flood water and sediment; and in draining or irrigating farms or ranches.

The types of technical services provided by soil conservationists are as follows: Maps presenting inventories of soil, water, vegetation, and other details essential in conservation planning and ap-

plication; information on the proper land utilization and the treatment suitable for the planned use of each field or part of the farm or ranch, groups of farms or ranches, or entire watersheds; and estimates of the relative cost of, and expected returns from, various alternatives of land use and treatment.

After the landowner or operator decides upon a conservation program that provides for the land to be used within its capability and treated according to the planned use, the conservationist records the relevant facts as part of a plan which, together with the maps and other supplemental information, constitute a plan of action for conservation farming or ranching. The soil conservationist then gives the land manager technical guidance in applying and maintaining the conservation practices.



Soil conservationist inspects range to determine effect of vegetation in controlling erosion.

Where Employed

Most soil conservationists are employed by the Federal Government, mainly by the U.S. Department of Agriculture's Soil Conservation Service and the Bureau of Indian Affairs in the Department of the Interior. Some are employed by colleges and State and local governments; others work for banks and public utilities.

Training and Advancement

A Bachelor of Science degree and a major in soil conservation or a related agricultural science constitute the minimum requirement for professional soil conservationists. Those who have unusual aptitude in the various phases of the work have good chances of advancement to higher salaried technical administrative jobs.

Employment Outlook

Employment opportunities for well-trained soil conservationists were good in 1968. Opportunities in the profession will expand because government agencies, public utility companies, banks, and other organizations are becoming interested in conservation and are adding conservationists to their staffs. Other new openings will occur in college teaching, particularly at the undergraduate level. In addition, some openings will arise because of the normal turnover in personnel.

Earnings

Since July 1968, soil conservationists having a bachelor's degree and employed by the Federal Government received \$5,732 a

year. Advancement to \$6,981 could be expected after 1 year of satisfactory service. Further advancement depends upon the individual's ability to accept greater responsibility. Earnings of well-qualified Federal soil conservationists with several years' experience range from \$10,203 to \$16,946 a year.

Sources of Additional Information

Additional information on employment as a soil conservationist may be obtained from the U.S. Civil Service Commission, Washington, D.C. 20415; Employment Division, Office of Personnel, U.S. Department of Agriculture, Washington, D.C. 20250; or any office of the Department's Soil Conservation Service.

OTHER PROFESSIONAL WORKERS

Nature of the Work

The discussion that follows deals primarily with job categories that are generally termed professional fields. These occupations generally require at least a bachelor's degree, and master's and Ph. D. degrees are becoming increasingly valuable both from the standpoint of salary and of executing the functions required on the job. Some of these jobs are discussed more fully elsewhere in the *Handbook*. (See index.)

Agricultural economists deal with problems related to production, financing, pricing, and marketing of farm products both in the United States and in several foreign countries. They are factfinders, evaluators, analysts,

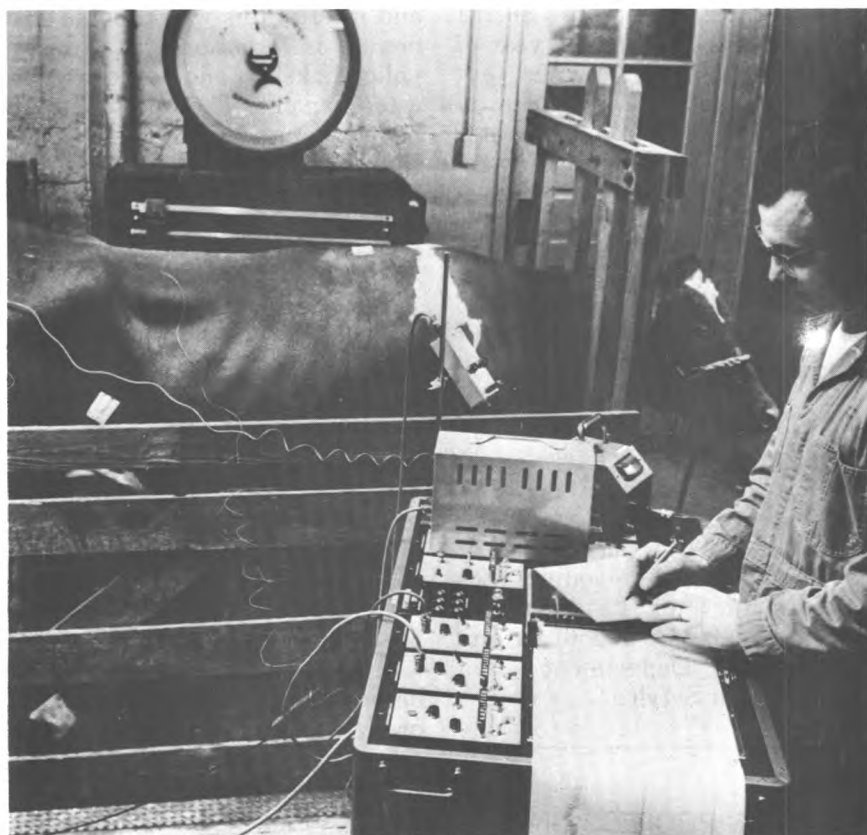
and interpreters who provide economic information to farmers, policymakers, and other interested persons. They provide cost-benefit analyses for evaluating farm programs at the National, State, and farm level. They study the effects of mechanization, technological advances, and other developments that influence the supply and demand for farm products and its accompanying effects on costs and prices of farm products.

Agricultural engineers develop new and improved farm machines and equipment, deal with the physical aspects of soil and water problems in farming; design and supervise installation of irrigation systems, watershed protection, flood prevention, and related works; devise new techniques for harvesting and processing farm products; and design more efficient farm buildings.

Agronomists are concerned with growing breeding, and improving field crops such as cereals and grains, legumes and grasses, tobacco, cotton, and others. They also do research in the fundamental principles of plant and soil sciences and study and develop seed propagation and plant adaption.

Animal physiologists and animal husbandmen study the environmental influences in relation to efficient management of farm animals; they also are concerned with the breeding, growth, nutrition, and physiology of livestock.

Veterinarians inspect livestock at public stockyards and points of entry into the U.S.; inspect establishments that produce veterinary biological supplies; administer tests for animal diseases; conduct programs for the control and eradication of animal disease; research livestock diseases and vaccines for disease control; work directly with farmers in protection or restoration of livestock



Animal physiologist conducts research on heat tolerance of cattle.

health; and provide services for the care of small animals and pets.

Geneticists try to develop strains, varieties, breeds, and hybrids of plants and animals that are better suited than those presently available to the production of food and fiber.

Microbiologists study bacteria and the relation of other micro-organisms to human, plant, and animal health and the function of these micro-organisms in the making of products such as vitamins, antibiotics, amino acids, sugars, and polymers.

Plant scientists study plant diseases and their nature, cause, and methods of control. They also study the structure of plants and the growth factors in plants. Methods of improving fruits, vegetables, flowers, and ornamentals, and means by which improve-

ments may be made by better management, environment, and propagation are also of concern.

Plant quarantine and plant pest control inspectors, who are trained in the biological sciences, supervise and perform professional and scientific work in enforcing plant quarantine and pest control laws. Plant Quarantine Inspectors inspect ships, planes, trucks, and autos coming into the country to keep out dangerous insect pests. Plant Pest Control Inspectors conduct programs to protect the crops of the country by prompt detection, control, and eradication of plant pests.

Entomologists study insects, both beneficial and harmful to farming. They particularly are concerned with identifying the populations and distributions of insects that injure growing crops

and animals, harm human beings, and damage agricultural commodities in shipping, storage, processing, and distribution and in finding means by which these insects may be controlled.

Foresters are concerned with the protection, production, processing, and distribution of our timber resources. They also study means by which wood may be seasoned, preserved, and given new properties.

Human nutritionists study the means by which the human body utilizes food substances.

Rural sociologists study the structure and functions of the social institutions (customs, practices, and laws) that are a part of and/or affect rural society.

School teachers in vocational agriculture and related fields supervise and give instructions in farm management, communications, mechanics, engineering, and related fields.

Farm managers supervise and coordinate the production, marketing, and purchasing activities of one farm or a group of farms.

Places of Employment

Persons trained in these specialties work in various capacities that relate to agriculture. Government agencies, colleges, agricultural experiment stations, and private businesses that deal with farmers hire many research workers. They also hire people to take technical and administrative responsibilities in public agencies involving farmers or programs affecting farmers. Agri-business and farmer cooperatives, private business, commercial, and financial companies that buy from, sell to, or serve farmers also employ many people. State, county, and municipalities hire many who serve as vocational agriculture teachers and workers in agricul-

tural communications, in farmers' organizations, or in trade associations whose members deal with farmers.

The number of research activities related to agriculture has increased very rapidly. The largest agencies in this field are the State experiment stations connected with the land-grant colleges and the various research branches of the U.S. Department of Agriculture. Other research organizations include some engaged in independent research, and some connected with companies that finance farming operations, market farm products, or produce chemicals, equipment, and other supplies or services for farmers. The U.S. Department of Agriculture employs workers in research positions in various parts of the country: in Washington, D.C., at the Agricultural Research Center at Beltsville, Md.; and at land-grant colleges. Other Government departments also have many agricultural research jobs.

Various independent research organizations, foundations, and private business groups in many parts of the country recently have initiated research related to agriculture. They tend to be located either in industrial centers or in areas of high agricultural activity, and include producers of feed, seed, fertilizer, farm equipment; and insecticides, herbicides, and other chemical dusts and sprays.

Public and private lending institutions, which make loans to farmers, employ men with broad training in agriculture and business. These workers ordinarily are required to have had practical farm experience, as well as academic training in agriculture, economics, and other subjects. Making financially sound loans involves careful analysis of the farm business and proper evaluation of farm real estate and other farm

property. These workers are employed by the cooperative Farm Credit Administration in its banks and in associations operating under its supervision throughout the country; by the Farmers Home Administration in its Washington and county offices; by rural banks; and by insurance companies that have substantial investments in farm mortgages.

The Federal and State Governments also employ various specialists in activities relating to agriculture. These specialists have technical and managerial responsibilities in activities such as programs relating to the production marketing, inspection, and grading of farm products; prevention of the spread of plant pests, animal parasites, and diseases; and management and control of wildlife.

Large numbers of professionally trained persons are employed by cooperatives and business firms that deal with farmers. Employment in these organizations may be expected to expand, as farmers rely increasingly on them to provide farm supplies, machinery, equipment, and services, and to market farm products. The size of the organization and the types of services it offers determine the number of its employees and the nature of their jobs. Large farm supply cooperatives and businesses, for example, may have separate divisions for feed, seed, fertilizer, petroleum, chemicals, farm machinery, public relations, and credit, each supervised by a department head. In smaller businesses and cooperatives, such as local grain-marketing elevators, the business is run almost entirely by the general manager who has only two or three helpers.

Agricultural communications is another expanding area of specialization. Crop reporters and

market news reporters are employed by the U.S. Department of Agriculture in field offices throughout the United States. Crop reporters gather information on crop production during all stages of the growing season. Market news reporters collect information on the movement of agricultural produce from the farm to the market. Radio and TV farm directors are employed by many radio and TV stations to report prices, sales, grades, and other agricultural information to farm people. Agricultural reporters and editors compile farm news and data for farm journals, bulletins, and broadcasts. Closely related to agricultural communications is employment in farmers' organizations or in-trade associations whose members deal with farmers.

The Nationwide, federally aided program of vocational education offers employment for persons technically trained in agriculture and related subjects. Teachers of vocational agriculture not only teach high school students interested in farming, but provide organized instruction to assist young farmers in becoming satisfactorily established in farming and in becoming community leaders. They also provide organized instruction for adult farmers, giving individual consultation on their farms to keep them abreast of modern farm technology.

The qualifications of workers in all of these fields ordinarily include a college education and special training in a particular line of work. In most of these fields, the demand for workers exceeds the supply. In recent years, the demand has been increased because of the need to recruit professional personnel to staff agricultural missions and to give technical aid to agricultural institutions and farmers in other countries.

Sources of Additional Information

Opportunities in Research. Additional information on research opportunities at land-grant colleges may be obtained from the dean of agriculture at the State land-grant college. Information on employment in the U.S. Department of Agriculture is available from the USDA recruitment representatives at land-grant colleges and from the Office of Personnel, U.S. Department of Agriculture, Washington, D.C. 20250.

The following publications will be valuable:

"Profiles-Careers in the U.S. Department of Agriculture," U.S. Department of Agriculture, October 1968. Superintendent of Documents, Washington, D.C. 20402. Price \$2.

"Rewarding Careers in the Dynamic Industry — Agriculture," American Association of Land-Grant Colleges and State Universities, Washington, D.C., 1966. Copies can be obtained free from your State Agricultural College.

"Scientific Careers in the Agricultural Research Service," U.S. Department of Agriculture, 1967. Superintendent of Documents, Washington, D.C. 20402. Price 35¢.

Opportunities in Agricultural Finance. Inquiries on employment opportunities in agricultural finance may be directed to the following:

Farm Credit Administration, Washington, D.C. 20578.

Farm Credit District—Springfield, Mass.; Baltimore, Md.; Columbia, S.C.; Louisville, Ky.; New Orleans, La.; St. Louis, Mo.; St. Paul, Minn.; Omaha, Nebr.; Wichita, Kans.; Houston, Tex.; Berkeley, Calif.; Spokane, Wash.

Farmers Home Administration, U.S. Department of Agriculture, Washington, D.C. 20250.

Agricultural Director, American Bankers Association, 90 Park Ave., New York, N.Y. 10016.

Opportunities With Cooperatives. Farmer cooperatives are located in every State. Information relating to job opportunities in farmer cooperatives may be obtained from local or regional cooperatives. If no jobs are available with these cooperatives, they may be able to make referrals to others which have openings. Other sources of information are the county agent and the Agricultural Economics Department of State Agricultural Colleges. General information may be obtained from the American Institute of Cooperation or the National Council of Farmer Cooperatives, both located at 1200 17th St. NW., Washington, D.C. 20036, and the Cooperative League of the U.S.A., 59 East Van Buren St., Chicago, Ill. 60605.

In cow testing and artificial breeding, an association of farmers employs one worker or more on a monthly basis to conduct the operations. Supervisors who do cow testing are employed by dairy herd improvement associations. They must have a high school education, and a farm background is almost essential. Artificial breeding associations employ inseminators who must have at least a high school education. Agricultural college training is desirable but not essential for employment in these occupations. Brief periods of approximately a month of specialized training are available through the associations.

Other services for farmers are more seasonal. These include the following: Fruit spraying (2-3 months), airplane dusting (4-6 months), grain combining (2 months) hay and straw baling (2-8 months), tractor plowing and cultivating (4-6 months), and sheep shearing (2-3 months).

These and many other services often are done by farmers who en-

gage in custom work as a sideline to keep their equipment busy. In areas where the growing season is long, however, the period when these services can be carried on is long enough to permit individuals to specialize in them.

Closely associated but somewhat more remote from farm operation are such activities as repairing and servicing farm machinery; feed grinding and mixing; maintaining storages and warehouses of agricultural products; operating nurseries and greenhouses; and packing, grading, and processing farm products.

Although these activities are sometimes performed on the farm, the current trend is to conduct them as specialized lines of business away from the farm. An agricultural background is helpful to people who enter these lines of work. The agricultural aspects, however, can be learned more readily than the required specialized skills.

Opportunities for Agricultural Economists. For additional information about opportunities in agricultural economics, check with the Department of Agricultural Economics at State land-grant colleges. For information on Federal employment opportunities, applicants may get in touch with USDA recruitment representatives at the State land-grant college or write directly to the Office of Personnel, U.S. Department of Agriculture, Washington, D.C. 20250.

Opportunities as Vocational Agriculture Teachers. As salaries, travel, and programs of vocational agriculture teachers vary slightly among States, prospective teachers should consult the Head Teacher Trainer in Agriculture Education at the land-grant college or the State Supervisor of Agricultural Education at the

State Department of Public Instruction in their respective States.

FARM SERVICE JOBS

In almost every type of agriculture, farmers require special-

ized services which readily can be earned and performed by other workers. A person can enter many of these services, either as an independent operator or as an employee. Some services require an extensive outlay of capital, and others require very little. Some are highly seasonal; others are

performed year round. These services and the operation of a small farm can sometimes be combined.

Services that provide year-round employment include the following: Cow testing, artificial breeding, livestock trucking, whitewashing, well drilling, fencing, and tilling.

MINING

The mining industry is a major supplier of the basic raw materials and energy sources required for industrial and consumer use. Metal mines provide iron, copper, gold, and other ores. Quarrying and other non metallic mining produce many of the basic materials such as limestone, gravel, and fire clay needed to build the country's schools, offices, homes, and highways. Petroleum, natural gas, and coal are the primary sources of nearly all our energy, both for industrial and personal use. Few of the products that are extracted from mines reach the consumer in their natural state. Nearly all require further processing in one or several of the manufacturing industries.

Mining is the smallest major industry division, employing 610,000 wage and salary workers in 1968. Nearly one-half of these workers are employed in the exploration and extraction of crude petroleum and natural gas. Coal mining, and quarrying and non-metallic mineral mining each account for about one-fifth of the industry's work force; the remaining workers, about 1 out of 7, are employed in mining metal ores.

The mining industry employs only a small number of women workers; most are in clerical positions. Seventy percent of all workers in mining are employed in blue-collar jobs, primarily as operatives and kindred workers. Included in the operative group are miners and mine laborers; mining machinery operators such as drilling and cutting machine operators, crusher operators, conveyor operators, and oil well drillers; and most other workers engaged in underground mining operations. Also included, and especially important in sur-

face mining, are truck and tractor drivers.

Skilled craftsmen and foremen account for the second largest occupational group. Mechanics and repairmen maintain the complex equipment and machinery used throughout the various mining industries. Many heavy equipment operators, such as excavating, grading, and power shovel operators, are employed in open pit mining operations. Large numbers of pumpers, gagers, and enginemen are needed in the extraction and transportation of petroleum and natural gas. Foremen, needed to supervise the mine work crews, also constitute an important part of the industry's work force.

The industry's white-collar workers are divided nearly equally among three major occupational groups—professional and technical, clerical, and managerial. Taken together, these three groups account for the remaining three-tenths of overall industry employment. Professional, technical, and kindred workers are concentrated largely in the crude petroleum and natural gas extraction industry. Most are employed in occupations such as engineer, geologist, and technician, and are engaged in the exploration and research activities that are so important to the discovery of oil and gas fields and new uses of petroleum products. Two out of three clerical employees work in the petroleum and gas extraction industry. Most are secretaries, office machine operators, and typists needed to support professional, technical, and managerial workers. The following tabulation shows the estimated distribution of occupational employment in the mining industry:

Major occupational group	Estimated employment, 1968 (percent distribution)
All occupational groups	100
Professional, technical, and kindred workers	10
Managers, officials, and proprietors	8
Clerical and kindred workers	9
Sales workers	1
Craftsmen, foremen, and kindred workers	26
Operatives and kindred workers ¹	44
Service workers	1
Laborers	

¹ Includes mine laborers.

NOTE.—Because of rounding, sums of individual items may not equal total.

Employment in the mining industry is expected to decline moderately through the 1970's, despite an anticipated substantial increase in mining output. The increased demand for mining products will be met largely through the use of more and improved equipment that will be operated by a more highly skilled work force. Even though employment in the industry as a whole is expected to decline, different growth patterns are likely within the industry. For example, employment in coal mining has declined steadily throughout the 1950's and 1960's, and further decreases are expected during the 1970's, although at a slower pace than in the past. Employment in petroleum and natural gas extraction also is expected to decline through the 1970's. On the other hand, employment in quarrying and nonmetallic mining has been growing and is expected to continue to rise over the 1970's. Population growth, rising incomes, and business activity, together with the increasing need for construction materials are likely to bring about a growing demand for manpower in quarrying and nonmetallic mining.

Employment in metal mining is expected to increase slightly through the 1970's, reversing a downward trend.

The statement that follows provides information on employment opportunities in the petroleum and natural gas extraction industry. More detailed information about occupations that are found in mining as well as other industries appears elsewhere in the *Handbook*. (See index in back of book.)

PETROLEUM AND NATURAL GAS PRODUCTION AND PROCESSING

Nature and Location of the Industry

Petroleum is one of the fossil fuels, having been formed from the decay of once living matter. It is extracted mainly in the form of crude oil and natural gas.

Thousands of companies are in the petroleum business, most of them specializing in a single activity, such as exploring for gas or oil, drilling wells, operating wells, transporting petroleum in crude form or as finished products, processing gas, and refining crude oil. Others operate gasoline service stations or supply natural gas for heating and cooking. Much of the petroleum business, however, is done by a small number of large firms that are involved in many of the industry's activities—from exploring for oil and gas to selling finished petroleum products. These firms provide a large share of the industry's jobs.

This chapter deals with the activities and jobs involved in (1) finding oil and gas and bringing

it to the surface of the earth, and (2) converting natural gas to useable products. It excludes petroleum refining, and the transporting and marketing of petroleum products. Occupations in petroleum refining are discussed in a separate chapter in the *Handbook*.

Petroleum Production. Because the processes involved in finding and extracting crude oil and natural gas are the same, the jobs and activities involved are similar up to the point where the gas or oil well starts producing. In this chapter, references to "petroleum production" also cover the discovery and extraction of natural gas. Petroleum production includes three broad fields of work; exploration, drilling and oilfield servicing, and well operation and maintenance. Firms that specialize in performing one or more of these activities under contract to oil companies employ almost one-half of all the workers in petroleum production. Major oil companies also engage in all of these production activities.

Since oil is difficult to find—only rarely are there any signs on the earth's surface of its presence underground—an important part of petroleum production activity involves using scientific methods to search for oil. After scientific tests are made which indicate the possible presence of oil beneath the surface of the earth, a site is selected and the drilling process begins.

Before a well can be drilled, a towerlike steel drilling rig is installed to support the tools and pipes that must be lowered into the well. Most rigs used today are portable ones brought to the drilling site, but some rigs are built at the site. Although a few large firms do some of their own drilling, over 90 percent of this work is performed by specialized drilling contractors.

A number of other services are performed in connection with oil-field drilling. These include building access roads, hauling supplies, cementing wells, cleaning and treating wells, and other special operations. Much of this work is handled by contractors.

When oil is reached and the well is completed, the job of the drilling crew is finished and that of the well-operating crew begins. About half of all petroleum production workers operate or maintain approximately 685,000 oil and gas producing wells in the United States. These wells are operated by thousands of companies which range in size from large firms with wells all over the world to small firms with only a single well. After oil or gas is brought out of the ground, it is transported to refineries or processing plants by pipelines, ships, barges and trucks.

Because natural gas, as it flows from the ground, is difficult to transmit through pipelines for long distances due to the various liquid compounds dissolved in it, natural gas processing plants, which remove these liquids, usually are located at or near gas fields. The natural gas liquid compounds—propane, butane, ethane, and natural gasoline—have important uses; for example, as raw materials for the chemical industry and oil refineries, and as a fuel for rural areas. In addition, natural gas may be compressed for delivery to pipeline transportation companies, or for use by oil well operators to force oil out of the ground.

In 1968 about 280,000 wage and salary workers were employed in the United States in petroleum production, including the production and processing of natural gas. Although drilling for oil and gas is done in about three-fourths of the States, nearly 90 percent of the workers are em-

ployed in 10 States. Texas is the leading State in the number of oilfield jobs, followed by Louisiana, Oklahoma, California, Kansas, Illinois, New Mexico, Wyoming, Mississippi, and Colorado. About 7,000 additional American workers are employed in foreign countries by United States oil companies, particularly in the Middle East, Africa, Western Europe, and South America.

Occupations in the Industry

Workers in the petroleum production branch of the oil industry explore for crude oil and natural gas, drill wells, and operate and maintain them. These activities require workers having a wide range of education and skills. (In this section, references to oil include natural gas.)

Exploration. Exploring for oil is the first step in petroleum production. Small crews of specialized workers travel to remote areas to search for geological formations likely to contain oil. Exploration parties, led by a *petroleum geologist* (D.O.T. 024.081), study the surface and subsurface composition of the earth. Geologists seek clues to the possibility of oil traps by examining types of rock formations on and under the earth's surface. Besides making detailed, foot-by-foot surveys, petroleum geologists depend on aerial exploration for a broad picture of the surface and subsurface features of the area being explored. They also may obtain rock samples from the bottom of the sea in their search for clues to oil-bearing formations. Geologists can determine the age of rocks by measuring their radioactivity. Sub-surface evidence is collected by making test drills and bringing up core samples of the rocks, clay, and sands that form the layers of the earth.



Geologists and petroleum engineers inspect core sample.

From these examinations, geologists can draw a cross-section map of the underground formations being surveyed to pinpoint areas where oil may be located.

Many geologists work in district offices of oil companies or exploration firms where they prepare and study geological maps. They also study core samples collected by exploration parties to find any clue to the presence of oil.

Exploration parties may include, in addition to the geologist, *paleontologists* (D.O.T. 024.081), who study fossil remains in the earth to locate oil-bearing sands; and *chemists* (D.O.T. 022.081) and *mineralogists* (D.O.T. 024.081), who study physical and chemical properties of minerals and rock samples. *Planetable operators* (D.O.T. 018.188), *draftsmen* (D.O.T. 010.281), and *rod-*

men (D.O.T. 018.587) assist in surveying and mapping operations.

Another way of searching for oil is through the science of geophysics—the study of the inner characteristics of the earth's structure. More than 95 percent of geophysical exploration is done by seismic prospecting. The seismograph is a sensitive instrument which records natural and man-made earthquakes. Manmade earthquakes in petroleum exploration are commonly made by exploding small charges of dynamite in the ground. The time it takes for sound waves to reach an underground rock layer and return indicates the depth of the layer. The seismograph records such as formation by wavy lines on a chart. Increasingly, this information is recorded on magnetic tape which is then placed in a computer and analyzed automatically. By setting off explosions at a number of points, underground formations can be mapped with considerable accuracy, thus providing a clue to the whereabouts of traps which may contain oil.

A seismograph crew generally includes 10 persons, led by a party chief who is usually a *geophysicist* (D.O.T. 024.081). Other members of the seismograph crew may include *computers* (D.O.T. 010.168), who prepare maps from the information recorded by the seismograph; *observers* (D.O.T. 010.168), who operate and maintain seismic equipment; *prospecting drillers* (D.O.T. 930.782) and their *helpers* (D.O.T. 930.886), who operate portable drilling rigs to make holes into which explosive charges are placed; and *shooters* (D.O.T. 931.381), who are in charge of placing and detonating explosive charges.

Once the oil company has decided where to drill, it must obtain permission to use the land.



Roughnecks prepare to change drilling bit.

The *landman* or *leaseman* (D.O.T. 191.118) makes the necessary business arrangements with owners of land in which his company is interested.

Another important job in oil exploration is that of the *scout* (D.O.T. 010.168). He keeps his company informed of all exploring, leasing, drilling, and production activity in his area.

Drilling. Despite all the petroleum exploration methods that have been developed, there is no device that actually will locate petroleum. Only by drilling can the presence of oil be proved. Overall planning and supervision of drilling are usually the responsibilities of the *petroleum engineer* (D.O.T. 010.081). He helps to prepare drilling sites and to select the methods of drilling. He directs workers in installing the drilling rig and machinery. He advises drilling personnel on technical

matters and may stay on the site until drilling operations are completed.

There are two methods of drilling a well—rotary drilling and cable-tool drilling. No matter which method is used, all wells are started in the same way. *Rig builders* (D.O.T. 869.884) and a crew of *helpers* (D.O.T. 869.887) install a drilling rig, the main purpose of which is to support the machinery and equipment which raise and lower the drilling tools.

The rotary method is used for drilling deep wells through rock and clay formations.

In rotary drilling, a revolving steel drill bit, with cutting teeth at its lower end, bores a hole in the ground by chipping and cutting rock. The bit is attached to a string of jointed pipe (drill stem), which is rotated by a steam, diesel, or gasoline engine or an electric motor. As the bit cuts through the earth, the drill stem is lengthened by the addition of more pipe which is screwed on at the upper end. A stream of mud is continuously pumped through the hollow pipe. This mixture of clay and water cools the drill bit, plasters the walls of the hole to prevent cave-ins, and floats the cuttings to the surface.

A typical rotary drilling crew consists of a rotary driller and four or five helpers. From 15 to 20 workers, divided into three crews, generally are required to operate a rig 24 hours a day and 7 days a week. A *rotary driller* (D.O.T. 930.782) is in charge of the work of the crew during his tour of duty. His major duties include operating the drilling machinery which controls drilling speed and pressure. He also selects the proper drill bit and keeps a record of operations. He must be ready to meet any emergency, such as breakdown of equipment or problems caused by

unusual geological formations. A *derrickman* (D.O.T. 930.782), second in charge of the crew, works on a small platform high on the rig. When a drill bit becomes dull and has to be replaced, he catches the upper ends of the pipe sections and guides them over to a rack beside his platform. He may have several miles of drill pipe racked up before the worn bit is brought to the surface.

Other members of a typical rotary drilling crew include *rotary floormen* (D.O.T. 930.884), who guide the lower end of the pipe to and from the well opening and connect and disconnect pipe joints and drill bits. Helpers, called *roughnecks* (D.O.T. 930.884), assist floormen in their duties. A *fireman* (D.O.T. 951.885) (if steam is used) or *engineman* (D.O.T. 950.782) (if diesel or electric power is used) operates the engines which provide power for drilling and hoisting.

An important oilfield worker is the *tool pusher* (D.O.T. 930.130), who acts as foreman of one or more drilling rigs. He also is in charge of supplying rig builders and drilling crews with needed materials and equipment. *Roustabouts* (D.O.T. 869.884), or general oilfield laborers, or not considered part of drilling crews but are used to do odd jobs, such as cleaning derrick floors and pipes or constructing and maintaining roads in oilfields.

In cable-tool drilling, a hole is broken through rocks by continuously raising and dropping a heavy, sharpened bit attached to the end of a cable. Cable-tool drilling is used mainly to drill shallow wells in soft rock formation. Most of it is done in Kentucky, Ohio, West Virginia, Pennsylvania, and certain areas of Texas and Oklahoma. Cable-tool drilling, however, is becoming obsolete as deeper holes are drilled

each year in order to reach the new oil reserves.

A cable-tool drilling crew usually consists of a driller and a tool dresser. The *cable-tool driller* (D.O.T. 930.280) is in charge of all operations during his tour of duty and maintains a detailed record of drilling activity. He controls the force with which the drilling bit strikes the rocks at the bottom of the well. He also supervises and helps in setting up the machinery and derrick. The *cable-tool dresser* (D.O.T. 639.781), whose job is related to that of a blacksmith, assists the driller and maintains the equipment.

Well Operation and Maintenance. Production is ready to begin when oil is found and the producing equipment installed. Drill pipe and bit are pulled from the well and casing and tubing are lowered. The upper end of the tubing is fastened to a system of valves and controls, called a "Christmas tree." Pressure in the well forces crude oil to the surface, through the Christmas tree, and into storage tanks. If natural pressure is not great enough to force the oil to the surface, pumping or other methods are used to produce an artificial flow.

Petroleum engineers generally have charge of overall planning and supervision of the operation and maintenance of wells. One of their principal duties is to prevent waste by deciding which production method to use and how fast the oil should flow. Some companies hire assistants for the petroleum engineer. These engineering aides perform routine duties such as making elementary calculations, running tests, and keeping records.

The job of pumper is numerically the largest occupation in the oilfield. *Pumpers* (D.O.T. 914.782) and their *helpers* (D.O.T. 914.887) operate and maintain motors, pumps, and other equip-

ment used to force an artificial flow of oil from wells. Their chief duty is to regulate the flow of oil according to a schedule set up by the petroleum engineer. Generally, a pumper operates a group of wells. *Switchers* work in fields where oil flows under natural pressure and does not require pumping. They open and close valves to regulate the flow of oil from wells to tanks or into pipelines. *Gagers* (D.O.T. 914.381) keep track of the amount of oil flowing into tanks or pipelines. They measure and record the contents of storage tanks and take samples of the oil to check its quality. *Treaters* (D.O.T. 541.782) make tests of crude oil for water and sediment. They remove these impurities from oil by opening a drain at the base of the tank or by using special chemical or electrical equipment. In many fields, pumping, switching, gaging, and treating operations are performed by automatic controls. Installation of computer systems at a central site now enables an operator to control the flow of oil from a large number of wells into several pipelines.

Many workers are employed in maintenance operations in oilfields. Welders, carpenters, electricians, and machinists repair and install pumps, gages, pipes, and other oilfield equipment. Roustabouts perform various field and well-maintenance jobs which require little skill but often involve heavy, hazardous work.

Natural Gas Processing. Operators have duties very similar to those of the oil refinery workers. The *dehydration-plant operator* (D.O.T. 541.782) tends an automatically controlled treating unit which removes water and other impurities from natural gas. The *gasoline-plant operator, or gasoline-plant engineer* (D.O.T. 950.782), operates equipment which

removes natural gasoline and sulfur from natural gas. The *compressor-station operator, or compressor-station engineer* (D.O.T. 914.132), operates a compressor which raises the pressure of the gas for transmission in the pipelines. The *gas-compressor operator* (D.O.T. 950.782), assists either of the last two employees named above.

As in oil refineries, many workers in the larger natural gas processing plants are employed in maintenance activities. However, the equipment in such plants is subject to less corrosion and wear than that in oil refineries, and it is generally more automated. As a result, the instrument repairman and the electrician are two key workers needed to maintain the instruments that control the automatic equipment. The welder and his helper also do much maintenance work in the processing plant. Other workers, whose jobs include maintenance functions, are engine repairmen and laborer.

Clerical, administrative, professional, and technical workers are a smaller proportion of employment in the larger gas processing plants than in oil refineries.

In the numerous smaller natural gas processing plants, many workers have multiple skills—usually combining the skills of operator and maintenance man. In addition, there are many very small plants which are so highly automated that they are virtually unattended. Either they are checked by maintenance workers or operators at periodic intervals, or they are monitored continuously by instruments which automatically report malfunctions and shut down the plant if an emergency develops.

Other Oilfield Services. Companies which offer oilfield services (other than exploration and drilling) on a contract basis provide

another important source of employment. Employees in these companies perform many services, including cementing and cleaning wells, and building foundations at well locations. Among these employees are skilled workers such as *cementers* (D.O.T. 930.281), who mix and pump cement into the space between steel casings and side walls of the well to prevent cave-ins; *acidizers* (D.O.T. 930.782), who force acid into the bottom of the well to increase the flow of oil; *perforator operators* (D.O.T. 931.782), who pierce holes in drill pipes or casings by using sub-surface "guns" to make passages through which oil can flow; *sample-taker operators* (D.O.T. 931.781), who obtain samples of soil and rock formations from wells to help geologists determine the presence of oil; and *well puller* (D.O.T. 930.883), who remove pipes and casings from wells for cleaning and repairing or for salvaging.

Offshore Operations. Most exploration, drilling, and producing activities are done on land, but an increasing amount of this work is done offshore, particularly in the Gulf of Mexico off the coasts of Louisiana and Texas. Some additional offshore work is being done in the Pacific Ocean off California, Oregon, Washington, and Alaska. Some wells have been drilled more than 100 miles from shore and in water more than 1,000 feet deep. These offshore operations require the same types of drilling crews as are employed on land operations. In addition, offshore operations require employment of radio men, able-bodied seamen, cooks, mess boys, and pilots for work on drilling platforms, crewboats, barges, and helicopters.

(Detailed discussions of professional, technical, mechanical, and

other occupations found not only in the petroleum and natural gas production industry, but in other industries as well, are given elsewhere in the *Handbook*, in the sections covering the individual occupations. See index for page numbers.)

Training, Other Qualifications, and Advancement

Exploration. Most workers in nonprofessional jobs with an exploration crew begin as helpers and advance into one of the specialized jobs after gaining experience. Their period of training on the job may vary from several months to several years. New workers usually are hired in the field by the party chief or by local company representatives. For many nonprofessional jobs, companies hire young men who have a high school or vocational school education, including training or aptitude in mathematics, drafting, and mechanics. College students majoring in physical or earth sciences or in engineering often are hired for part-time or summer work with an exploration crew. This may be a means of working into a full-time job after graduation.

For entry into professional occupations, such as geologist, geophysicist, chemist, or engineer, college training with at least a bachelor's degree is required. Professional workers usually start at junior levels and after several years of experience in field surveys, are eligible for promotion to the job of party chief. After much field survey experience they may get a position of responsibility in an area or division office and then perhaps in the central office. Scientists and engineers having research ability, preferably those with advanced graduate degrees,

may transfer to research or consulting work.

Drilling. Members of drilling crews usually begin work in the industry as roughnecks. As they acquire experience, they may advance to more skilled jobs. In rotary drilling, for example, a worker may be hired as a roughneck, advance to the job of floorman, and eventually to derrickman. After several years, he may become a driller. He then may be promoted to the job of tool-pusher, in charge of one or more drilling crews. Some drilling companies hire high school and college students for jobs during the summer months.

Drilling requires men capable of performing heavy physical labor. Drilling crew members usually are between the ages of 20 and 40. Some companies, however, report that their best drillers are over 50 and even in their sixties, for the job of driller requires good judgment combined with practical experience.

Well Operation and Maintenance. Companies generally hire persons who live near operating wells for well operation and maintenance jobs. They prefer men who have mechanical ability and a knowledge of oilfield processes. Because this type of work is less strenuous and offers the advantage of a fixed locale, members of drilling crews or exploration parties who prefer not to travel often transfer to well operation and maintenance jobs.

New workers may start as roustabouts and advance to jobs as switchers, gagers, or pumper helpers, and later to pumpers. Training usually is acquired on the job; at least 2 years of experience are needed to become a good all-round pumper.

The preferred educational qualification for a petroleum engineer is a college degree with specialization in courses on the

petroleum industry. However, college graduates having degrees in chemical, mining, or mechanical engineering, or in geology or other related sciences, sometimes are hired for petroleum engineering jobs. Petroleum engineering aids frequently are former roustabouts or pumpers who are given several months of specialized on-the-job and classroom training.

Information on occupational training, qualifications, and advancement in natural gas processing plants is similar to that for occupations in petroleum refining, discussed on page 687.

Employment Outlook

Employment in petroleum and natural gas production during the 1970's is expected to continue the slow decline which began during the late 1950's, despite anticipated increases in oil and gas production. The use of data-processing equipment and improved seismic techniques is expected to reduce the number of crews needed in petroleum exploration. The employment level in oil and gas field production also should decline because of the increasing use of automatic equipment to control production activities.

About 2,700 new workers in crude petroleum production operations will be hired each year during the next decade. These job openings will result primarily from the need to replace workers who retire, die, or transfer to other fields of work. Although some untrained workers will be hired for less skilled jobs, the greatest demand will be for workers having electrical and mechanical training and/or experience. These skills are becoming more necessary to maintain and repair the increasingly complex equipment used in oil and gas field production.

Most of the job opportunities created by replacement needs will be in the 10 States which together account for 90 percent of oilfield jobs—Texas, Louisiana, Oklahoma, California, Kansas, Illinois, New Mexico, Wyoming, Colorado, Mississippi. And in addition, a substantial number of job opportunities should occur as new oilfields are opened in Alaska.

Offshore activities have accounted for only a small portion of total production employment. However, offshore drilling activities are expected to continue to increase during the 1970's particularly off the coasts of Texas, Louisiana, California, and Alaska; and offshore drilling activities may be extended to Washington, Oregon, Florida and to the Atlantic seaboard.

Earnings and Working Conditions

In 1968, earnings of non-supervisory employees in oil and gas extraction averaged \$137.71 a week, or \$3.21 an hour for a 42.9 work-week. This compares with average earnings of \$122.51 weekly or \$3.01 an hour for all production workers in manufacturing establishments.

The work schedule for most oilfield workers is 40 hours a week. Drilling operations are performed 24 hours a day, with a complete crew for each 8 hour shift. Generally, workers in these crews receive 15 cents more an hour for work on the second shift and 30 cents an hour more for the third shift. Most establishments provide 8 paid holidays annually. Paid vacations are granted according to length of service—generally 2 weeks after 1 year of service, 3 weeks after 5 years, and 4 weeks after 10 years.

The majority of oilfield employees do most of their work outdoors and are exposed to all kinds of weather. Although some fields may be near cities, they are more often far from sizeable communities and are sometimes located in swamps or deserts. Drilling employees may expect to move from place to place since their work in a particular field may be completed in less than a year. Exploration personnel move even more frequently. They may be away from home for weeks or months at a time, living in a trailer or tent. Workers in well operation and maintenance often remain in the same location for long periods.

Most workers in natural gas processing plants and oil refineries have similar working conditions. Only a moderate amount of physical effort is involved. Some workers are required to open and close valves, to climb stairs and ladders to considerable heights, and to work 1 of 3 shifts. The plants are relatively safe places in which to work.

Some workers in particular natural gas processing plants have unusual working conditions. They are responsible for maintaining several small, unattended automated plants in widely separated, isolated locations. They make periodic trips, of 1-day duration or more, to check these automated plants. They travel over rough, unpaved terrain and are exposed to all kinds of weather. These maintenance jobs may be very satisfying to those who like working outdoors and alone.

In offshore operations, earnings usually are higher than those in land operations. Except for drilling activity that is close to shore, workers living quarters are on platforms held fast to the ocean bottom or on ships anchored nearby.

Sources of Additional Information

Further information concerning jobs, processes, and working

conditions in the petroleum industry can be obtained from the public relations department of individual petroleum companies and from:

American Petroleum Institute,
1271 Avenue of the Americas,
New York, N.Y. 10020.

Washington, D.C. 20036.
National Petroleum Refiners Association,
1725 DeSales St. NW.,

CONSTRUCTION

The activities of the construction industry touch nearly every aspect of our daily lives. The houses and apartments we live in; the factories, offices, and schools in which we work; and the roads we travel upon are examples of some of the products of this important industry. The industry encompasses not only new construction projects but also includes additions, alterations, and repairs to existing structures.

In 1968, about 3.3 million persons were employed in the construction industry. An additional 1.4 million workers are estimated to be either self-employed—mostly owners of small building firms—or are State and local government employees engaged in building and maintaining our Nation's vast highway system.

The contract construction industry is divided into three major segments. About half of the work force is employed by electrical, air conditioning, plumbing, and other special trade contractors. Almost one-third work in the general building sector where most residential, commercial, and industrial construction occurs. The remaining one-fifth, are engaged in building dams, bridges, roads, and similar heavy construction projects.

As illustrated in the accompanying tabulation, on p. — workers in all blue-collar occupations made up nearly four-fifths of the construction industry employment in 1968. Craftsmen and foremen alone account for more than one-half of the total employment in this industry—a much higher proportion than that of any other major industry. Most of these skilled workers are em-

ployed as carpenters, painters, plumbers and pipefitters, construction machinery operators, and bricklayers, or in one of the other construction trades. Laborers are the next largest occupational group and account for 1 out of 6 workers. They provide material, scaffolding, and general assistance to the craftsmen at the worksite. Semiskilled workers (operatives and kindred workers), such as truck drivers, welders and apprentices, represent about one-tenth of the industry's total work force. Managers, officials, and proprietors—mostly self-employed—also account for about the same share of employment. Professional and technical workers make up slightly less than 5 percent of the work force employed in construction. Engineers, together with engineering technicians, draftsmen, and surveyors account for most of the employment in this occupational group. Clerical workers, largely women working as stenographers, typists, and secretaries, and in general office work, constitute another 6 percent of the industry's employment.

Major occupational group	Estimated employment, 1968 (percent distribution)
All occupational groups	100
Professional, technical, and kindred workers	5
Managers, officials, and proprietors	12
Clerical and kindred workers ..	6
Sales workers	(1)
Craftsmen, foremen, and kindred workers	52
Operatives and kindred workers	10
Service workers	1
Laborers	16

¹Less than 0.5 percent.

Through the 1970's, employment requirements are expected to rise rapidly in the construction industry. As the national economy expands, as population increases, and as personal and corporate incomes rise, the demand for contract construction activities are expected to undergo a substantial increase. Likewise, the number of construction workers employed by State and local highway departments also is expected to increase because of the need to meet the demands of the country's expanding highway systems. Even though employment in the construction industry is likely to grow, the increasing application of the latest technology in tools, material, and work methods, together with the rising skill level of the work force, will make it possible to increase the level of construction activity without a correspondingly large increase in employment.

Contract construction is the major source of employment for skilled craftsmen such as bricklayers, painters, carpenters, and others who are discussed more fully elsewhere in the *Handbook*. For information on these and similar construction occupations, see the Building Trades chapter of the *Handbook*. For information on occupations which are found in many other industries, see the index in back of the book.

MANUFACTURING

Manufacturing is the activity around which our Nation's economy revolves. From factories flow the goods that have provided a standard of living unmatched elsewhere in the world. The products of the manufacturing industries range in complexity from a simple plastic toy to an intricate electronic computer, and in size from miniature electronic components to gigantic nuclear powered aircraft carriers. Many diverse processes are carried out in manufacturing. Workers refine ores and petroleum, process foods and chemicals, print books and newspapers, spin and weave textiles, fabricate clothing and footwear, and produce the thousands of products needed for our personal and national benefit. Our society, as we know it today, could not have reached its present level of prosperity without the goods provided by the manufacturing industries.

Nearly 20 million persons worked in manufacturing—the largest of the major industries—in 1968. Within manufacturing, durable goods industries accounted for three-fifths of all workers. The largest employers in the durable goods industries were the machinery, transportation equipment, and electrical equipment industries, and the primary metals and fabricated metal industries. Each of these industries accounted for at least 1 million workers and ranged from 1.3 million in primary metals to more than 2 million in transportation equipment. Producers of nondurable goods account for another two-fifths of total employment in manufacturing. The food processing industries had the largest single work force within this group—1.8 million workers—

more than one-fifth of all nondurable goods employment. Other large employers in the nondurable goods industries are the apparel, printing, chemicals, and textile industries. Employing fewer than 100,000 workers, tobacco manufacturers are the smallest industry in manufacturing.

In 1968, 55 million women were employed in manufacturing, and accounted for more than 1 out of every 5 women who worked. Large numbers are employed as secretaries, typists, office machine operators, and in many other office clerical occupations. In some industries, such as apparel, tobacco, electrical equipment, textiles, and instrument industries, women are increasingly being employed in production occupations. They account for a growing proportion of the work force. Thousands of women hold jobs as assemblers, sewers, bindery workers, checkers and sorters, inspectors, and other types of production workers. In heavy industries such as primary metals, transportation equipment, petroleum refining, and lumber and wood products, women are employed almost exclusively in white-collar occupations and consequently make up only a small part of the total work force.

As illustrated in the following table, blue-collar jobs made up over two-thirds of the employment in manufacturing in 1968. Operatives and kindred workers alone accounted for 44 percent of the work force. Most of these semiskilled workers were spinners and weavers (textile industry), sewing machine operators (apparel and leather industries), machine tool operators and welders (metalworking industries), fur-

nacemen and heaters (primary metals), or operators of the specialized processing equipment used in the food, chemical, paper, and petroleum industries.

Craftsmen, foremen, and kindred workers make up the next largest group of workers and account for nearly one-fifth of the employment in manufacturing in 1968. Many of these skilled workers install and maintain the wide assortment of machinery and equipment required in all manufacturing industries. Others are employed in skilled production occupations and are engaged directly in the manufacturing process. Machinists, for example, are especially important in the metalworking industries, as are skilled inspectors and assemblers. In the printing and publishing industries, compositors and typesetters, photoengravers and lithographers, and pressmen make up a large share of the work force. Bakers, millers, stillmen, tin-smiths, millwrights, and tool and diemakers are a few of the other important skilled occupations in manufacturing.

Clerical workers represented the third highest concentration of workers—approximately 1 out of every 8—and in manufacturing were the largest white-collar occupational group.

Professional, technical, and kindred workers accounted for 1 out of every 10 workers employed in manufacturing. Engineers, scientists, and technicians represent a large share of the professional workers employed in manufacturing. These highly trained workers are required not only to oversee and guide the production processes, but also to carry out the extensive research and development activities needed in the

aerospace, electronics, chemical, petroleum, and other industries. Other important professional occupations in manufacturing are editor and reporter, accountant, and personnel and labor relations worker.

Major occupation group	Estimated Employment, 1968 (percent distribution)
All occupational groups	100
Professional, technical, and kindred workers	10
Managers, officials, and proprietors	6
Clerical and kindred workers	12
Salesworkers	2
Craftsmen, foremen, and kindred workers	19
Operatives and kindred workers	44
Service workers	2
Laborers	5

NOTE.—Because of rounding, sums of individual items may not add to total.

Population growth, rising personal income, and expanding

business activity will stimulate a substantial increase in the demand for manufactured products through the 1970's. Employment in manufacturing, however, is expected to increase at a slower pace or about 11 percent between 1968 and 1980. The increasing application of modern technology to manufacturing processes, together with the rising skill level of the work force, will make possible substantial increases in production of goods without a corresponding increase in the work force. Although the average rate of employment growth will be slow, employment trends of individual industries within manufacturing will vary widely. Rubber and miscellaneous plastics products manufacturing employment may increase more than one-third and furniture and

fixtures employment may increase about 30 percent, far above the average increase. Several industries including: machinery stone, clay and glass; and apparel; and instruments are expected to about double the average employment growth rate for all manufacturing. On the other hand, some manufacturing industries expect employment to decline. Petroleum refining, ordnance, transportation equipment, lumber and wood products, tobacco, food, leather, and textiles all may decrease in employment during the 1970's.

The statements that follow provide information on employment opportunities in several of the manufacturing industries. More detailed information about occupations that are found in many industries appears elsewhere in the *Handbook*. (See index in the back of the book.)

OCCUPATIONS IN AIRCRAFT, MISSILE, AND SPACECRAFT MANUFACTURING

Known generally as the "aero-space" industry, the manufacture of aircraft, missiles, and spacecraft is among the largest and most rapidly changing industries in the country. Some 1.5 million persons were employed in the industry in 1968, many of whom were engaged in work concerned with developments such as supersonic flight and space exploration. These and other activities in research and development have made the industry somewhat different than most manufacturing industries. Sometimes, the manufacture of a particular item is only incidental to discovering new fields of knowledge. Because of these priorities, intensive effort has been required to develop the materials, products, and the concepts necessary for activities such as space travel. Continued efforts to improve and develop aerospace products and technology are expected to ensure the country's defense capability and further advances in space exploration.

Because this industry's products are complex and changing, scientists, engineers, and technicians represent a larger proportion of total employment than in most other manufacturing industries. These workers probably will account for an even higher proportion of the industry's work force through the 1970's. However, employment of certain skilled, semiskilled, and unskilled workers is expected to decline.

Nature and Location of the Industry

Aircraft, missiles, and spacecraft have the same main com-



Electronics technician performs systems test.

ponents: A frame to hold and support the rest of the vehicle, an engine to propel the vehicle, and a guidance and control system. A major difference among them is that missiles and spacecraft can reach into space and attain speeds many times that of sound, whereas aircraft fly in the earth's atmosphere and at slower speeds. Another difference is that aircraft are manned and missiles and some spacecraft are not.

Types of aircraft vary from small personal planes, costing not much more than an automobile, to multi-million-dollar giant transports and supersonic fighters. Aircraft plants also produce smaller planes for business and personal use, and helicopters. Approximately one-half to two-thirds of aircraft production in

dollar value is manufactured for military use; the rest is for commercial passenger and freight traffic, private business and pleasure use, and civilian flying instruction.

Missiles and spacecraft also vary greatly in the purposes for which they are made, and in their size and capabilities. Missiles are produced chiefly for military use and generally carry destructive warheads. Some can travel only a few miles and are intended for purposes such as the support of ground troops and defense against low flying aircraft. Others, such as the Atlas, Titan, and Minuteman, have intercontinental ranges of 7,000 miles or more. Some missiles are designed for launching from land or underground sites; others, for firing from aircraft, submarines, or ships.

Spacecraft are sent aloft carrying instruments which can measure and record conditions in space and transmit the data to receiving stations on earth. Manned spacecraft also include a cabin capsule for astronauts. The first American space vehicles had payloads (useful cargo) weighing only 20 to 30 pounds or less; the Saturn V launch vehicle is able to lift almost 150-ton payloads into near-earth orbit, or send 50 tons to the moon. Some space vehicles probe the space environment and then fall back to earth. Others are put into orbit and become artificial satellites around the earth, sun, or other celestial bodies. Nearly all of this country's missiles and spacecraft are built for the Air Force, Navy, Army, or the National Aeronautics and Space Administration (NASA).

Because the aerospace industry makes many kinds of finished products, it uses many kinds of engines, electronic systems, and other components. Aircraft engines may be reciprocating (piston), jet, or rocket. Missile engines may be jet or rocket. Space-



Precision assembler measures and recesses computer recording heads.

craft are always rocket powered because rockets are the most powerful type of engine and can operate in airless space, whereas other engine types need oxygen from the air for combustion. Today's rocket engines are powered by chemical propellants, either liquid or solid. New sources of rocket propulsion, such as nuclear or electric energy, are being investigated and may be available in the future. Guidance, control, and instrument payload systems are largely electronic. Missiles and spacecraft generally have more complex guidance and control systems than aircraft.

An aircraft, missile, or spacecraft is manufactured usually under the technical direction of a prime contractor. He manages and coordinates the entire project, subject to periodic inspections by the Federal agency or the airline ordering the vehicle. His engineering department prepares design drawings, blueprints, and other specifications. These go to the production department,

where planners work on the many details regarding machines, materials, and operations needed to manufacture the vehicle in the numbers required. Decisions must be made as to what part of the production work will be done by the prime contractor, and what part will be subcontracted to outside firms.

Special tools, dies, jigs, and fixtures are required in manufacturing the vehicle. Many sheet-metal workers, machinists, machine tool operators, and other metal processors produce these tools and the thousands of parts and components which make up into the craft. All parts and equipment must be inspected and tested many times, both before and after they are assembled, and all assembly work must be thoroughly inspected and checked. In every stage of the production process, assemblers and installers are needed to fit together, hook up, and install systems and components. After its final assembly, the vehicle is checked out by a team of mechanics, flight tested if an aircraft, and then prepared for delivery.

Many thousands of subcontractors participate in the production of parts and subassemblies that make up aircraft, missiles, and spacecraft. Some subcontractors make individual parts or supplies such as metal forgings, bearings, plastic material, rocket fuels, or special lubricants. Others produce subassemblies, such as communications or telemetry equipment, guidance instruments, or jet engines, and may depend on other subcontractors to supply parts for the subassemblies. The prime contractor, too, may manufacture components of a craft and may do the final assembly work.

Aerospace plants range in size from the large factories of major manufacturers, each with thousands of employers, to the shops

of small subcontractors and suppliers that employ only a few workers each. Jobs in aerospace work may be found in practically every State, although roughly one-third are concentrated in California. Other States with large numbers of aerospace jobs include New York, Washington, Connecticut, Texas, Florida, Ohio, Missouri, Pennsylvania, Massachusetts, Kansas, Alabama, Maryland, and New Jersey.

An estimated 1.5 million people—about one-fifth of them women—were working on aerospace products in 1968. Aerospace employment has risen sharply since 1966, reflecting, in part, increased requirements associated with the Vietnam buildup. About half a million of these workers were producing missiles and spacecraft; more than 700,000 were making aircraft, aircraft engines, and propellers; and more than 240,000 worked in the electronics field producing equipment for aircraft, missiles, and spacecraft. The remainder, approximately 85,000 were mostly civilian employees of the Federal Government working in the aerospace field, primarily in the Department of Defense and NASA. In addition to those employed directly in the aerospace field, thousands of other Federal Government workers were engaged in the negotiation, administration, and supervision of related contracts.

Workers with many different kinds of educational backgrounds and job skills are needed to design and manufacture aircraft, missiles, and spacecraft. For example, engineers and scientists who have advanced degrees, as well as plant workers who can learn their jobs after a few days or weeks of training, are employed.

Occupational needs vary among establishments in the in-

dustry, depending on the work being done. Research and development laboratories employ mainly engineers, scientists, and supporting technicians and craftsmen. Manufacturers, universities, independent research organizations, and Government agencies, such as the Air Force, Navy, Army, and NASA, run these laboratories. Factories engaged in production, on the other hand, employ mostly plant workers such as assemblers, inspectors, tool and die makers, sheet-metal workers, machinists, and machine tool operators.

Some of the more important jobs found in aerospace-products manufacturing are described below under three major categories: Professional and technical occupations; administrative, clerical,

and related occupations; and plant occupations. (Many of the jobs in this industry are found in other industries as well and are discussed in greater detail elsewhere in the *Handbook* in the sections covering individual occupations.)

Professional and Technical Occupations. Before production of an aircraft, missile, or spacecraft can begin, a design must be approved. This requires many experiments and "feasibility" studies to determine how well various design possibilities meet the conditions under which the vehicle will be operating. A scale model is made from the approved design. It is tested in wind, temperature, and shock tunnels, on ballistic ranges, and in centrifuges where actual

flight conditions are simulated. The next step is to develop a full-size experimental model or prototype, which is thoroughly tested in the air and on the ground. If test results are satisfactory, production may begin. Many modifications in the craft normally are made during the course of design and development, and often even after production has started.

The pace of discovery and change is so rapid that much equipment becomes obsolete while still in the experimental stage or soon after being put into operation. Research and development are vital in the industry, particularly in the missiles and spacecraft field. An intensive effort is being made to develop aerospace vehicles with greater speeds, ranges, and reliability; engines with more power; and metals and plastics with wider capabilities. The industry's research and development capability has encouraged aerospace firms to apply their abilities to other new areas of exploration such as oceanographic research and hydrofoil ocean vessels.

Increasing emphasis on research and development makes the aerospace industry an important and growing source of jobs for engineers, scientists, and technicians. It is estimated that in 1968, about one-fourth of all employees in plants making aerospace products were engineers, scientists, and technicians, a considerably higher proportion than in most other manufacturing industries.

Many kinds of engineers and scientists are employed in aerospace work. For example, over 30 different college degree fields are represented among the engineers and scientists employed by NASA.

Among the more important types of engineers working in the industry are electronics, electri-



Research engineers solve complex problems of modern aircraft systems.

cal, aerospace, chemical, nuclear, mechanical, and industrial engineers. Some of the type of scientists employed in the industry include physicist, mathematician, chemist, metallurgist, psychologist, physiologist, and astronomer. Aerospace engineers and scientists work in a wide and varied range of applied fields such as materials and structures, energy and power systems, fluid and flight mechanics, measurement and control systems, communications and data systems, life sciences and systems, and space sciences.

Engineers and scientists are assisted by many types of workers such as draftsmen, mathematics aids, laboratory technicians, electronics technicians, research mechanics, and research electricians. They also work with *production planners* (D.O.T. 012.188), who plan the layout of machinery, movement of materials, and sequence of operations so that manufacturing processes will flow efficiently from one step to the next; and they work with *technical writers* (D.O.T. 139.288) and *technical illustrators* (D.O.T. 017.281), who produce technical manuals and other literature used to describe the operation and maintenance of aircraft and spacecraft and their many parts.

Administrative, Clerical, and Related Occupations. Managerial and administrative jobs generally are comparable with similar jobs in other industries, except that they are related most closely to engineering because of the importance of research and development in the aerospace field. Personnel in these jobs include executives, responsible for the direction and supervision of research and production; and officials in departments such as sales, purchasing, accounting,

public relations, advertising, and industrial relations. Many thousands of clerks, secretaries, stenographers, typists, tabulating machine operators, and other office personnel also are employed.

Plant Occupations. About half of all workers in the aircraft, missile, and spacecraft field were employed in plant jobs in 1968. Plant jobs can be classified in the following groups: Sheet-metal work; machining and tool fabrication; other metal processing; assembly and installation; inspecting and testing, flight checkout; and materials handling, maintenance, and custodial.

Sheet-Metal Occupations. Sheet-metal workers shape parts from sheet metal by hand or machine methods. When hand methods are used, the workers shape the part by pounding them with mallets and by bending, cutting, and punching them with handtools. Machine methods involve the use of power hammers and presses, saws, tube benders, and drill presses. The all-round *sheet-metal worker* (D.O.T. 804.281) lays out the sequence of operations on the basis of blueprints and other engineering information. He then fabricates complicated metal shapes, using handtools or machines. Less complex parts, as well as those produced in large numbers, are fabricated by less skilled sheet-metal workers or workers who specialize in operating a single machine. They have titles such as *power brake operator* (D.O.T. 617.380), *power hammer operator* (D.O.T. 617.782), *power shear operator* (D.O.T. 615.782 and 615.885), *punch press operator* (D.O.T. 615.782), and *profile cutting machine operator* (D.O.T. 816.782).

Machining and tool fabrication occupations. Another important

group of workers engaged in shaping and finishing metal parts with machine tools are *machinists* (D.O.T. 600.280 and .281) and *machine tool operators* (D.O.T. 609.885). The most skilled of these are the all-round or general machinists who can lay out the work and set up and operate several types of machine tools. They perform machining operations of a highly varied and nonrepetitive nature. They are employed most frequently in departments engaged in experimental and prototype production.

Machine tool operators are employed in the large-volume production of metal parts. They generally specialize in the operation of a single type of machine tool such as a lathe, drill press, or milling machine. The more skilled machine tool operators are able to set up the work on a machine and handle difficult and varied jobs. The less skilled operators usually do more repetitive work.

Machinists and machine tool operators represent a higher proportion of the work force in engine and propeller plants, which are basically metalworking establishments, than in plants performing the final assembly of air and space vehicles. Among engine plants, those manufacturing reciprocating engines do relatively more machining and less sheet-metal work than those producing jet or rocket engines.

Many of the plants in the aerospace industry make a large proportion of the jigs, fixtures, tools, and dies they use. Fabrication of these items requires skilled metal-processing workers, chiefly *jig and fixture builders* (D.O.T. 761.381) and *tool and die makers* (D.O.T. 601.280). Jig and fixture builders make the workholding and tool-guiding devices used in production and assembly operations. On the basis of information received from the engineering de-



Assembler attaches cliquots, a device for pneumatic placement of screws.

partment, they plan the sequence of metal machining operations involved in making a jig and carry the job through to completion. Tool and die makers make the cutting tools and fixtures used in machine tool operations, and the dies used in forging and punch press work. They must be experts in the use of machine tools. *Other metal-processing occupations.* Other metalworkers, such as tube benders, riveters, and welders also are employed. *Tube benders* (D.O.T. 709.884) form tubings used for oil, fuel, hydraulic, and electrical conduit lines. *Riveters* (D.O.T. 800.884) and *welders* (D.O.T. 810.782 and .884; 811.782 and .884; 812.884 and 813.380 and .885) join fabricated parts by hand or machine

riveting and by electric arc, gas, or electric resistance welding.

Additional metal fabricating is performed by skilled foundry workers such as patternmakers, molders, and coremakers. Drop hammer operators and other forge shop workers are employed in the forging departments.

Many aircraft, missile, and spacecraft parts are chemically and heat-treated during several stages of their manufacture to clean, change, or protect their surface or structural condition. Sheet-metal parts are heat-treated to keep the metal soft and malleable while it is being worked into the required shape. Many processes, such as painting and plating, are used on the surfaces of parts. Workers in these metal-

processing jobs have titles such as *heat treater* (D.O.T. 504.782), *painter* (D.O.T. 845.781), and *plater* (D.O.T. 500.380).

Assembly and installation occupations Assembly and installation workers are a major occupational group, employed in practically all plants in the industry. Many work in factories producing engines, electronic equipment, and auxiliary components, but the majority are found in plants that assemble air or spacecraft into completed form. They perform final assembly work such as the fitting together of major subassemblies and the installing of major components. In aircraft, for example, this work involves joining wings and tail to the fuselage and installing the engine and auxiliary equipment such as the fuel system and flight controls. In the course of their duties, assemblers perform operations such as riveting, drilling, filing, bolting, soldering, cementing, and gluing.

A large proportion of assemblers are semiskilled workers doing repetitive work, but some are skilled mechanics and installers. Many of the latter perform diversified assembly or installation operations, and often work on experimental, prototype, or special craft. They assemble, take apart, inspect, and install complex mechanical and electronic assemblies. They read blueprints and interpret other engineering specifications. They may be called *final assemblers* of complete aircraft (D.O.T. 806.781), *missile assembly mechanics* or *rocket assembly mechanics* (D.O.T. 625.281).

Some skilled assemblers are employed in plants which produce relatively large numbers of aircraft and missiles rather than a few experimental types. These assemblers usually specialize in one field of work or more. They



Engine installer makes propeller adjustments.

often are assisted by less skilled assemblers who do the more routine work. For example, a *class A armament assembler* (D.O.T. 801.381) typically does work such as assembling, installing, and aligning power turrets, weapons, gun cameras, and related accessories. Lower rated armament assemblers typically do work such as uncrating and cleaning weapons, loading ammunition, installing armor plate, and placing parts in jigs. *Power plant installers* (D.O.T. 621.381), sometimes known as engine mechanics, install, align, and check the various types of engines and accessories. Skilled *electrical assemblers* (D.O.T. 728.884), sometimes called electricians, install, hook up, and check major units in electrical or radio systems. They are assisted by less skilled assemblers, who do the more routine installations and wire routings by following standard wiring diagrams and charts. Assemblers also specialize in other systems such as plumbing, hydraulic,

heating and ventilating, and rigging and controls.

Inspecting and testing occupations. Because aircraft, missiles, and spacecraft are extremely complex, thousands of painstaking inspections and tests must be made as each component and part moves toward final assembly of the whole system. Inspections are made not only by employees of the manufacturers but also by civilian employees of Federal agencies which have contracted for the equipment.

Some inspectors specialize in examining materials and equipment purchased from the outside; others inspect components during fabrication and subassembly within their own plants; still others inspect completed craft after their final assembly. Many inspection jobs require highly skilled workers. On the other hand, some tests are made by automatic equipment which can be run by relatively unskilled persons. Such equipment not only checks the component or assembly under test but may run simultaneous checks on itself.

Some of the most skilled inspections, especially in final assembly plants, are *outside production inspectors* (D.O.T. 806.381). They examine machined parts, subassemblies, and tools and dies which have been ordered from other firms. They also serve as liaison men between their own engineering departments and supplying companies. Other inspectors, frequently known as *receiving inspectors* (D.O.T. 806.384), with less responsibility than outside production inspectors, check purchased materials and parts for conformity with blueprints, armed services requirements, and other established standards. They operate testing equipment and must be familiar with specifications of the

parts and materials purchased from different sellers.

In the production department, *machined parts inspectors* (D.O.T. 609.381) determine, by the use of precision testing instruments, whether or not a part has been machined properly to conform to blueprint specifications. They also may test for hardness and porosity and determine the "machineability" of castings and forgings. *Fabrication inspectors* (D.O.T. 807.381) are generally skilled sheet-metal workers. They inspect fabricated sheet-metal work and complex parts which have required numerous fabricating operations.

As the parts are fitted together, they undergo numerous inspections by *assembly inspectors* (D.O.T. 806.381). These inspectors are employed, for the most part, in the later stages of the assembly process. They usually inspect complete major assemblies and installations, such as fuselage, wing, and nose sections, to insure their proper final fitting. They also check the functioning of systems such as hydraulics, plumbing, and controls. Less skilled assembly inspectors usually check subassemblies.

Flight checkout occupations. Checking out an aircraft or spacecraft before its first flight requires a team of mechanics having different levels and types of skills. Sometimes the checking-out process involves making repairs or returning the craft to the plant for repairs. The *chief mechanic* or *crew chief*, who is the most skilled worker of the team, is responsible for the entire checking-out operation, including repair work. He usually directs the work of a crew of mechanics, each of whom specializes in one field or more. For example, *engine mechanics* specialize in checking out the powerplant, including the en-



Production mechanic tightens small bolt in forward cockpit area.

gine, propellers, and oil and fuel systems. They use handtools, testing equipment, and precision measuring instruments. The *electronics checkout* men perform or supervise the final operational checkout of systems such as radio, radar, automatic pilot, fire control, and complete electronic guidance systems. Other skilled workers may specialize in checking out and repairing armament, instruments, rigging and controls, plumbing, and hydraulic systems. In some cases, less skilled mechanics help conduct tests and make repairs.

Materials handling, maintenance,

and custodial occupations. Aerospace plants employ large numbers of materials handlers such as truckdrivers, crane operators, shipping clerks, stock clerks, and tool crib attendants. Maintenance workers, who keep equipment and buildings in good operating condition and make changes in the layout of the plant, include maintenance mechanics, millwrights, electricians, carpenters, plumbers, painters, and welders. Guards, firemen, and janitors make up a major portion of the plant's protective and custodial employees.

Training, Other Qualifications, and Advancement

A college degree in engineering or in one of the sciences usually is the minimum requirement for engineering and scientific jobs in the aerospace industry. A few workers may get jobs as professional engineers without a college degree, but only after years of semiprofessional work experience and some college-level training. Since many kinds of engineers and scientists are employed in aerospace work, college graduates in many different degree fields may qualify for professional jobs in the industry. Regardless of his degree field, the undergraduate student preparing for professional aerospace work is well advised to get as solid a background as possible in fundamental concepts and basic general areas of engineering and science. Mathematics and physics courses are especially important, since these sciences provide the necessary language understood by the variety of engineers and scientists working on any given project. Education or training in the more specialized fields of the aerospace industry generally is received in graduate school or on the job.

An increasing number of semiprofessional workers, such as electronics technicians, engineering aids, draftsmen, production planners, and tool designers, receive training for their jobs through 2 years of formal education in a technical institute or junior college. Others qualify through several years of diversified shop experience.

Training requirements for plant jobs vary from a few days of on-the-job instruction to several years of formal apprenticeship. Apprenticeship programs develop craftsmen such as ma-

chinists, tool and die makers, sheetmetal workers, patternmakers, aircraft mechanics, and electricians. These programs vary in length from 3 to 5 years, depending on the trade; during this time, the apprentice handles work of progressively increasing difficulty. Besides on-the-job experience, he receives classroom instruction in subjects related to his craft. Such instruction for a machinist apprentice, for example, would include courses in blueprint reading, mechanical drawing, shop mathematics, trade theory, physics, safe working practices, and other subjects.

Many levels of skill are required for other factory jobs. Workers who have little or no previous training or experience are hired for the less skilled assembly jobs. On the other hand, skilled assemblers may need 2 to 4 years of plant experience in addition to a high school or vocational school education or its equivalent. Skilled assemblers must be able to read and interpret engineering blueprints, schematic diagrams, and production illustrations.

Skilled inspectors often have several years of machine shop experience. They must be able to install and use various kinds of testing equipment and instruments, read blueprints and other engineering specifications, and use shop mathematics. New workers who have little or no experience in shop trades also may be hired and trained for jobs requiring less skilled inspectors.

Mechanics who perform the final checkout of aircraft and spacecraft qualify for their jobs in several ways. Many gain experience as mechanics by working in the earlier stages of the plant's production line before final checkout of the craft. Others receive all their training in checkout work,

or come from "line maintenance" jobs with commercial airlines.

Chief mechanics usually need 3 to 5 years of experience in the manufacture of aircraft, missiles, and spacecraft, including at least 1 year as a checkout mechanic. Specialized mechanics, working under the supervision of the chief mechanic, usually are required to have at least 2 years' experience. Workers having less experience serve as helpers or assistants and learn the mechanic's skills on the job and through plant training courses.

Because the manufacture of their complex and rapidly changing products requires workers who are highly trained and aware of new developments, the majority of aerospace plants support some kind of formal worker training. Instruction of this type supplements day-to-day job experience and helps workers advance more rapidly to higher skills and better paid work. Many of the industry's major producers conduct educational and training classes themselves; others pay tuition and related costs for outside courses taken by their employees; and some do both. Some classes are held during working hours, in which case trainees are paid for class time; other classes are conducted after working hours. Courses are available for practically every occupational group and cover many skills and areas of knowledge. Examples of subjects typically offered include blueprint reading, drafting, welding, aircraft maintenance and repair, electronic data processing, shop mathematics, supervisory practices, and safe working practices. Most trainees take short-term courses designed to meet immediate skill needs. Only a relatively few employees are enrolled in long-term programs scheduled to run for several years, such as apprenticeship.

Employment Outlook

Employment in the aerospace industry is expected to approximate current (1968) levels or decline slightly by the late 1970's. However, there still will be tens of thousands of job opportunities annually in this large field, stemming primarily from the need to replace workers who transfer to other fields of work, retire, or die. Retirements and deaths alone will result in roughly 25,000 job openings each year during the next decade.

Products of the aerospace industry have been developed primarily to assure our national security and to advance our goals in the conquest of space. The industry's future, therefore, depends largely on the level of Federal expenditures. Changes in these expenditures usually have been accompanied by sharp fluctuations in aerospace employment. In the past, many workers, including some scientists, engineers, and technicians, have been laid off during production cutbacks. The outlook in this industry is based on the assumption that defense expenditures (in constant dollars) in the late 1970's will be somewhat higher than the level prior to the Vietnam buildup, approximating the level of the early 1960's. If they should differ substantially, the demand for workers in the aerospace industry will be affected accordingly.

Changes in the relative importance of various segments of aerospace activity may be expected during the next decade. Employment levels in aircraft manufacturing by the late 1970's may be below the current level. Employment in the industry has increased substantially between 1966 and 1968, reflecting the continually increasing demand for civil aircraft superimposed upon

the critical demands of the Viet Nam conflict. Jobs in the spacecraft field may increase moderately because of space exploration. Relatively stable employment is anticipated in plants that produce electronic units for this industry.

Expenditures for research and development should continue at the current high level or rise slightly.

Employment opportunities will be relatively more favorable for workers such as engineers, scientists, draftsmen, electronics technicians, mathematics aids, and research craftsmen. Many job openings in these occupations will become available not only in manufacturing but also in university laboratories and independent research organizations working on aerospace contracts, and in Federal agencies such as the Air Force, Navy, Army, and NASA.

Some job openings also will become available for skilled plant personnel such as machine repairmen. Because of the continuing emphasis on custom production of many diversified products, employment of semiskilled and unskilled assembly line workers is expected to decrease.

Earnings and Working Conditions

Plant workers' earnings in the aerospace industry are higher than those in most other manufacturing industries. In 1968, for example, production workers in plants making aircraft and parts earned on the average \$152.04 a week or \$3.62 an hour; production workers in all manufacturing industries as a whole averaged \$122.51 a week or \$3.01 an hour. Production workers in the Department of Defense and other Federal agencies receive wages equal

to prevailing rates paid for comparable jobs by local private employers.

Earnings of professional and technical workers in the aerospace field are higher than those for similar workers in most other industries because of the rapid growth of research and development activity for missiles and spacecraft, which has created an urgent need for well-qualified engineers, scientists, and technicians. (General information on earnings of professional and technical personnel may be found in the sections on individual occupations in the *Handbook*.)

The following tabulation indicates an approximate range of hourly wage rates for selected occupations in mid-1968, obtained from the collective bargaining agreements of a number of major aerospace companies; these rates do not include incentive earnings. The ranges in various jobs are wide, partly because wages within an occupation vary according to workers' skills and experience, and partly because wages differ from plant to plant, depending upon type of plant, locality, and other factors.

Aircraft mechanics	\$2.45 - \$3.80
Assemblers	2.40 - 3.50
Electronics technicians	2.90 - 3.95
Heat treaters	2.40 - 3.65
Inspectors and testers	3.35 - 4.10
Jig and fixture builders	2.50 - 4.10
Laboratory technicians	2.40 - 3.95
Machine tool operators	2.40 - 3.70
Machinists	2.45 - 3.90
Maintenance craftsmen	2.40 - 3.95
Riveters	2.50 - 3.90
Tool and die makers	2.85 - 4.10
Welders	2.45 - 3.70

Fringe benefits are common in the industry. Workers usually get 2 weeks of paid vacation after 1 or 2 years of service, and 3 weeks after 10 or 12 years. They generally get 8 to 10 paid holidays a year and 1 week of paid sick

leave. Other major benefits include life insurance; medical, surgical, and hospital insurance; accident and sickness insurance; and retirement pensions. Fringe benefits in Federal aerospace employment are comparable with those in the rest of the industry.

Most employees work in modern factory buildings which are clean, light, and airy. Some work is done outdoors. Operations, such as sheetmetal processing, riveting, and welding, may be noisy, and some assemblers may work in cramped quarters. Aerospace plants are comparatively safe working places; the injury-frequency rate in 1967 averaged only about one-third of that for manufacturing as a whole.

Most plant workers in the aerospace field are union members. They are represented by several unions, among them the International Association of Machinists and Aerospace Workers; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; and the International Union of Electrical, Radio and Machine Workers. Some craftsmen, guards, and truck drivers are members of unions which represent their specific occupational groups.

Sources of Additional Information

Additional information about careers in the aerospace field may be obtained from:

National Aeronautics and Space Administration, Washington, D.C. 20546.

Aerospace Industries Association of America, Inc., 1725 DeSales St. NW., Washington, D.C. 20036.

International Association of Machinists and Aerospace Workers,
1300 Connecticut Ave. NW.,
Washington, D.C. 20036.

International Union, United Automobile, Aerospace and Agricul-

tural Implement Workers of
America, 8000 East Jefferson
Ave., Detroit, Mich. 48214.

International Union of Electrical,
Radio and Machine Workers,

1126 16th St. NW., Washington,
D.C. 20036.

Electronics Industries Association,
2001 Eye St. N.W., Wahington,
D.C. 20006.

EMPLOYMENT OUTLOOK AND OCCUPATIONS IN THE ALUMINUM INDUSTRY

About 93,000 workers were employed in the aluminum industry in 1968. Employment was concentrated mainly in the rolling and extruding sector, although individual primary reduction plants in some cases employed more workers than rolling and extruding plants.

Considered a specialty metal having limited application only a short time ago, aluminum today is mass-produced in quantities second only to iron and steel. It is used in products ranging from appliances and cooking utensils to automobiles and aircraft and aerospace applications. Aluminum siding, containers, and electrical cables are among the more recent applications of this versatile metal. During 1968, the industry produced about 6.5 billion pounds of primary aluminum—over twice the output of only 10 years earlier.

The use of aluminum is growing rapidly because of its natural properties, the industry's strong research and development activities, and its aggressive marketing program. Some of aluminum's qualities are its light weight, good corrosion resistance, high strength to weight ratio (in alloy form), good heat reflectivity, electrical conductivity and ductility. The major aluminum consuming industries are construction and building supplies, transportation equipment (autos, trucks, rail, aircraft, ships), electrical and communications, consumer durables (refrigerators, washing machines, and others), containers and packaging, and machinery and equipment.

This chapter describes occupations in the primary aluminum

industry which comprises plants engaged in producing aluminum and aluminum alloys from aluminum oxide (alumina). It also describes occupations in plants engaged in rolling, drawing, and extruding aluminum and aluminum-base alloys. The so called secondary aluminum industry, which produces aluminum primarily from aluminum scrap, is excluded as are the mining of bauxite, fluor-spar, and other raw materials, and the refining of bauxite to alumina. Occupations concerned with casting, stamping, forging, machining, and fabrication of aluminum are discussed separately in the *Handbook* chapters dealing with forging and machining occupations.

Some companies that produce aluminum are integrated completely—that is, they operate bauxite mines; maintain a fleet of ships to transfer the ore to processing plants; refine the ore into alumina; reduce alumina to aluminum; and form aluminum into semifinished and finished products by rolling and a wide variety of fabricating methods. Other companies fabricate metal that they produce but buy alumina from other sources. The great majority of companies do not produce the basic metal, but purchase aluminum from primary or secondary (scrap) sources and form the metal into semifinished and finished products.

The South Central area of the country, which includes Alabama, Arkansas, Louisiana, Tennessee, and Texas leads in the production of primary aluminum, although the State of Washington is the Nation's largest producer. Plants within its borders represent about

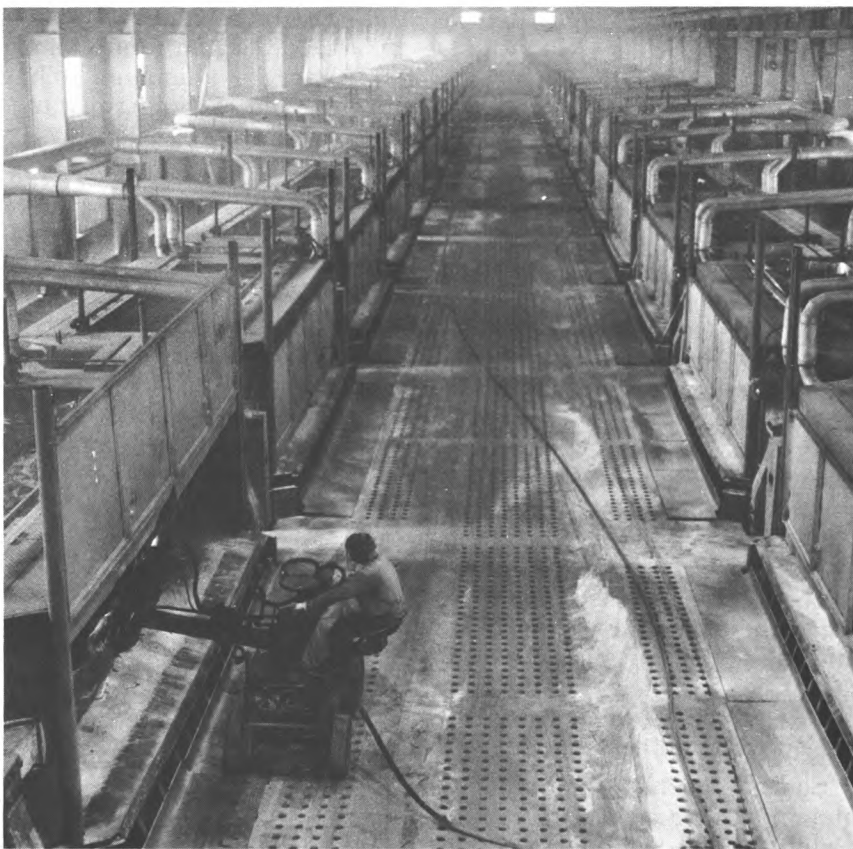
one-fifth of national primary aluminum capacity. The North Central area, consisting of Illinois, Indiana, Michigan, and Ohio, is the center for aluminum rolling, drawing, and extruding plants.

Occupations in the Industry

Employment in the aluminum industry falls into several categories. First, there is a wide assortment of jobs directly concerned with smelting and transforming aluminum into industrial and consumer products. Another group of occupations maintain and service the complex machinery and equipment used in the manufacturing process. In addition, a fairly large group of clerical, sales, professional, technical, administrative, and supervisory positions is needed to facilitate the production process and to operate the companies.

About 4 out of 5 workers employed in the industry work in production and maintenance occupations. They produce aluminum from alumina and form the metal, maintain plant machinery and equipment, and facilitate the flow of materials throughout the plant. The remaining one-fifth are in clerical, sales, professional, technical, administrative, research, managerial, and supervisory occupations.

Due to the relatively high temperatures associated with aluminum reduction and the strenuous nature of some tasks necessary for its production, women make up only about 3 percent of the work force in primary aluminum plants. Although most women employed in the industry work in clerical, secretarial, and other office jobs, they constitute about 9 percent of the work force in rolling and drawing plants and are found in jobs such as graders, sorters, and inspectors.



Tapper breaks hole in electrolytic crust with automatic pot puncher.

Processing Occupations

The largest proportion of employees in the aluminum industry are in factory jobs processing the metal. To illustrate the types of processing occupations found in the industry, a description of the major steps in the production (reduction) and fabricating of aluminum follows.

To produce aluminum, the metal is separated from the oxygen with which it is combined in alumina by smelting. This process involves mixing alumina and other additives in a bath of cryolite (sodium aluminum fluoride) and occurs in deep rectangular cells or "pots" of thermally insulated steel, lined with carbon. The cells or furnaces are generally about

20 feet long, 10 feet wide, and about 3 feet deep.

Reduction—The cells containing molten cryolite are lined with carbon which serve as the cathode or one electrode. Depending on the type of cell used, either one large block of carbon (Soderberg) or a number of small blocks of carbon (prebaked) suspended from the top of the cell acts as the anode or other electrode. Direct electrical current is introduced, and the alumina is reduced to aluminum and accumulates at the bottom of the cell. The oxygen is deposited on the anode and is oxidized to carbon dioxide.

Anode men (D.O.T. 630.884) are responsible for maintenance of the anodes on the reduction cells. Among their duties are pull-

ing pins from the anodes by means of hydraulic pullers and cleaning scales from the pins using a sandblasting device. They may replace the pins using a steel driver.

Pot liners (D.O.T. 519.884) rebuild the Soderberg type anode and reline the reduction furnaces when they burn out. To line the pot, the pot liners pour water into it to loosen the sediment. They then dig out the material using jackhammers or diggers. Next, they lay a brick base in the pot floor and drop carbon mix into the cell. The potliners line the walls and floor with carbon blocks and tamp carbon paste into cracks using a pneumatic hammer.

Potmen (D.O.T. 512.885) tend the reduction pots and are responsible for their continuous operation. Each potman attends a number of different cells. During the operation of the pot, the alumina gradually is consumed. When the dissolved alumina content of one of the cells decreases from approximately 5 percent to 2 percent of the electrolyte, the electrical resistance of the pot rises suddenly from about 5 to 30 volts or more causing an electric bulb on the side of the pot to lightup. This development, known as "anode effect," signals the potman to break the crust of the electrolyte bath and stir in hot alumina which has been lying on the surface. This operation causes the voltage to return to normal levels and the crust reforms. In operating the pots, operators try to reduce anode effects by adding specified amounts of materials at designated time intervals.

Every 24 to 72 hours, part of the molten aluminum is syphoned from the bottom of the reduction cells into huge cast-iron crucibles which have airtight lids. The *tapper* (D.O.T. 514.884) and *tapper helper* (D.O.T. 514.887) signal the *hot-metal crane operator*

(D.O.T. 921.883) to place the overhead crane near the pot to be tapped. They then break a hole in the electrolytic crust using an automatic pot puncher. One end of a curved cast iron tube is inserted into the pot, the other into a crucible of up to 8,000 pounds capacity. A compressed air hose is attached to the siphon and the molten metal is drawn into the crucible. After the completion of several tappings, an overhead crane removes the loaded crucible to a remelting furnace.

A *scalesman* (D.O.T. 502.887) weighs and takes samples of the molten metal for laboratory analysis and separates grades and types of alloys to be blended with the molten aluminum. The molten metal in the crucibles is poured into a "charging hearth" or remelt furnace. A *remelt operator* (D.O.T. 512.885) adds specified portions of aluminum scrap and molten metal from other crucibles. Other metals are added (alloying) to the furnace to obtain desired properties.

Final steps in the preparation of the metal are fluxing and degassing. A compound is added to flux the molten metal, forcing oxides of aluminum to the surface for a hand skimmer to remove. Before the molten metal is removed from the charging furnace, nitrogen or chlorine gas is added to eliminate the hydrogen gas.

After the alloying and fluxing processes, the metal is transferred to the second compartment of the furnace, the "holding" section, until a sufficient supply is obtained for pouring. The *d.c. casting operator* (D.O.T. 514.782) has charge of the pouring station in which the molten metal is cast into ingots. He controls the cooling condition of the casting unit by maintaining a constant level of metal in the molds and operates a series of instruments which spray water against the molds to

produce ingots of uniform crystalline structure.

Rolling—Over half of aluminum wrought products consist of plate, sheet and strip, which are produced by rolling. The first step in rolling operations is to remove surface impurities from the ingot. The *scalper operator* (D.O.T. 605.782) manipulates levers of a scalper machine and cuts approximately one-fourth inch layers of metal from the ingots. To improve corrosion resistance of the surface, ingots are sometimes clad with thin layers of pure aluminum. These layers which are clamped

on the sides of the ingot join with the central layer of the sheet during the rolling process. The ingots are brought to proper working temperatures for rolling by heat treating. Overhead cranes lower the ingot vertically into furnaces, or "soaking pits" where they are sealed hermetically for 12 to 18 hours. The *soaking pit operator* (D.O.T. 613.782) manages the furnace and sets controls to adjust temperature and heating time.

The huge rolling ingots are positioned on the "breakdown" or hot rolling mill where they are



Aluminum is tapped into crucible.

converted into elongated slabs of aluminum. Reduction operations are controlled by trained *rolling mill operators* (D.O.T. 613.782) who manipulate the ingots back and forth between powerful rollers of a large tandem hot reversing mill until they are reduced in thickness to about 3 inches. The slabs then move down the line on rollers to additional hot mills where they are worked down to about one-eighth of an inch thick. At the end of the hotline, a *coiler operator* (D.O.T. 613.885) tends a coiler which automatically winds the metal onto reels.

Coiled aluminum is cooled at room temperature and then cold rolled to a still thinner size. Cold rolling assures a better surface finish and increases the metal's strength and hardness. Since continual cold rolling could make the metal too brittle, intermediate steps of heat treating are necessary. Heat treating or annealing takes place in furnaces under the control of an *annealer* (D.O.T. 504.782).

After annealing, the metal may be further cold rolled to a specified thickness and then heat treated again to soften it for future fabrication. To relieve internal stress from rolling and annealing or contour defects, the finished sheet or plate may be placed in large stretchers which pull the metal from end to end. *Stretcher-leveler-operators* (D.O.T. 619.782) and *stretcher-leveler-operator helpers* (D.O.T. 619.886) position the metal in a stationary vise, determine stretch requirements to meet production specifications, and operate the machine.

During both production and fabricating processes inspections of the metal are conducted to assure quality and consistency of the product. Radiographic testing and ultrasonic testing are two processes used for inspection. *Ra-*

diographers (D.O.T. 199.381) operate various types of X-ray equipment to take radiographs of the metal. Computers monitor operations and adjust any differences that may occur between scheduled temperatures, diameter of metals, and speed of operations.

Fabrication of Rods, Bars, and Structurals—In rod and bar mills, square castings called "blooms" are heated to make them softer and then rolled through pairs of openings, each progressively smaller, until the proper size is reached. To produce wire, hot rolling is continued until the rod is about three-eighths of an inch in diameter. Then it is cold-worked and drawn through dies which have openings smaller than the rod to reduce cross-sectional dimensions. *Wire draw operators* (D.O.T. 614.782) operate machines which draw the wire through the series of dies and automatically coil it on revolving reels.

Structural shapes such as I beams and angles may be hot rolled or extruded. Hot rolled structurals are made by passing a square bloom with rounded corners between rolls having a series of grooves. As the grooves become smaller, the bloom is reduced in cross section and elongated. The shape of the structural is determined by the contour of the grooves in the rolls.

Extrusion. Extruding of metal often is compared with squeezing toothpaste from a tube. Extruded aluminum shapes are produced by placing heated billets (aluminum logs) in an enclosed cylinder in a powerful press. A hydraulic ram which has a force of several million pounds pushes the metal through a hole cut in a die at the other end of the cylinder. The metal takes the contour of the die in cross-section and then may be cut into desired lengths. By designing different dies, almost any

shape of aluminum product may be formed. The press is operated by an *extrusion press operator* (D.O.T. 614.782) who regulates the rate of extrusion to prevent metal rupture and adherence of metal to contour walls.

Another type of extrusion is impact extrusion, a combination of extrusion and forging. Shapes of aluminum are inserted in dies of powerful presses, some up to three stories high. A punch gives the slug a forceful downward blow, and the metal of the slug is forced around the punch. The production process is basically complete in the one blow.

Maintenance, Transportation and Plant Service Occupations

Large numbers of workers are employed in the aluminum industry to keep machines and equipment operating properly. Others are engaged in moving materials, supplies, and finished products throughout the plants; still others are employed in service occupations such as guard, policeman, and custodian. Many of these occupations also are common to other industries. (See index to the *Handbook*.)

The critical importance of electricity to the reduction process requires a relatively large number of *electricians* to install electrical wiring and maintain electrical fixtures, apparatus, and control equipment. *Electronics mechanics* repair computers, industrial controls, radiography equipment, and other complex electronic gear.

Millwrights move, maintain, and repair mechanical equipment. They take apart and restore to operating use machinery essential to aluminum production and fabrication. *Maintenance machinists* are employed in plant machine shops to make and repair mechanical parts used in the plant

machinery and equipment. *Stationary engineers* operate and maintain the powerplants, turbines, steam engines, and motors used in aluminum plants.

Diemakers lay out, assemble, and repair dies used in aluminum metalworking operations. *Bricklayers* build, rebuild, and reline boilers, furnaces, soaking pits, and similar installations. *Plumbers and pipefitters* lay out, install, and maintain piping and piping systems for steam, water, and industrial materials used in aluminum manufacture. *Maintenance welders* join metal parts by hand or machine riveting and by resistance welding and electric arc and gas welding.

Professional, Technical, and Related Occupations

Engineers, scientists, and technicians make up a significant proportion of nonproduction worker employment in the industry.

Quality control is essential in producing aluminum. Companies in the industry employ *chemists* to control the quality by making chemical analyses of aluminum and the raw materials used in its production. *Process metallurgists* study the reduction process to determine the most efficient methods of producing aluminum from raw materials. *Physical metallurgists* conduct microscopic, X-ray, spectroscopic, and physical and mechanical property tests of aluminum and alloys to determine their physical characteristics. They also develop new alloys and new uses for aluminum and alloys.

Chemical engineers and mechanical engineers design and supervise the construction and operation of reduction and fabricating facilities. Most mechanical engineers are employed in the fabricating sectors of the industry, where they may design, regulate,



Chemical engineer and potroom supervisor discuss reduction operations.

and improve rolling mills and related equipment.

Electrical engineers plan and oversee the installation, operation, and maintenance of the electric generators, transmission, and distribution systems used in the manufacture of aluminum.

Industrial engineers conduct work measurement studies, develop management control systems to aid in financial planning and cost analysis, and, in general, determine the most effective methods of using the basic factors of production: manpower, machines, and materials.

Engineering technicians, laboratory technicians, and chemical analysts assist engineers and chemists in research and development work. *Draftsmen* prepare the working drawings that are required for the manufacture and repair of reduction and fabricating machinery.

A wide range of other professional and administrative occupations is needed to facilitate the manufacture of aluminum. Top executives manage the companies

and determine policy decisions. Middleline managers and superintendents direct individual departments, offices, and operations. Other administrative personnel function in staff positions such as accountants, lawyers, statisticians, economists, and mathematicians.

Clerical and Related Occupations

A large group of clerical workers, including bookkeepers, secretaries, stenographers, clerk typists, and keypunch and computer operators keep records for the company and transact everyday business.

Training, Other Qualifications, and Advancement

Aluminum companies generally hire and train inexperienced workers for processing and maintenance jobs. For most professional occupations, the minimum requirement is a bachelor's or first professional degree. For research and development work, most companies prefer graduate degrees. Administrative and management positions usually are filled by people who have engineering or other specialized backgrounds and have been promoted to such jobs. Sales positions often are filled by people having engineering or related technical backgrounds.

Applicants and employees who demonstrate a capacity for technical work have opportunities to qualify as technicians, laboratory assistants, and other semiprofessionals. Some college background in science or graduation from a technical institute or community college is required for many technical jobs.

Some jobs in the industry can be learned in a few days; craft,

engineering, and scientific positions require years of preparation. New, unskilled workers often begin their careers in labor pools from which they are assigned to fill in for regular workers who are absent. After working in the pool for a specified period, they become eligible for a permanent position in a shop or department. As workers acquire additional skills and seniority with the company, they usually move to more responsible and better paying positions. Former production and maintenance workers fill many foremen and supervisory positions.

Craftsmen are trained most often on the job. A number of companies, particularly the larger ones, have formal apprentice training programs. Under these programs, apprentices take related instruction courses in classrooms or at home and also work with experienced craftsmen to obtain practical on-the-job experience. The length of the apprenticeship varies according to the requirements of the particular craft, although most require 3 or 4 years. The following crafts are included among the apprenticeship programs currently in force in the industry: Electrician, welder, brickmason, carpenter, pyrometer man, machinist, maintenance mechanic, pipefitter, die-maker, roll grinder, sheet-metal worker, and automotive mechanic. The method of selecting candidates for apprentice programs varies by company, but generally they are chosen from promising young men already employed by the company.

Employment Outlook

Employment in the industry is expected to rise moderately through the 1970's, although the amount of aluminum produced

annually is likely to increase sharply. Most job opportunities will stem from the need to replace workers who retire, die, or leave the industry for other reasons. Openings arising from deaths and retirements alone are expected to average about 2,000 a year.

Demand for aluminum is expected to continue to grow at a fast rate because industries that represent major markets for aluminum are growing industries with potential for new product development. For example, motor vehicle manufacturers are expanding the use of the metal in automobile components, and virtually the entire bodies of many trucks and buses are made of aluminum. Today's aircraft average 75 to 85 percent aluminum. Aluminum is being used widely in the construction of large office and institutional buildings and for residential construction and remodeling. Space applications for aluminum include components for manned space vehicles and scientific satellites, rockets, launch facilities, guidance systems, and powder for rocket propellant. To take advantage of this potential, the aluminum industry supports a strong research and development program which should continue to develop new alloys, processes, and products. As a result, the number of engineers, scientists, and technical personnel is expected to increase as a proportion of total employment.

On the other hand, larger cell and plant capacities and technological developments, such as continuous casting and computer controlled rolling operations, will limit employment growth among some production occupations.

Earnings and Working Conditions

Earnings of plant workers in the aluminum industry are higher

than the average for other manufacturing industries. For example, in 1968, earnings of production workers in primary aluminum plants averaged \$155.45 a week or \$3.71 an hour. Production workers in aluminum rolling and drawing plants averaged \$149.70 a week or \$3.41 an hour. This compares with average earnings of \$122.51 per week or \$3.01 an hour for production workers in all manufacturing.

Skilled operators and skilled maintenance and craft workers hold the highest paying plant jobs. Standard hourly rates effective in 1967 for selected occupations in a number of plants of a large aluminum producer are shown as follows:

Occupation	Hourly wage rate
Reduction:	
Laborer	\$2.97
Scalesman	3.22
Industrial trucker	3.29
Soaking pit operator	3.42
Annealing furnace operator	3.55
Potman	3.56
Pourer	3.55
Tapper	3.82
Fabricating:	
Mill helper	3.03
Stretcher-leveler operator ..	3.42
Scalper operator	3.42
Inspector	3.48
Hot mill operator	3.94
Continuous mill operator ..	4.00
4-Hi mill operator	4.00
Maintenance:	
Boiler fireman	3.81
Carpenter	4.07
Welder, pipefitter, millwright	4.13
Layout man	4.26
Electrician, machinist, pyrometer man	4.33

In addition to the above rates, premium pay is given for overtime work and for work on Sundays and holidays. Aluminum workers also receive other benefits, such as paid vacations and holidays; retirement benefits; life, sickness and accident, hospital, medical and surgical insur-

ance; shift differentials; supplemental jury pay; and supplemental unemployment benefits. Most workers receive vacation pay ranging from 1 to 4 weeks, depending on length of service. In addition, an extended vacation plan that is in effect in the industry provides 13-week vacations (including regular vacation time) every 5 years.

Salaried personnel generally receive employee benefits comparable to those for hourly employees in the plant. The salary of employees varies considerably from very high paying executive positions to relatively low paying clerical jobs. Starting salaries are determined by a number of factors, some of which are the job being filled, the applicant's qualifications, comparable area and industry wage scales, and the structure of the hourly pay scale at the plant. Graduates of accredited colleges receive good starting salaries, and engineering graduates usually receive the highest offers.

The reduction of alumina to aluminum requires high temperatures and makes the potroom an uncomfortable place to work. The workplace is often dusty and smoky, although aluminum companies have improved working conditions in recent years in reduction plants through extensive fume control programs and other projects. The fabricating side of the industry offers more favorable work conditions. Workers in certain jobs are subject to high temperatures, noises, and other discomforts; however, the plant-wide conditions are more pleasant than those found in reduction operations. Maintenance shops offer a favorable working atmosphere. Because aluminum reduction is a continuous operation, some workers are required to work at night and on weekends.

The industry stresses safe working conditions and conducts intensive programs of worker safety education. For example, reduction plants have had a con-

sistently lower frequency rate of injuries per man-hour than in other primary nonferrous metal reduction and refining plants.

Most process and maintenance workers in the aluminum industry belong to labor unions. In addition, labor organizations represent some office, technical, and security personnel. The unions having the greatest number of members in the industry are United Steelworkers of America; Aluminum Workers International Union; and International Union, United Automobile, Aerospace and Agricultural Implement Workers of America.

Sources of Additional Information

The Aluminum Association, 420
Lexington Ave., New York, N.Y.
10017.

OCCUPATIONS IN THE APPAREL INDUSTRY

Over a million workers are employed in making clothing for the Nation's population. The apparel industry produces about \$170 worth of clothing annually for every man, woman, and child.

The industry is an important source of jobs for workers who have widely different skills and interests. Many of the jobs in this industry can be learned in a few weeks; others take several years.

The apparel industry is the Nation's largest employer of women in manufacturing. Four out of five garment workers are women. Most sewing machine operators are women. However, many others work in jobs such as hand sewer, bookkeeper, and designer. Men usually predominate in jobs such as cutter and marker, presser, production manager, engineer, and salesman.

Nature and Location of the Industry

About 1.4 million men and women were employed in the apparel industry in 1968. Approximately 633,000 produced women's and children's apparel; and about 505,000 produced men's clothing. About 430,000 workers made dresses, skirts, blouses, suits and coats and 124,000 produced undergarments for women and children. In the men's apparel industry, 133,000 workers produced tailored clothing (suits, overcoats, topcoats and sportcoats) for men and boys and 372,000 made men's and boys' shirts, slacks, work clothes, separate trousers, nightwear, undergarments and other furnishings. Another 104,000 were employed in shops which made miscellaneous apparel, such as fur

goods, raincoats, gloves, and dressing gowns. About 176,000 workers classified in the apparel industry produced curtains and draperies.

Although apparel factories are located in nearly all States, approximately 7 out of every 10 of the workers are employed in 10 States: New York, Pennsylvania, New Jersey, Tennessee, California, North Carolina, Georgia, Massachusetts, Texas, and South Carolina. New York City is the Nation's fashion center and most large apparel manufacturers maintain sales offices there. Store buyers visit these showrooms to see the latest styles, especially "high fashion" women's apparel, including dresses, coats, and suits. As a result, many of the jobs which have to do with designing, sample making, and selling are in New York City.

In women's apparel manufacturing, almost one-half of the workers were employed in plants located in the New York-North-eastern New Jersey metropolitan area and in areas of Pennsylvania such as Wilkes-Barre-Hazleton, Allentown - Bethlehem - Easton, and Philadelphia. However, many jobs for workers manufacturing women's apparel also are found in Los Angeles-Long Beach and San Francisco, California; Fall River-New Bedford, Massachusetts; Chicago, Illinois; Miami, Florida; Dallas, Texas; and St. Louis, Missouri.

In the men's and boy's tailored clothing industry the major manufacturing centers are: New York City, Philadelphia, Chicago, Rochester - Buffalo, Allentown-Reading-Easton, Baltimore, Boston, Cleveland, Cincinnati, Los Angeles-Long Beach, and St. Louis. Most of the factories mak-

ing men's, youths' and boys' furnishings such as trousers, work clothing, shirts, and nightwear are located in small communities primarily in the South and Southwest.

Most apparel factories are small. Although plants have been growing larger in recent years, only about 20 percent of them employ more than 100 workers. Many of the large plants make men's and boys' apparel. Plants that manufacture garments that are subject to rapid style change tend to be smaller than those making standard type garments such as work pants.

Occupations in the Industry

The major operations in making apparel are designing the garment, cutting the cloth, sewing the pieces together, and pressing the assembled garment. Generally, high-grade apparel and style-oriented garments are more carefully designed and involve more handwork and fewer machine operations than the cheaper, more standardized garments. For example, much hand detailing goes into a woman's high-priced fashionable cocktail dress or into a man's high priced suit or coat. In contrast, standardized garments such as men's undershirts, overalls, and work shirts usually are sewn entirely by machine. To make the many different types, styles, and grades of garments, workers with various skills and educational backgrounds are employed in the apparel industry.

Designing Room Occupations. Typically, the manufacturing process begins with the *designer* (D.O.T. 142.081) who creates original designs for new types and styles of apparel. The designer usually works with one type of apparel, such as men's suits or women's dresses. Women predominate as the designers of women's dresses; some men design

women's coats and suits. For women's apparel, the designer may get ideas by visiting museums, libraries, and major fashion centers in both the United States and Europe. The designer makes sketches of his designs and presents them to the management and sales staff of his company for approval. The sketches include information about the type of fabric, trim, and color. In designing women's or children's garments, he may make an experimental garment in muslin from approved sketches. He cuts, pins, sews, and adjusts the muslin on a dress form or on a live model until the garment matches his sketch. In large manufacturing plants, a *sample stitcher* (D.O.T. 785.381) prepares these sample garments by following the designer's sketch and performing all necessary machine and hand sewing operations.

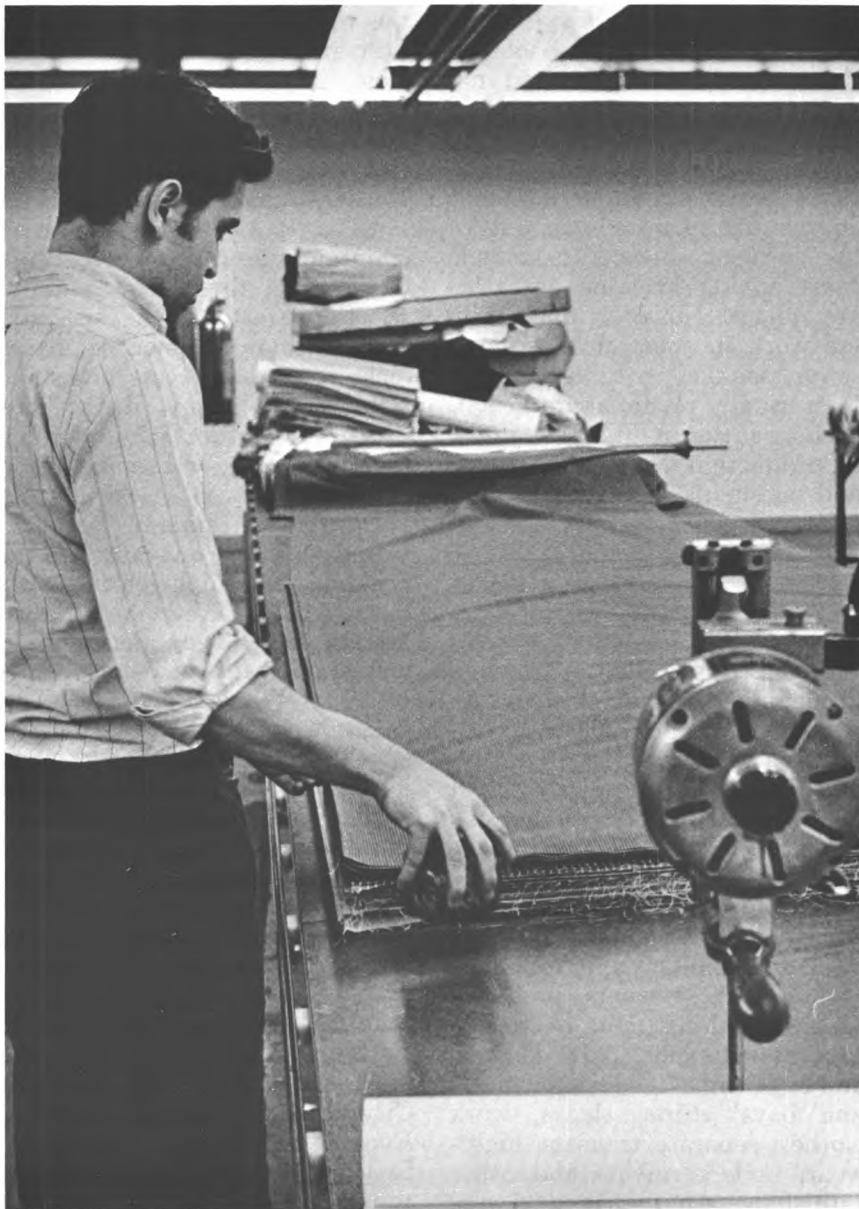
Since designing is a creative job, designers usually work without close supervision, but they must produce a satisfactory number of successful styles during a season, especially when designing women's fashion garments. A large garment manufacturer generally has one designer and several assistants who often have specialized designing responsibilities of their own. Many small plants and plants making standardized garments do not employ designers but purchase ready-made designs or patterns.

When the sample garments or sketch has been approved, it is sent to a *patternmaker* (D.O.T. 781.381) who constructs a full-size master pattern. Working closely with the designer, the patternmaker translates the sketch or sample garment into paper or fiberboard pattern pieces to be used as guides for cutting fabric. In drawing and cutting pattern pieces, the patternmaker must make allowances for pleats, tucks,

yokes, seams, and shrinkage. In some shops designers or all-round tailors make patterns; in other shops the assistant designer performs the patternmaking tasks.

The master pattern serves as a guide for the *pattern grader* (D.O.T. 781.381) who makes a wide range of sizes in each garment style. In a sense, the pattern grader is a specialized draftsman.

He measures the pieces that make up the master pattern and modifies them to fit all sizes. The pattern grader then outlines each revised pattern piece on fiberboard and cuts out the pieces by following the outlines. After he completes a set of pattern pieces for each garment size, he attaches a label to identify the part and size of the garment. Some large plants



Hand spreader lays out cloth.



Marker traces outlines of pattern.

use computers to reduce the length of time required to draw up the pattern for each garment size from the master pattern.

Cutting Room Occupations. Workers in the cutting room prepare cloth for sewing into articles of wearing apparel. There are five basic operations in the cutting department: spreading, marking, cutting, assembling, and ticketing. Small shops may combine two or more of these operations into a single job. Most jobs in the cutting room are held by men.

Hand spreaders (D.O.T. 781.-887) lay out neat bolts of cloth into exact lengths on the cutting

board. **Machine spreaders** (D.O.T. 781.884) are aided by machines in laying the cloth evenly back and forth across the table.

In most plants, **markers** (D.O.T. 781.484) trace the fiber-board pattern pieces on large sheets of paper and make several carbons of these tracings. Some plants that make men's and boys' suits and coats trace the pattern

pieces with chalk directly on the cloth itself, rather than on paper. To get the greatest number of cuttings from a given quantity of cloth, markers arrange pattern pieces so that there is just enough distance between them for the cutter to work. Plaids, stripes, and other patterned fabrics must be marked so that adjoining garment parts will match when the garment is assembled. Before



Cutter directs electrically powered cutting knife through layers of cloth.

making the full-size paper markers, larger plants may photograph miniature patterns which have been arranged in acceptable positions to minimize fabric waste.

A *cutter* (D.O.T. 781.884) cuts out the various garment pieces from the layers of cloth which are spread on the cutting table. He follows the outline of the pattern on the cloth with an electrically powered cutting knife which cuts through all the layers at once. Sometimes layers of cloth are as high as 9 inches. The work of a cutter and a marker frequently is combined into a single job of cutter-marker.

Other types of cutters are employed in shops making high-quality garments. *Hand cutters* or *shapers* (D.O.T. 781.887) trim and cut the pieces for these garments to make them conform exactly to the original pattern. Sometimes cutters sit in sewing rooms so that they can trim and shape garments as they advance through sewing operations.

The pieces of cloth that have been cut are prepared for the sewing room by another group of specialized workers. *Assemblers*, sometimes called *bundlers* or *fitters*, (D.O.T. 781.687) bring together and bundle garment pieces and accessories (linings, tapes, and trimmings) needed to make a complete garment. They match color, size, and fabric design and use chalk or thread to mark locations for pockets, buttonholes, buttons, and other trimmings. They identify each bundle with a ticket, which is also used to figure the earnings of workers who are paid for the number of pieces they produce. The bundles are then routed to the various sections of the sewing room.

Sewing Room Occupations. Almost half of all apparel workers are sewers and stitchers. Most of the employees in these jobs are women. Sewers stitch garment

cuttings together either by machine or by hand. The quality and style of the finished garment usually determine how much handwork is involved. Generally, higher priced clothing, such as suits and coats, require more handwork than do standardized garments. In the average plant, however, the work is broken down into a large number of machine operations. Some handwork is done when the garment nears completion.

Sewing machine operators (D.O.T. 787.782) use sewing machines that are generally heavier and capable of faster speeds than the sewing machines found in the home. Special devices or attachments that hold buttons, guide stitches, or fold seams are often used. Some sewing machine operators specialize in a single operation such as sewing shoulder seams, attaching cuffs to sleeves, or hemming blouses. Others make garment sections such as pockets, collars, or sleeves. Still others assemble and join these completed sections to the main parts of the garment. Some sewing machine operators employed in shops making high priced dresses and women's coats and suits perform all the machine operations on a garment.

Sewing machine operators generally are classified according to the type of machine they use, such as single-needle sewing machine operator or blindstitch machine operator. Others are known by the type of work performed, such as collar stitcher, sleeve finisher, cuff tacker, or coat baster.

Hand sewing is done on better quality or highly styled dresses, suits, or coats to produce garments which are superior in fit and drape. *Hand sewers* (D.O.T. 782.884) use needle and thread to perform various operations ranging from simple sewing to complex stitching. Many hand

sewers specialize in a single operation, such as buttonhole making, lapel basting, or lining stitching.

In a typical apparel plant, bundles of cut garment pieces move through the sewing department, where the garments take form as they pass through a series of sewing operations. Each operator performs one or two assigned tasks on each piece in the bundle and then passes the bundle to the next operator. Some plants employ material handlers (D.O.T. 929.887) often called floor boys or floor girls who move garment bundles from one sewing operation to another.

At various stages of the sewing operations, *inspectors* and *checkers* (D.O.T. 789.687) examine garments for proper workmanship. They mark defects such as skipped stitches or bad seams, which are repaired before the garments are passed on to the next sewing operation. Inspectors sometimes make minor repairs. *Trimmer*, hand (D.O.T. 781.887) often called thread trimmers and cleaners remove loose threads, basting stitches, and lint from garments. This is called "in-process inspection."

Tailoring Occupations. *Tailors* (D.O.T. 785.381 and .261) and *dressmakers* (D.O.T. 785.361) are able to make garments from start to finish by hand or by machine. Some skilled tailors who are employed in plants to make men's, women's, and children's outer garments may make up sample garments from the designer's specifications.

Bushelmen (D.O.T. 785.281), repair defects in finished garments that were rejected by the inspector. They alter garment parts that have not been sewn correctly, rearrange padding in coats and suits, and do other sewing necessary to correct defects.

Pressing Occupations. The



Presser finishes slacks.

shape and appearance of the finished garments depend to a large extent on the amount of pressing that is done during and after sewing operations. Pressing is particularly important in making high-quality garments. For example, from time to time during the sewing of suits, coats, and better quality dresses, seams are pressed open in order to produce a better fitting and neater garment and to make it easier to assemble the garment. This is called "underpressing." In the manufacture of lighter weight garments, on the other hand, pressing is done only after completion of all the sewing operations.

Pressers (D.O.T. 363.782, .884, and .885) use various types of steam pressing machines, including manikins and body forms, or hand irons to flatten seams and to shape garment parts and finished garments. Pressers may

specialize in one type of pressing or ironing. For example, in a shirt factory, a *collar pointer* (D.O.T. 583.885) operates a pressing machine that shapes and presses points of shirt collars.

There are two basic types of pressers—underpressers and finish pressers. Underpressers specialize on particular garment parts, such as collars, shoulders, seams, or pockets. Their duties vary from simple smoothing of cloth and flattening of seams to skillful shaping of garment parts. Finish pressers generally do final pressing and ironing at the end of the sewing operations.

Fur Shop Occupations. The apparel industry includes plants that manufacture garments made of fur. Because furs are expensive and difficult to work with, each operation in making a fur garment requires skilled handwork by an experienced craftsman. Many of these workers have special skills not found in plants that make other types of apparel.

The most skilled job in a fur garment manufacturing plant is that of a cutter who sometimes is also the foreman in the shop. A *fur cutter* (D.O.T. 783.781) selects and matches enough fur skins to make a single garment, such as a fur coat or jacket. He arranges and cuts the skins on pattern pieces so that the choice sections of fur are placed where they will show. Following the sewing instruction given by the cutter, *fur machine operators* (D.O.T. 787.782) stitch these pelts together to form the major garment sections. A *fur nailer* (D.O.T. 783.884) wets the sewn garment sections, stretches them by hand, and nails them on a board so that they will cover the pattern. When the sections are dry, the nailer removes the nails and trims the fur exactly along the outline of the pattern. The fur machine operator then fin-

ishes sewing the various sections together to make the complete garment. *Fur finishers* (D.O.T. 783.381) sew in the lining, tape edges, make pockets, and sew on buttons and loops.

Administrative, Sales and Maintenance Occupations. The majority of the administrative positions in an apparel plant are in the production department. The production manager occupies a strategic position in apparel firms. He is responsible for estimating production costs, scheduling the flow of work, hiring and training workers, controlling quality, and supervising the overall production activities of the plant.

The industrial engineer advises management about the efficient use of machines, materials, and workers. (Further discussion of industrial engineers is included elsewhere in the *Handbook*.)

Clerks, bookkeepers, stenographers, and other office workers make up payrolls, prepare invoices, keep records, and attend to other paperwork, required in this industry. In some larger plants, many clerical functions are being done by computers. This requires keypunch operators, computer programmers and operators, and systems analysts. Salesmen, purchasing agents, models, credit managers, and accountants are among other types of workers in the apparel industry. Sewing machine mechanics are responsible for keeping the industry's large number of sewing machines in good running order. (Discussions of many of these jobs can be found elsewhere in the *Handbook*.)

Training, Other Qualifications, and Advancement

Training requirements for production (plant) jobs in the ap-

parel industry range from a few weeks of on-the-job training to several months of training and experience. The difference in training time needed before an employee can reach his maximum speed and efficiency depends on the type of job, the worker's aptitude, and the employers training program. Many plant workers pick up their skills while working as helpers or assistants to experienced workers. Apprenticeship is infrequent and is limited mainly to designing, cutting, or tailoring jobs. Some private and public schools in garment manufacturing centers offer instruction in occupations such as designing, patternmaking, and cutting as well as machine and hand sewing.

Good eyesight and manual dexterity are essential for most production jobs in the apparel industry. Many occupations are well suited for handicapped workers since most jobs are performed while the worker is seated. Little physical exertion is required. Older workers and women also perform well in a variety of jobs. Many workers in their fifties and sixties are among the industry's most skilled and productive. Women are employed in most of the occupations in this industry, although men hold most of the cutting, tailoring, and pressing jobs.

Designers enter the industry in various ways. Many receive their training by working on the job with experienced designers, by advancing from cutting or patternmaking jobs, or through apprenticeship. There is an increasing tendency for apparel firms to recruit designers from colleges that offer specialized training in design. Some young people with a background in designing may take jobs as designers with small firms, and once their reputations have been established, transfer to jobs in larger, better paying

firms. In large firms, young people may start as assistant designers.

A designer should have artistic ability, including a talent for sketching, a thorough knowledge of fabrics, a keen sense of color, and the ability to translate design ideas into a finished garment. He should also be acquainted with garmentmaking techniques which he may learn by working briefly at various operative jobs, such as machine sewing, draping, sample making, and cutting.

The production manager usually begins as a management trainee, and the industrial engineer as a junior engineer. A college education is increasingly being required for these jobs. For those without this educational background, many years of on-the-job training in all production processes ranging from selection of fabrics to shipment of finished apparel are often required to qualify as a production manager.

Most patternmakers pick up the skills of the trade by working for several years as helpers to experienced patternmakers. Pattern graders and cutters are occasionally promoted to patternmaking jobs. Patternmakers must have the ability to visualize from a sketch or model furnished by the designer the size, shape, and number of pattern pieces required. Patternmakers must also have a detailed understanding of how garments are made as well as a knowledge of body proportions. Like the designer, they must also have a thorough knowledge of fabrics.

Pattern graders usually are selected from employees working in the cutting room or in other plant jobs. Training in drafting is helpful since much of the work requires the use of drafting tools and techniques.

Most workers enter the cutting

room by taking jobs as assemblers (bundlers or fitters). Patience and the ability to match colors and patterns are necessary qualifications for these jobs. Assemblers (bundles, or fitters), may be promoted to jobs such as spreader. Several years of experience in the cutting room are required before an employee can become a skilled marker or cutter. A small number of the larger plants have apprenticeship programs which usually last 4 years and include training in spreading, cutting, marking, and patternmaking.

Entry into beginning hand- or machine-sewing jobs is relatively easy for young women, since there are few restrictions regarding educational, and physical condition. Some previous training in sewing operations is preferred, but many apparel plants hire workers who have had no experience in sewing. Generally, training is informal and received on the job. New workers usually start by sewing straight seams, under the supervision of a section foreman or experienced worker.

Some large companies have formal on-the-job training programs for sewing machine operators. Training usually consists of learning how to perform a single operation with minimal finger, arm, and body movements.

Most sewing jobs require the ability to do routine work rapidly. The same sewing operation is repeated on each identical garment piece. Since almost all these workers are paid on the basis of the number of pieces produced, any clumsiness of hand may reduce the worker's earnings. Good eyesight and ability to work at a steady and fast pace are essential for both hand- and machine-sewing jobs.

The average sewing machine operator has little opportunity for promotion beyond section



Clipper cuts loose threads from finished garment.

forelady, although some sewing machine operators have worked their way up to production manager. Most sewers stay on the same general type of operation throughout most of their working

lives. However, some workers may be moved from simpler sewing operations to more complicated tasks that pay higher piece rates.

Some tailors and dressmakers

learn the trade through vocational training in day or evening schools. Graduates from vocational schools frequently are hired and given additional training on the job. Others learn the trade informally, on the job, first doing relatively easy sewing operations and progressively advancing to more difficult operations. It requires several years of experience to become an all-round tailor or dressmaker.

Tailors and dressmakers may qualify for jobs as fitters or alteration tailors in department stores, clothing stores, and cleaning and dyeing shops.

Pressers usually begin as underpressers working on simple seams and garment parts. This job can be learned in a very short time. After the pressers gain experience, they work on more difficult operations and eventually may be promoted to the job of finish presser. Pressing, like tailoring, is one of the few needle trades in which workers can find similar employment in stores and in cleaning and dyeing shops. There is some transferring back and forth between pressing jobs inside and outside the apparel industry.

Employment Outlook

Employment in the apparel industry is expected to increase moderately through the 1970's. In addition to the thousands of job opportunities expected to result from employment growth, a considerable number of opportunities for young people will occur because of the tens of thousands of experienced workers who will leave the industry. About three-fourths of the industry's workers are women, a large number of whom leave the industry each year to marry or to raise families. Also, this industry employs more

older workers than many industries. It is estimated that deaths and retirements alone will provide 70,000 job openings annually.

Demand for apparel in the years ahead is expected to increase rapidly. The increased demand for apparel will result mainly from a growing, more affluent, and younger population. For example, the number of people in their teens and twenties will rise greatly in the years ahead, and these are the age groups in which spending for apparel is greatest. The trend toward more workers in clerical, sales, professional, and other white-collar occupations will increase the demand for apparel, since these workers spend more for apparel than other workers. Increasing numbers of working women, particularly those in secretarial and other office jobs that require "dressing up," will stimulate apparel purchases. Men, also, are buying more clothing, including highly styled garments as well as sports and leisure wear. Employment in the apparel industry is not expected to increase as rapidly as this demand. Gradual increases in the use of mechanized equipment and other labor saving devices resulting from anticipated increases in research and development expenditures are expected to result in greater output per worker. Examples of such equipment include sewing machines that can position needles and trim threads automatically; devices that automatically position fabric pieces under the needle and remove and stack completed pieces; equipment that automatically spreads fabrics on cutting tables; and the more widespread use of computers and conveyor systems for controlling and improving the movement of fabrics and apparel. The major impact of mechanization is expected

to be in reducing the time an operator must spend in positioning and removing work done at each stage of a production process. Most sewing, pressing, and cutting operations are expected to continue primarily as manual operations through the 1970's.

Most employment opportunities will be in sewing machine operator jobs because this occupational group is the largest and is made up mostly of women who have a high turnover rate. Some job openings also will occur in tailoring occupations in which a large proportion of the employees are older workers. Designers will have many opportunities because this group also is composed largely of women.

There also will be several thousand job opportunities, each, for industrial and mechanical engineers, salaried managers, and skilled machine mechanics. Shortages of these workers probably will continue due to the expected growth in the size of individual

apparel establishments, in the number and size of companies operating more than one establishment, and in the installation of new mechanical equipment.

Opportunities for tailors, sample makers, and other skilled occupations in the apparel industry will continue to be mainly in the metropolitan centers where plants manufacturing dresses, women's suits and coats, or men's and boys' suits and coats are located. There will be a small number of new employment opportunities in men's clothing designing, patternmaking, and cutting room jobs.

Earnings and Working Conditions

In 1968, average earnings of production workers in the apparel industry were \$79.78 a week or \$2.21 an hour, compared with \$122.51 a week or \$3.01 an hour for those in all manufacturing industries. Production workers in



Most sewing machine operators are women.

	<i>Estimated average hourly earnings</i>		
	<i>Boston</i>	<i>Miami</i>	<i>New York City</i>
<i>Women's and Misses' dresses</i>			
All production workers	\$2.60	\$1.91	\$3.28
Cutters and markers (almost all men)	3.62	2.89	4.25
Pressers, hand (women)	2.75	2.01	3.53
Pressers, hand (men)	4.72	2.65	5.88
Sewing machine operators, section system (almost all women)	2.36	1.85	2.75
Sewing machine operators, single hand (tailor) system (almost all women)	2.84	1.94	3.46

this industry generally worked fewer hours per week than those in manufacturing as a whole. Production workers have much higher earnings in some kinds of garment factories than in others. For example, those making women's suits and coats averaged \$91.46 a week in 1968, whereas those producing men's work clothing averaged \$69.17 a week. Earnings of apparel workers also vary by occupation and geographical area. For example, average hourly earnings of cutters and pressers in almost all areas are higher than those of sewing machine operators; and average hourly earnings generally are lower in the South than in the Middle Atlantic States. The following tabulation gives estimated average hourly earnings for selected occupations and geographical areas in one segment of the apparel industry in August 1968.

Because most production workers in the apparel industry are paid on the basis of the number of pieces they produce, their total earnings depend upon speed as well as skill. Sewing machine operators, hand sewers, and pressers generally are paid on a piecework basis. Cutters are paid either piecework rates or hourly wages, depending upon the practice in the area or shop in which they work. Most of the other workers, including tailors, patternmakers, graders, inspectors, and work distributors, are paid by the hour or week.

In most metropolitan areas, most apparel employees work in

shops that have union contracts. New employees in plants which have these agreements are required to join the union after 30 days of employment. These agreements deal with such subjects as wages; hours of work; vacation and holiday pay; seniority; health, insurance, and pension plans; and other employment matters. Among the unions to which apparel workers belong are the Amalgamated Clothing Workers of America (ACWA), International Ladies' Garment Workers' Union (ILGWU), and United Garment Workers of America (UGW). The ILGWU sponsors vacation resorts for union members and their families. Both the ACWA and the ILGWU operate health centers for garment workers in major producing areas.

Workers in the apparel industry can expect to lose very little work time as a result of strikes or other work stoppages because the industry has had many years of peaceful labor-management relations. However, workers making certain type of garments may have layoffs of several weeks during slack seasons. Generally, such layoffs occur more often in plants making seasonal garments, such as women's coats and suits, than in plants producing standardized garments, such as pajamas and men's shirts, which are worn all year long. In many plants, the available work during slack periods is divided so that workers can be assured of at least some earnings.

Old buildings, whose surroundings and facilities may frequently leave much to be desired, continue to house many apparel establishments, especially those in metropolitan areas. Newly constructed plants usually have ample space, good lighting, and air conditioning. Some of the new plants have cafeterias, and health clinics with a registered nurse on duty.

Most sewing jobs are performed while sitting and are not physically strenuous. The working pace is rapid because workers' earnings depend on their production. In addition, many tasks are extremely monotonous. Serious accidents among sewers are rare, although a sewer may occasionally pierce a finger with a needle. On the other hand, pressing may be strenuous work and involves working with hot steam.

Working conditions in cutting and designing rooms are pleasant. In manufacturing establishments, designing and cutting are often performed in a separate area away from the main sewing and pressing operations. Jobs in designing and cutting operations are more interesting and less monotonous than most other apparel jobs. Moreover, since accuracy, skill, individual talent, and judgment are valued more than speed in these jobs, the work pace is less rapid.

Sources of Additional Information

Information relating to vocational and high schools that offer training in designing, tailoring, and sewing may be obtained from the Division of Vocational Education of the Department of Education in the State capital.

Information concerning apprenticeships may be obtained from the Apprenticeship Council of the State Labor Depart-

ment or the local office of the U.S. Employment Service. Some local Employment Service offices give tests to determine hand-eye coordination, which is important for many apparel industry jobs.

Information of a general nature may be obtained from the following sources:

Amalgamated Clothing Workers of America, 15 Union Square, New York, N.Y. 10003.

American Apparel Manufacturers Association, Inc., 2000 K St. NW., Washington, D.C. 20006.

Associated Fur Manufacturers, Inc., 101 West 30th St., New York, N.Y. 10001.

Clothing Manufacturers Association of U.S.A., 135 West 50th St., New York, N.Y. 10020.

National Outerwear and Sportswear Association, Inc., 347 Fifth Ave., New York, N.Y. 10016.

International Ladies' Garment Workers' Union, 1710 Broadway, New York, N.Y. 10019.

United Garment Workers of America, 31 Union Square, New York, N.Y. 10003.

International Association of Clothing Designers, 125 12th Street, Philadelphia, Pennsylvania 19107.

National Board of the Coat and Suit Industry, 450 Seventh Ave. New York, N.Y. 10001.

National Dress Manufacturers' Association, Inc., 570 Seventh Ave. New York, N.Y. 10018.

OCCUPATIONS IN THE ATOMIC ENERGY FIELD

Atomic energy is a very compact source of enormous heat and radiation that can be used in many ways for peaceful as well as military purposes. Peaceful applications of atomic energy are still in the early stages of development, and continuing research and development programs will be needed during the next several decades to find new and more efficient ways of utilizing this force.

In 1968, about 200,000 workers were employed in a variety of atomic energy activities. Large numbers were engaged in research and development work. Others were in activities such as the manufacture of nuclear weapons and other defense materials, the design and manufacture of nuclear reactors, and the production of nuclear fuels. Most atomic energy workers are scientists, engineers, technicians, or craftsmen. Employment opportunities for these workers will continue to be especially favorable through the 1970's.

large quantities of sea water to produce fresh water—a process known as desalinization. Plans are already being developed to build combination power generation and desalinization plants.

Nuclear reactors provide power for naval and commercial ships. By virtually eliminating the need for refueling, nuclear propulsion greatly extends the range and mobility of our naval forces. Research towards developing nuclear propulsion for space vehicles hold excellent promise for extending space flights beyond lunar range by eliminating the need to carry great quantities of conventional fuel.

Although existing reactors generate tremendous amounts of power from a small amount of uranium, research is continuing to develop even more efficient reactors. Still further in the future, we can hope to generate power through controlled fusion. Scientists already have produced uncontrolled fusion in the hydrogen bomb, but have not yet produced

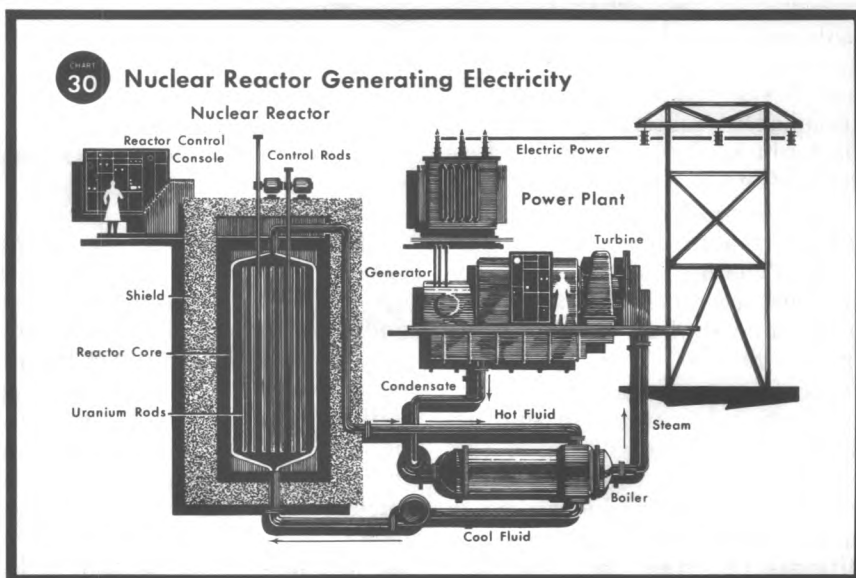
a controlled fusion reaction on a relatively small scale. Research also is being conducted in the "Plowshare" program to develop peaceful uses for nuclear explosives. The program has many potential applications in areas such as gas and oil recovery, other mining operations, and the excavation of harbors, canals, and mountain passes.

Another significant application of atomic energy is in the use of radioisotopes which decay or disintegrate spontaneously, by emitting radiation that special instruments, such as thickness gages, can detect. Radioisotopes are very valuable as research tools in agriculture, medicine, and industry and for use in industrial inspection and control devices.

Nuclear radiation also has good potential as an aid in the preservation of food. One of the major causes of food spoilage is the activity of micro-organisms. When food is treated with radiation, these organisms are killed, and the spoilage is greatly inhibited. This treatment makes possible the long term storage of certain foods without refrigeration, and extends the time for marketing certain perishable refrigerated items as fresh fruits and fish.

Applications of Atomic Energy

One of the most significant uses of atomic energy is in the production of commercial electricity, by using nuclear reactors as the heat source. (See chart 30). Steam produced by such reactors is now generating electricity for several communities. In many areas, these reactors have become competitive with systems using fossil fuels, such as coal and oil, and it is anticipated that many more than 150 nuclear facilities will be built by 1980. Since reactors are an efficient source of thermal energy, they also can be used to evaporate



How Atomic Energy Is Produced

Atomic energy, or more accurately nuclear energy, may be produced through several processes, the two most important of which are fission and fusion. In fission, the nucleus of a heavy atom is split, and energy released in the form of heat and radiation produces two or more lighter elements. In fusion, energy is released by combining the nuclei of two light atoms into a heavier atom. The detonation of atomic bombs is an application of the explosive release of enormous amounts of atomic energy. Non-weapon applications require that release of this energy be carefully controlled and regulated so that it proceeds at a manageable rate.

Controlled fission is the essential feature of a nuclear reactor. The reactor, being a furnace, requires fuel to operate. The principal source material for reactor fuel is uranium 235. Uranium in its natural state contains less than 1 percent of readily fissionable material, uranium U-235. Although natural uranium is sometimes used as reactor fuel, a more concentrated and enriched fuel can be produced and used by increasing the proportion of U-235 isotopes through a process called gaseous diffusion. U-235 undergoes fission readily, but manmade fissionable materials, such as plutonium, also can be used as reactor fuel.

Under proper conditions, in a nuclear reactor, the fuel will sustain a "chain reaction"—the continuous fissioning (or splitting) of the nuclei of atoms—resulting in the release of energy in the form of heat and radiation. When the fissionable atoms in the fuel split, they release neutrons (so-called "atomic bullets", that cause other fissionable atoms to split. These, in turn, release additional neutrons that similarly

split more atoms. The level of the chain reaction is carefully controlled, usually by inserting special neutron-absorbing rods into the fuel chamber or "core," of the reactor. In this way, the rate of the fission reaction and of the energy produced can be regulated or stopped completely.

Thus, harnessed atomic energy is produced in a nuclear reactor in the form of heat and radiation. However, if reactors are to be used for power, the heat must be removed from the reactors and converted to electricity by conventional equipment. The major difference between nuclear and conventional thermal electric power stations is that the heat needed to generate steam to drive turbines comes from a nuclear reactor rather than from a conventional steam-generating boiler fueled with coal, gas, or oil.

During the fission process, nuclear radiation is released. This radiation, identifiable only by sensitive instruments, can be ruinous to equipment and can be highly dangerous to unprotected personnel. Therefore, special materials, resistant to damage by radiation, are used in reactors and great care is taken to protect personnel.

Nature of the Atomic Energy Field

Many different kinds of research and industrial activities are required for the production and application of nuclear energy. Included in the various industrial processes are the mining, milling, and refining of uranium-bearing ores; the production of nuclear fuels; the manufacture of nuclear reactors, reactor components, and nuclear instruments; the production of special mate-

rials for use in reactors; the design, engineering, and construction of nuclear facilities; the operation and maintenance of nuclear reactors; the disposal of radioactive wastes; the processing and packaging of radioisotopes; the production of nuclear weapons; and research and development work.

These activities are performed in plants in several different industries, as well as in laboratories and other types of facilities. Much of this work, such as ore mining and milling, manufacture of heat transfer equipment, and construction of facilities, differs little from similar nonatomic energy work. Other activities, such as manufacture of the fuels needed to run reactors, are unique to the atomic energy field.

The Federal Government supports most of the basic atomic energy activities. The U.S. Atomic Energy Commission (AEC) directs the Federal Government's atomic energy program and regulates the use of nuclear materials by private organizations. The operation of AEC-owned facilities, including laboratories, uranium processing plants, nuclear reactors, and weapon manufacturing plants, is contracted out to private organizations. More than half of all workers in atomic energy are employed in these government owned facilities. In their own installations, private firms are engaged in many types of atomic energy activity, except development and production of military weapons and certain nuclear fuel-processing operations.

A large amount of research and development work is done in the atomic energy field. Much of this work is carried on by the AEC-owned laboratories and by university and college laboratories, other nonprofit institutions, and industrial organizations under Commission contracts.

Occupations in the Atomic Energy Field

Engineers, scientists, technicians, and craftsmen account for a higher proportion of total employment in this field than in most other fields, largely because of the importance of research and development. Office personnel in administrative and clerical jobs represent another large group. Most of the remaining employment consists of semiskilled and unskilled workers in production work, and plant protection and other service workers.

Although many engineers in atomic energy are highly trained in nuclear technology, engineers in all major engineering fields are employed. Mechanical engineering is the largest single engineering occupation, but large numbers of electrical and electronics,

nuclear and reactor, chemical, civil, and metallurgical engineers also are employed. Many of these engineers do research and development work; others design nuclear reactors, nuclear instruments, and other equipment used in atomic energy, and in the operation of production plants.

Research laboratories and other organizations engaged in atomic energy employed a large number of scientists to perform basic and applied nuclear research. Physicists and chemists predominate, but included are many types of scientists, such as mathematicians, biological scientists, and metallurgists.

A large number of technicians assist engineers and scientists in research and development and in designing and testing equipment and materials. These workers include draftsmen; electronics, in-

strument, chemical, and other engineering and physical science technicians; and radiation monitors.

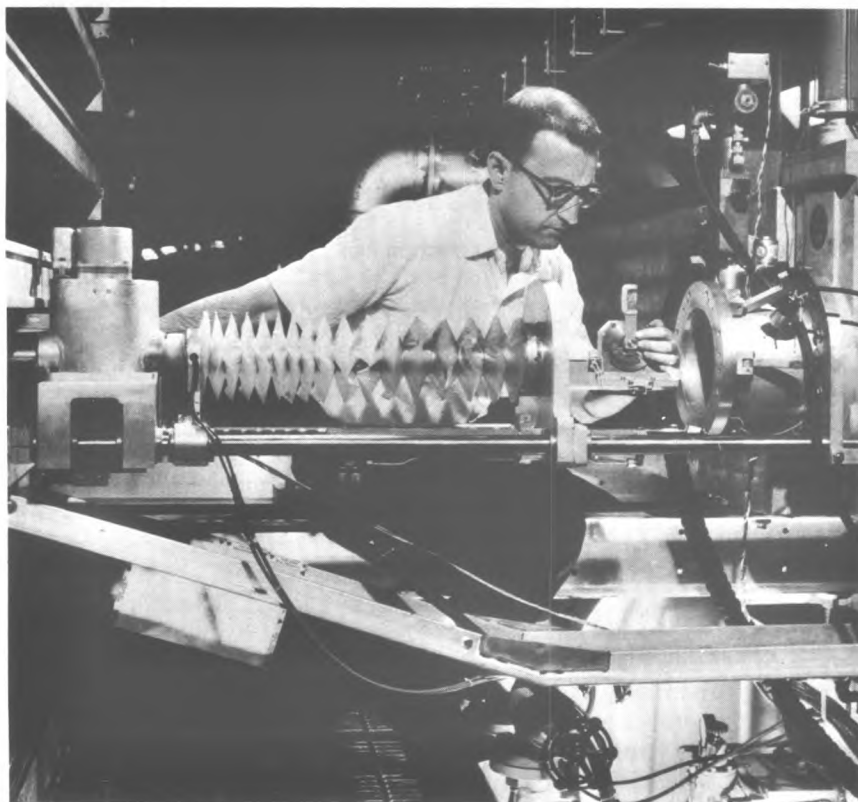
The atomic energy field employs many highly skilled workers to fabricate special parts and equipment to use in experimental and pilot work and to maintain the considerable amount of complex equipment and machinery. Maintenance mechanics (e.g., machinery repairmen and millwrights) and all-round machinists are employed extensively in most atomic energy activities, as are electricians, plumbers, pipefitters, and other craftsmen and chemical process operators.

Activities in the Atomic Energy Field

A brief description of some important atomic energy activities and the types of workers employed in them follows.

Uranium Exploration and Mining. The 5,100 persons employed in uranium exploration and mining in 1968 had jobs similar to those in the mining of other metallic ores. Their jobs are largely concentrated in the Colorado Plateau area of the Far West, in the States of New Mexico, Wyoming, Utah, Colorado, and Arizona. A relatively few mines account for the bulk of production and employment. Most workers in uranium mines are in production jobs, such as miner and driller in underground mines; and as truck-driver, bulldozer operator, and machine loader in open pit mines. About 1 out of 10 employees in uranium exploration and mining is in a professional job, such as mining engineer and geologist.

Uranium Ore Milling. In uranium mills, metallurgical and chemical processes are used to extract ura-



Chemist prepares proton bombardment test.

nium from mined ore. Uranium mills, located primarily in the Colorado Plateau, employed about 2,000 workers in 1968.

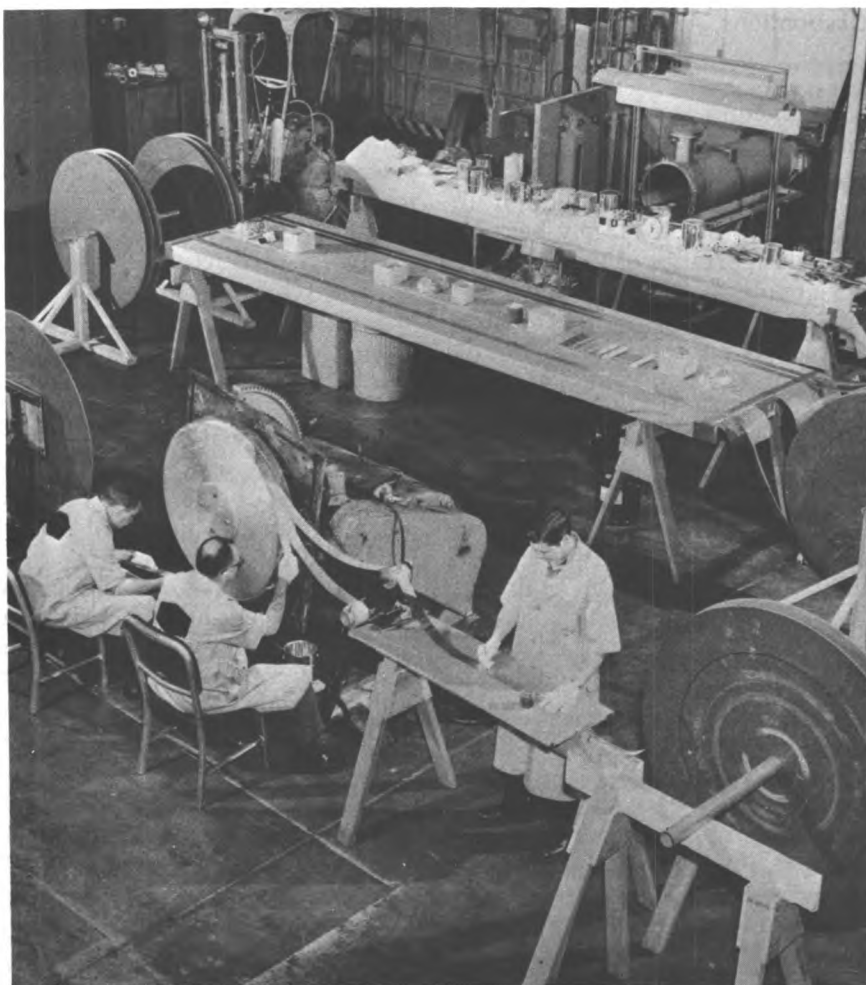
These mills employ skilled machinery repairmen, millwrights, pipefitters, carpenters, electricians, and chemical process operators. A small proportion of the employees in milling operations are scientists and engineers.

Uranium Refining and Enriching. Milled uranium is chemically processed to remove impurities and then converted to metal or intermediate chemical products for reactor fuel preparation. Conventional chemical and metallurgical processes are used, but they must meet more exacting standards than in most other industries. The output of refining plants may be further processed to obtain enriched uranium.

Activity in this segment of the atomic energy field is centered in Ohio, Tennessee, Kentucky, and Illinois. In 1968, uranium refining and enriching plants employed about 5,300 workers.

Maintenance craftsmen, particularly in the high automated uranium enriching plants, account for a large proportion of skilled workers. Large numbers of chemical process operators also are employed. Chemical engineers and chemists accounted for almost half of the engineers and scientists. Many of the technicians worked in chemical analytical laboratories associated with production processes.

Reactor Manufacturing. About 16,500 workers were employed in 1968 to design and manufacture nuclear reactors and unique reactor components. Reactor manufacturers do extensive development work on reactors and auxiliary equipment, design the reactor, and generally fabricate some of the intricate components,



Skilled workers manufacture special electromagnets needed for research studies.

such as fuel elements, control rods, and reactor cores.

About one-half of the employees in firms that design and manufacture reactors are scientists, engineers, and technicians. Engineers alone represent about one-quarter of the employment; mechanical engineers and reactor engineers, who are specialists in reactor technology, predominate. Among scientists, the largest group of workers are physicists, but many chemists, mathematicians, and metallurgists also are employed. Assisting these engineers and scientists are many draftsmen, engineering aids, and physical science technicians.

Skilled workers are employed by reactor manufacturers in experimental, production, and maintenance work. All-round machinists account for a large proportion of these craftsmen. Other craftsmen such as sheet metal workers, instrument makers, machinery repairmen, instrument repairmen, and electricians also are employed. Reactor manufacturers employ nuclear reactor operators to operate experimental and test reactors.

Reactor Operation and Maintenance. About 1,300 workers operated and maintained nuclear reactors producing commercial

electricity in 1968. Some of the occupations found in the operation of a nuclear power station are mechanical engineer, electrical and electronics engineer, instrument technician, electronics technician, radiation monitor, reactor operator, and other power plant operators and attendants. Among the employees needed to maintain and repair reactors are machinery repairmen, instrument repairmen, electricians, and pipefitters.

Research and Development Facilities. A number of research and development laboratories and other research facilities are owned by the Atomic Energy Commission and are operated for the AEC by universities and industrial concerns. These facilities are major centers for basic and applied nuclear research in the physical, engineering, and life sciences and in the development of nuclear reactors and other nuclear equipment. In 1968, these facilities employed more than 52,000 workers. More than half of the employees in AEC research and development facilities are engineers, scientists, and supporting technicians. Among the engineers and scientists are physicists, mechanical engineers, electrical and electronics engineers, chemists and chemical engineers, mathematicians, reactor engineers, metallurgists and metallurgical engineers, biological scientists, and health physicists. Assisting scientists and engineers are many physical science and engineering aids; draftsmen; electronics, instrument, and biological technicians; and radiation monitors.

Administrative and clerical workers together account for a large proportion of employment. The skilled worker group includes large numbers of all-round machinists, electricians, machin-

ery repairmen, and millwrights, as well as substantial numbers of tool and die makers instrument makers, and pipefitters. Nuclear reactor operators are employed to operate research and test reactors and many service workers are employed in plant protection and security operations.

Although most nuclear energy research is performed in AEC research and development facilities, additional research is performed in the privately owned research laboratories of educational institutions, other nonprofit institutions, and industrial concerns. Like the AEC facilities, these laboratories employ a large proportion of workers in scientific, engineering, and other technical jobs.

Production of Nuclear Weapons and Other Defense Materials. More than 25,000 workers were employed in 1968 in establishments producing nuclear weapons and weapon components, plutonium, and other defense materials.

About 1 out of every 4 workers in these defense production facilities is a skilled worker in a production or maintenance job. Included among these skilled workers are large numbers of machinery repairmen and millwrights, chemical process operators, all-round machinists, electricians, instrument repairmen, pipefitters, tool and die makers, and instrument makers.

Among the large number of scientists and engineers employed at these facilities are many chemists, physicists, and mechanical, chemical, and electrical and electronics engineers. Many engineering and physical science aids, draftsmen, radiation monitors, and electronics technician, are employed to assist scientists and engineers.

Other Atomic Energy Activities.

About 1,800 workers were employed in 1968 to produce special materials such as beryllium, zirconium, and hafnium for use in reactors.

About 3,500 workers were employed by companies that manufacture reactor control instruments, radiation detection and monitoring devices, and other instruments for the atomic energy field. Production of these instruments involves work similar to that in instrument manufacturing in general. Engineers and technicians represent a substantial proportion of employment in this field.

About 800 persons were employed in companies which specialize in the manufacture of particle accelerators or their specialized components. These machines enable scientists to study the structure and properties of the elementary particles that make up the nucleus of an atom. Workers employed in the design and manufacture of these machines include electrical and electronics engineers, mechanical engineers, physicists, draftsmen, electronics technicians, and machinists.

Other workers in the atomic energy field are engaged in activities such as processing and packaging radioisotopes, manufacturing radiography units and radiation gages, packaging and disposing of radioactive wastes, and industrial radiography.

Government Employment. The Atomic Energy Commission, which directs the Federal Government's atomic energy program, employed about 7,500 workers in its headquarters and field offices in 1968. Over 1,300 engineers and scientists were employed by the Commission, including personnel in nearly every major engineering and scientific occupation. Since the AEC is pri-

marily an administrative and regulatory agency, approximately two-thirds of Commission employees are in administrative and other professional positions or in clerical jobs. This proportion of administrative and clerical personnel is much larger than in most other activities in the atomic energy field.

In addition to those employed by the Atomic Energy Commission, several thousand government employees are engaged in atomic energy work in other Federal agencies and in regulatory and promotional activities of State and local governments. Their responsibilities involve atomic energy research and application, and establishment of radiation health and safety measures.

Unique Atomic Energy Occupations. Most of the occupations discussed in the preceding sections are similar to those found in other industrial activities, although they may have job titles unique to the atomic energy field (such as nuclear engineer, radiation chemist, and nuclear reactor operator) and require some specialized knowledge of atomic energy. A detailed discussion of the duties, training, and employment outlook for most of these occupations appears elsewhere in the *Handbook*.

The health physics occupations, which are unique to the atomic energy field, and some other occupations that are unique in that they require training in the handling and use of radioactive materials or radiation-producing equipment, are discussed briefly in the following sections.

Health physicists (sometimes called radiation or radiological physicists or chemists) are responsible for detecting radiation and applying safety standards to control exposure to it for workers in atomic energy installations and

for people in surrounding communities. In 1968, more than 900 health physicists were employed in radiation protection work, research, or teaching.

Health physicists are responsible for planning and organizing radiological health programs at atomic energy facilities. They establish standards of inspection and determine procedures for protecting employees and eliminating radiological hazards. They supervise the inspection of work areas with potential radiation hazards and prepare instructions

covering safe work procedures in these areas.

Health physicists also plan and supervise training programs dealing with radiation hazards and advise others on methods of dealing with such hazards. In some cases, they are employed on research projects dealing with the effects of human exposure to radiation and may develop procedures to be followed in using radioactive materials.

Radiation monitors (also called health-physics technicians) generally work under the supervision



Health physicist positions can of paint under gamma scintillation counter before monitoring its radiation content.

of health physicists. An estimated 1,300 radiation monitors were employed in the atomic energy field in 1968. They use special instruments to monitor work areas and equipment to detect radioactive contamination. Soil, water, and air samples are taken frequently to determine radiation levels. Monitors may also collect and analyze radiation detectors worn by workers, such as film badges and pocket detection chambers.

Radiation monitors inform their supervisors when a worker's exposure to radiation or the level of radiation in a work area approaches specified maximum permissible limits and they recommend work stoppage in potentially unsafe areas. They calculate the amount of time that personnel may work in contaminated areas, considering maximum radiation exposure limits and the radiation level in the area. Monitors also may give instructions in radiation safety procedures and prescribe special clothing requirements and other safety precautions for workers entering radiation zones.

Nuclear reactor operators perform work in nuclear power stations similar to that of boiler operators in conventional power stations; however, the controls operated are different. In addition, reactor operators may assist in the loading and unloading of reactor cores. Nuclear reactor operators who work with research and test reactors check reactor control panels and adjust controls to maintain specified operating conditions within the reactor, such as power and radiation levels. About 900 persons were employed as nuclear reactor operators in 1968.

Accelerator operators set up and coordinate the operation of particle accelerators. They adjust machine controls to accelerate

electrically charged particles, in accordance with instructions from the scientist in charge of the experiment, and set up target materials which are to be bombarded by the accelerated particles. They also may assist in the maintenance of equipment.

Radiographers take radiographs of metal castings, welds, and other objects by adjusting the controls of an X-ray machine or by exposing a source of radioactivity to the object to be radiographed. They select the proper type of radiation source and film to use and apply standard mathematical formulas to determine exposure distance and time. While taking radiographs, they use radiation detection instruments to monitor the work area for potential radiation hazards. Radiographers also may remove and develop the film or plate and assist in its analysis.

Hot-cell technicians operate remote-controlled equipment to test radioactive materials that are placed in hot cells—rooms that are enclosed with radiation shielding materials, such as lead and concrete. By controlling "slave manipulators" (mechanical devices that act as a pair of arms and hands) from outside the cell and observing their actions through the cell window, these technicians perform standard chemical and metallurgical operations with radioactive materials. Hot-cell technicians also may enter the cell wearing protective clothing to set up experiments or to decontaminate the cell and equipment. *Decontamination men* have the primary duty of decontaminating equipment, plant areas, and materials exposed to radioactive contaminants. They use radiation-detection instruments to locate the contamination; eliminate it by the use of special equipment, detergents, and chemicals; and then

verify the effectiveness of the decontamination measures. *Waste-treatment operators* operate heat exchange units, pumps, compressors, and other equipment to decontaminate and dispose of radioactive waste liquids. *Waste-disposal men* seal contaminated wastes in concrete containers and transport the containers to a burial ground or arrange for sea burial. *Radioisotope-production operators* use remote control manipulators and other equipment to prepare radioisotopes for shipping and to perform chemical analyses to ensure that radioisotopes conform to specifications.

Training and Other Qualifications

Training and educational requirements and advancement opportunities for most workers in atomic energy activities are generally similar to those for comparable jobs in other fields and are discussed elsewhere in the *Handbook* under the specific occupation. However, specialized training is required for many workers because the atomic energy field is relatively new, requires rigorous work standards in both its research and production activities, and has unique health and safety problems.

Engineers and scientists at all levels of professional training are employed in the atomic energy field. Many of them have had advanced training, particularly those engaged in research, development, and design work. Of the scientists and engineers employed in research and development by major AEC contractors about one-fourth have a Ph. D. degree. The proportion of engineers with Ph. D. degrees is smaller than the proportion of scientists with such degrees. However, graduate training is preferred for an increasing number of engineering jobs.



Waste disposal men bury canisters containing fission products.

Training in nuclear engineering, although increasing at the undergraduate level, is predominately at the graduate level.

Specialized knowledge of nuclear energy, which is essential for most scientific and engineering positions in atomic energy, may be obtained at a university or sometimes on-the-job.

Colleges and universities have expanded their facilities and curriculums to provide training in nuclear energy. Engineers and scientists who plan to specialize in the atomic energy field generally take graduate work in nuclear energy, although introductory or background courses may be taken at the undergraduate level. Some colleges and universi-

ties award graduate degrees in nuclear engineering or nuclear science. Others offer graduate training in these fields, but award degrees only in the traditional engineering or scientific fields.

Craftsmen in some atomic energy jobs need more training than most craftsmen in comparable nonatomic jobs. High skill requirements are often needed because of the extreme precision required to insure efficient operation and maintenance of complex equipment and machinery. For example, pipefitters may have to fit pipe to tolerances of less than one ten-thousandth of an inch and work with pipe made from rare metals costing more than \$1,000 a foot. Welding also may

have to meet higher reliability standards than in most non-atomic fields. Craftsmen in atomic energy generally obtain the required special skills on-the-job. Many AEC installations also have apprentice training programs to develop craft skills.

Health physicists should have at least a bachelor's degree in physics, chemistry, or engineering, and a year or more of graduate work in health physics. A Ph. D. degree often is required for teaching and research.

To qualify for on-the-job training as a radiation monitor, a high school education with courses in mathematics, physics, and chemistry usually is sufficient. Radiation monitors must become familiar with characteristics of radiation, maximum permissible radiation exposure levels, and methods of calculating exposure periods. They also must learn how to calibrate the instruments they use.

Nuclear power reactor operators need a basic understanding of reactor theory and a working knowledge of reactor controls. Most operator trainees have a high school education. Trainees usually are selected from conventional power plant personnel having experience as operators of boiler, turbine, or electrical machinery. Preference sometimes is given to those who have completed courses in science and engineering at the college level. Workers who operate the controls of private nuclear reactors must be licensed by the AEC. To qualify for a license, the trainee must pass an operating test, a written test given by the AEC, and a medical examination.

To qualify for on-the-job training as an accelerator operator, a high school education that includes courses in mathematics and physics usually is required. Accelerator operators receive sev-

eral months of on-the-job training covering operating, repair, and safety procedures. To qualify for on-the-job training as a radiographer, a high school education, including courses in mathematics, chemistry, and physics, usually is sufficient.

High school graduates with some mechanical experience usually can qualify for on-the-job training as hot-cell technicians and decontamination men. They may be given in-plant training lasting several months. For the job of radioisotope-production operator, a high school education, with courses in chemistry, usually is required. High school graduates can qualify as waste-treatment operators, but experience in reading electronic instruments or in a chemical laboratory is desirable. High school graduates also can qualify for employment as waste-disposal men. They receive on-the-job training in the operation of equipment and the avoidance of radiation hazards.

Other workers in the atomic energy field also need special training because of the presence of potential radiation hazards. Employees who work in the vicinity of such hazards are always given on-the-job training in the nature of radiation and the procedures to follow in case of its accidental release.

Individuals who handle classified data (restricted for reasons of national security) or who work on classified projects in the atomic energy field must have a security clearance, based on an investigation of a person's character, loyalty, and associations.

The Atomic Energy Commission, at its contractor-operated facilities, supports on-the-job and specialized training programs to help prepare scientists, engineers, technicians, and other workers for the atomic energy field. The AEC also offers graduate fellow-

ships in specialized nuclear fields.

About 600 fellowships were awarded for the 1967-68 academic year. In addition, other Federal agencies also gave a number of fellowships for graduate work in nuclear science and technology. The prerequisite for consideration for a fellowship is a bachelor's degree in engineering or physical science.

Fellowships in health physics provide for 9 months' training at a university, followed by 3 months' training at a Commission laboratory. Approximately 70 such fellowships are available each year to students with degrees in biology, chemistry, engineering, or physics.

Additional educational and training opportunities are offered in cooperative programs arranged by AEC laboratories with colleges and universities. Temporary employment at AEC-owned laboratories is available to faculty members and students. Engineering undergraduates may work at laboratories and other Commission facilities on a rotation basis with classroom studies, and many graduate students do their thesis work at AEC laboratories.

Many Commission contractors provide employees with training at their own plants or at nearby colleges and universities.

Employment Outlook

Total employment in the atomic energy field is expected to increase moderately during the 1970's as commercial activities in atomic energy expand, and as new applications of this energy form are developed.

Many factors point to a long-term expansion in this field. Expenditures for atomic energy research and development should lead to further employment

growth in production activities; the use of nuclear reactors in electric power generating stations is becoming increasingly widespread; and the use of reactors in conjunction with power generation to desalinate sea water also is expected to increase. Growth in the use of nuclear reactors for propulsion of surface ships is anticipated, although progress in this area may not be as rapid as in electric power generation. Expansion also is expected in the "Plowshare" program to develop peaceful uses for nuclear explosives, in programs to further develop radioisotope technology, and in the use of nuclear power in space.

Employment opportunities are expected to rise significantly for workers who design and manufacture nuclear power reactors and instruments, and who process and package radioisotopes. As more nuclear reactors are built and put into operation, employment will further increase both in the operation and maintenance of reactors, and in related activities such as the fabrication and reprocessing of reactor fuel elements and the disposal of radioactive wastes. Employment in mining, milling, refining, and enrichment of uranium will increase as the demand for nuclear fuel increases. As the use of nuclear power becomes more widespread, there also will be an increase in employment of regulatory workers in both the Atomic Energy Commission and in State agencies to insure safe use of atomic energy. Expansion in these areas of atomic energy will create very good employment opportunities for trained professional and technical workers and for skilled craftsmen.

In addition to the employment opportunities created by expansion in atomic energy activities, other job openings will occur because of the need to replace work-

ers who retire, die, or transfer to other industries.

Earnings and Working Conditions

In 1968, blue-collar workers employed by contractors at AEC laboratories and other installations had average straight-time hourly earnings of \$3.65; blue-collar workers in all manufacturing industries had average earnings of \$3.01 an hour.

Professional workers employed at AEC installations averaged \$13,200 a year in base pay in 1968, and other white-collar workers (largely clerical and other office personnel) averaged about \$7,000 a year. (Earnings data for many of the occupations found in the atomic energy field are included in the statements on these occupations elsewhere in the *Handbook*.)

Working conditions in uranium mining and milling, instrument and auxiliary equipment manufacturing, and facilities construction are generally similar to those in comparable nonatomic energy activities, except for radiation safety precautions. Nearly all uranium mines are equipped with mechanical ventilation systems that reduce the concentration of radioactive radon gas—a substance that can cause lung injury if inhaled over a number of years.



Technician works inside leaktight glove-boxes.

Efforts to eliminate this hazard are continuing. In other atomic energy activities, in which the major proportion of workers in the field are employed, working conditions generally are very good. Buildings and plants are well lighted and ventilated. Equipment, tools, and machines are modern and sometimes the

most advanced of their type. Only a small proportion of employees in the atomic energy field actually work in areas where direct radiation hazard dangers exist. Even in these areas, shielding, automatic alarm systems, and other devices and clothing give ample protection to the workers. In some cases, plants are located in remote areas.

Extensive safeguards and operating practices ensure the health and safety of workers, and the AEC and its contractors have maintained an excellent safety record. The AEC regulates the possession and use of radioactive materials, and AEC personnel inspect nuclear facilities to insure compliance with the AEC's health and safety requirements. Constant efforts are being made to provide better safety standards and regulations.

Most plant hourly paid workers belong to unions that represent their particular craft or industry.

Sources of Additional Information

Additional information about the atomic energy field may be obtained from:

U.S. Atomic Energy Commission,
Washington, D.C. 20545.

OCCUPATIONS IN ELECTRONICS MANUFACTURING

The science of electronics has contributed greatly to the spectacular achievements of the age in which we live. Electronic instruments guide unmanned missiles for our Nation's defense and control the flights of our astronauts as they rocket into outer space. Other electronic instruments make it possible for man to see, hear, and communicate over vast distances. Electronic devices direct, control, and test production processes in industries such as steel, petroleum, and chemicals. Electronic data-processing equipment enables business and Government to handle tons of paper work with great accuracy and speed. Hospitals use electronic instruments to perform laboratory tests and to check body functions. In individual homes, television and radio receivers provide information and entertainment. Indications are that electronics will play an even greater role in the future.

In 1968, an estimated 1.1 million workers were engaged in manufacturing electronic products. Throughout the 1970's, a moderate increase in employment is anticipated. Job opportunities are expected to be particularly favorable in plants producing industrial electronic equipment, output of which is expected to grow more rapidly than other electronic products.

Nature and Location of Electronics Manufacturing

The heart of every electronic product is a circuit or system that includes electron tubes, semiconductors, and other electronic devices which regulate,

control, or direct the flow of small, active particles of negative electricity (electrons) through the circuit. Because of their unique functions, electronic devices are finding many applications.

Electronic products may be grouped into four major categories: (1) Government products, (2) industrial products, (3) consumer products, and (4) components. In 1968, government products accounted for half of total electronic sales. Industrial products accounted for about one-fourth, and consumer products accounted for about one-fifth; components produced as replacement parts were only a small percentage of total sales. (Components produced as original equipment for end products are included in the shipments value of the end products.)

Government products include electronic guidance and tele-metering systems for missiles and spacecraft; radar and other detection devices; automatic communications and computing systems; gyroscopes and other navigational equipment; and fire controls (such as air-to-air target seeking and detonating equipment. Government products are also used in the fields of medicine, education, crime detection, and traffic control.

Important industrial electronic products include computers; commercial radio and television broadcasting equipment; commercial and private aircraft communications and navigational apparatus; and industrial testing, measuring, and production control equipment. Principal consumer products include television sets, radios, phonographs, tape recorders, and hearing aids.

Electronic components fall into three broad classifications: tubes, semiconductors, and "other components." Tubes include receiving tubes, power tubes, television picture tubes, and special purpose tubes. Principal semiconductor devices are transistors, diodes, rectifiers, and microelectronic devices, which include combinations of miniaturized semiconductors. "Other components" include items such as capacitors, antennas, resistors, transformers, relays, connectors, and electronic switches.

Of the estimated 1.1 million workers employed in electronics manufacturing establishments in 1968, about three-fifths—683,000 worked in plants producing end products. About 366,000 of these workers produced military and space equipment; 189,000 produced industrial and commercial products; and 128,000 produced consumer items. The remaining 434,000 workers were in plants making electronic components.

Electronics manufacturing plants are located in nearly every State, but the majority of electronics manufacturing workers in 1968 were employed in seven States: California, New York, New Jersey, Illinois, Massachusetts, Pennsylvania, and Indiana. Metropolitan areas with large numbers of electronics manufacturing workers included Chicago, Los Angeles, New York, Philadelphia, Newark, Boston, Baltimore, and Indianapolis.

In addition to the employees in electronics manufacturing plants, about 79,000 electronics workers were employed by the Federal Government, universities, and nonprofit research centers in activities such as research, development, and the negotiation and administration of contracts.

How Electronic Products Are Made

Many plants manufacturing electronic products specialize in

one type of end product, such as television sets, radios, or electronic computers; or one type of component, such as television picture tubes, power tubes, or semiconductors. In plants which produce several types of end products or components, each type generally is made in a separate department.

Subassemblies, such as tuners and record changers, often are made in plants specializing in these products. Research and development activities are performed in establishments specializing in such work or in separate departments of manufacturing plants.

A large proportion of workers in plants manufacturing end products are engaged in assembly operations. Inspecting and testing of subassemblies and end products are also important activities. Some end-product plants have fabricating and processing departments in which workers do

machining, sheet-metal work, and cleaning and coating of metals such as painting, plating, and plastic molding.

In assembling radios, television sets, and other end products produced in large quantities, major subassemblies, such as circuit boards or panels, transformers, tuners, tubes, and speakers, are attached mainly by hand onto a chassis. A moving conveyor often is used to transport the chassis from one work station to another. Assembled units are placed into metal, plastic, or wooden cabinets. Where complex electronic products are made in small lots, as in the case of scientific and research devices and electronic equipment used in space exploration, a small number of highly trained specialists may assemble a complete unit by hand.

Semiautomatic and automatic machinery are being used more frequently to perform processing and assembly operations, particularly where products are mass-produced. For example, in the manufacture of circuit boards, many plants use automatic punch presses to make holes in thin sheets of plastic (one or both sides of which is coated with a thin layer of copper) so that components can be attached. Machines are used to etch electrical circuits, which replace wires on the circuit boards. Machines also position components into the proper holes in the circuit boards. Mechanical devices bend the wires or metal "ears" on the bottom of the components, locking them into place on the board. Wire leads on the components are commonly soldered to the etched circuits in one continuous operation (called "dip" or "wave" soldering).

Parts used in end products usually are brought to the assembly line by hand truck since most electronic parts are not bulky.

They may be loose in boxes, fed from hoppers (receptacles for parts), or held in special containers or jigs. During assembly operations, components and subassemblies are inspected and tested to locate and replace or repair faulty parts or connections or other defects.

In components manufacturing plants, most assembly work is done by machine. Some types of components usually are assembled by hand, such as experimental parts, special purpose tubes, and extremely tiny semiconductors used in military and space equipment. Electronic components are inspected and tested many times, beginning with visual inspection of raw materials as they enter the plant and continuing through all stages of manufacture.

Electronics Manufacturing Occupations

A wide variety of occupations, requiring a broad range of training and skills, is found in plants manufacturing electronic products. About half the workers in electronics manufacturing are in plant jobs (production, maintenance, transportation, and service); the rest are in white-collar jobs (engineering, scientific, finance, administrative, clerical, and sales).

The proportions of plant and white-collar workers differ from one establishment to another, depending mainly on the products being manufactured. For example, the proportion of plant workers is generally higher in establishments producing consumer products than in establishments manufacturing government products.

More than two-fifths of the workers employed in electronics manufacturing plants are women.



Engineers develop new products.

In some plants, particularly those producing electron tubes and semiconductors, women account for half or more of total employment. Most women are employed as semiskilled plant workers, chiefly as assemblers, inspectors, and testers, and as office workers. However, opportunities for women exist in nearly all types of jobs in electronics manufacturing.

Professional and Technical Occupations. A large proportion of electronics manufacturing workers are in engineering, scientific, and other technical jobs. Engineers and scientists alone represent about 1 out of every 9 electronics workers. Generally, they account for a much larger proportion of employment in plants making military and space equipment than in those producing other types of electronic products.

The largest group of engineers is electrical or electronics engineers. They generally are employed in research and development, although many work in production operations as design engineers or as test methods and quality control engineers. Electronics engineers also work as field engineers, sales engineers, or engineering liaison men.

Substantial numbers of mechanical engineers and industrial engineers also are employed in electronics manufacturing plants. Mechanical engineers work as design engineers in product development and in tool and equipment design. They work also as plant engineers—chiefly concerned with the maintenance layout and operation of plant equipment. Most industrial engineers work as production engineers or as efficiency, methods, or time-study engineers. Other engineers employed in electronics manufacturing include chemical, metallurgical, and ceramic engineers.

Physicists make up the largest



Precision assembler works in surgically clean room.

group of scientists in electronics manufacturing. Now that smaller package circuitry has been achieved through the development of microminiaturization, physicists are working to produce the complete circuit. This process is accomplished by integrating elements that duplicate the functions formerly performed by discrete components such as capacitors, resistors, and inductors, together with transistors. Many scientists in electronics manufacturing are chemists and metallurgists, employed mainly in research work and in materials preparation and testing. Mathematicians and statisticians work with engineers and scientists on complex mathematical and statistical problems, especially in the

design of military and space equipment and computers. Statisticians also are employed in the fields of quality control, production scheduling, and sales analysis and planning. Industrial designers work on the design of electronic products and the equipment used to manufacture them.

Technicians—such as electronics technicians, draftsmen, engineering aids, laboratory technicians, and mathematical assistants—represent about 1 out of every 15 electronics manufacturing workers.

Many electronics technicians are engaged in research and development work, helping engineers in the design and construction of experimental models.

They also are employed by manufacturers to work on electronic equipment in customers' establishments. Other electronics technicians work in highly technical inspecting, testing, and assembly jobs in the engineering laboratories of firms manufacturing electronic products.

Draftsmen usually are employed in engineering departments to prepare drawings from sketches or specifications furnished by engineers. Manufacturers of military and space equipment generally employ a higher proportion of draftsmen than do manufacturers of other types of electronic products.

Engineering aids are another important group of technicians. They assist engineers by making calculations, sketches, and drawings, and by conducting performance tests on components and systems. Laboratory technicians help physicists, chemists, and engineers by performing duties such as setting up apparatus and assisting in laboratory analyses and experiments. Some laboratory technicians themselves may conduct analyses and experiments, usually of a standardized, routine nature. Mathematical assistants help to solve mathematical problems, following procedures outlined by mathematicians. They also operate test equipment used in the development of electronic computers.

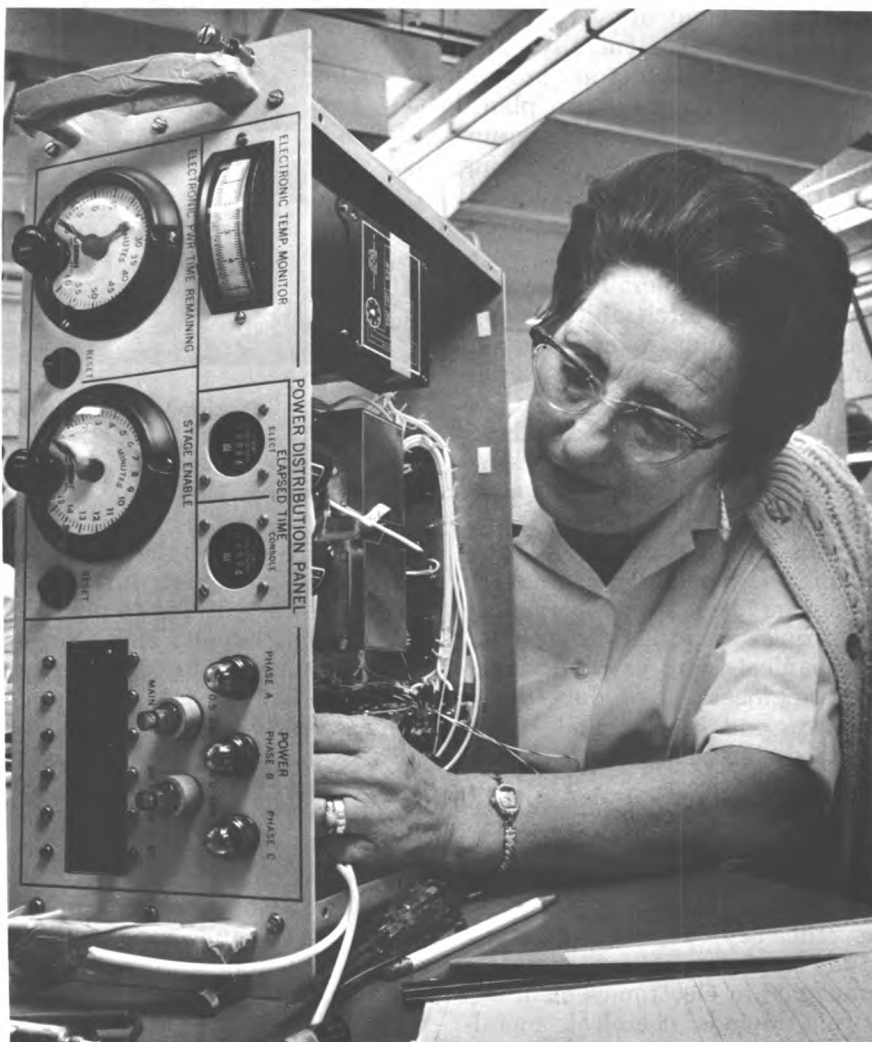
Technical writers work closely with engineers, particularly in plants making military-space and industrial-commercial products, and in establishments doing research and development work. They prepare training and technical manuals describing the operation and maintenance of electronic equipment. They also prepare catalogs, product literature, and project reports and proposals. Specifications writers compile lists of required measurements

and materials. Technical illustrators draw pictures of electronic equipment for technical publications and sales literature.

Administrative, Clerical, and Related Occupations. About 1 out of 4 workers in electronics manufacturing plants are in administrative or other office jobs. Administrative workers include purchasing agents, sales executives, personnel workers, advertising personnel, and marketing research specialists. Clerks, secretaries, stenographers, typists, and business machine operators, many of whom are women, are among the

thousands of other office workers employed by electronics manufacturing firms. A small but growing proportion of these office workers operate electronic computers and auxiliary equipment. Most of these computers are used to process office records, including payroll, production, costs, sales, and inventory data.

Plant Occupations. About half of electronics manufacturing employees work in assembly, inspecting and testing, machining, fabricating, processing, maintenance, and other plant operations. The proportion of workers



Most assemblers are women.

in each of these operations differs among electronics plants, depending largely on whether end products or components are produced and the types manufactured. For example, the proportion of assemblers is higher in plants making components and consumer end products than in plants producing military space equipment and industrial-commercial products. The proportion of machining and fabricating workers is higher among manufacturers of military space equipment and industrial-commercial products than among manufacturers of other types of products.

Assembly occupations (D.O.T. 729.884; 720.884; 726.781 and .884). Assemblers make up the largest group of electronics plant workers. Both end-product and component manufacturing firms employ assemblers with many different skills. However, most assemblers are semiskilled workers.

Most end products are assembled mainly by hand, using small handtools, soldering irons, and light welding devices. Assemblers use diagrams, models, and color-coded parts and wires to help them in their work. Some assembly work is done by following instructions presented on color slides and tape recordings. Color slides flash a picture of an assembly sequence on a viewing screen, while the assembler listens to recorded directions.

Precision assemblers install components and subassemblies into end products in which moving parts and mechanisms must operate within clearances measured in thousandths, or even millionths, of an inch. Some of these assembly workers do repair work, experimental and developmental work, and model assembly work. Most precision assemblers are employed in the manufacture of military space and industrial-commercial electronic equipment.

Machines are used in some assembly work on end products. For example, in putting together subassemblies such as circuit boards, automatic machines often are used to position components on the boards and to solder connections. Here the assemblers work as machine operators or loaders.

Most components are assembled by machines, since their assembly involves many separate but simple and repetitive operations. Even some types of miniaturized semiconductors and other components, made with parts small enough to pass through the eye of a needle, now are assembled on highly complex machines. Some of these machines are automatically controlled.

Hand assembly is needed for some components such as receiving tubes, special purpose tubes, and some types of transistors, diodes, capacitors, and resistors. Hand assemblers only may perform a single operation on these components as they move down the assembly line, but some may assemble completely a particular type of component. Tiny components often are hand-assembled under magnifying lenses or powerful microscopes.

Hand assemblers sometimes may use machines to assist them in performing assembly operations on components. For example, precision welding equipment may be used to weld connections in microminiature components and circuit assemblies. Some circuit assemblies are so small that hundreds of components may be precision welded in a cubic inch of space. Machines also may be used to position and hold component parts during assembly operations.

Hand assemblers also are employed in electronics research laboratories and in the research and development departments of electronics manufacturers. These

workers—frequently called electronics technicians—generally do difficult assembly work on small quantities of complex, often experimental, equipment. They also may work on the development of new ways to assemble large quantities of components or subassemblies by machine. Some electronics technicians install subassemblies into complex systems such as those in guided missiles. These hand assemblers usually must know enough electronics theory to understand the operation of the items being assembled.

Most assemblers are women. They are employed mainly as machine operators or tenders, and as hand assemblers of items made in large quantities. Men are employed chiefly in experimental assembly work, in model assembly, and in assembly jobs requiring relatively heavy work. Men also are employed in assembly departments as “trouble shooters.” These workers analyze end products and subassemblies, which have failed routine performance tests, to pinpoint the exact cause of faulty operation.

Machining occupations. Metal machining workers are employed in most electronics manufacturing plants, particularly those making military-space and industrial-commercial products. Machine-tool operators and machinists operate power-driven machine tools to produce metal parts of electronic products. Toolmakers construct and repair jigs and fixtures used in the fabrication and assembly of parts. Diemakers specialize in making metal forms (dies) used in punch and power presses to shape metal parts.

Fabricating occupations. Fabricating workers are employed in many electronics manufacturing plants, but the largest proportion is in establishments producing industrial products. Among the

fabricating workers are sheet-metal workers who make frames, chassis, and cabinets.

Glass blowers and glass lathe operators (D.O.T. 674.782) are employed chiefly in electronic tube experimentation and development work; in the manufacture of special purpose tubes, which are made in small numbers; and in rebuilding television picture tubes. Other fabricating workers include *punch press operators*, *blanking machine operators* and *shear operators*.

Some fabricating jobs involve the molding, firing, and glazing of ceramics used as insulating materials in many components. Workers also may operate machines that mold plastic components. In electron tube manufacturing, special fabricating workers are employed. For example, *grid lathe operators* (D.O.T. 725.884) make grids (devices in electronic tubes which control the flow of electrons) by winding fine wire around two heavy parallel wires. Other fabricating workers include spot welders and *coil winders* (D.O.T. 724.781 and .884), and *crystal grinders and finishers* (D.O.T. 726.884).

Processing occupations. A relatively small but important group of electronics manufacturing workers is engaged in processing activities, chiefly in plants producing electronic components. *Electroplaters and tanners* (D.O.T. 501.885) coat many parts with metal. *Anodizers* (D.O.T. 501.782) treat parts in electrolytic and chemical baths to prevent corrosion. *Silk screen printers* (D.O.T. 726.887) print patterns on circuit boards and on parts of electronic components.

Etching equipment operators (D.O.T. 590.885) do chemical etching of copper on circuit boards.

Processing workers also im-

pregnate or coat coils and other electronic components with waxes, oils, plastics or other materials. Some operate machines which encase microminature components in plastic resin to join and insulate them in circuits, seal out moisture, and reduce chances of connection failure caused by heat and vibration.

Another group of processing workers operate furnaces, ovens, and kilns, used chiefly to harden ceramics, bake on coatings, and eliminate contamination by gases and foreign materials. *Operators of infrared ovens and hydrogen furnace fires* (D.O.T. 590.885) rid tubes of foreign deposits. In tube manufacturing, *exhaust operators* (D.O.T. 725.884) and *sealers* (D.O.T. 692.885) operate gas flame machines which seal the mount (the part of an electronic tube consisting of a Bakelite base and stem) in the tube, clear the tube of impurities, exhaust the gas, and seal the tube.

Testing and inspection. Testing and inspection in electronics manufacturing begin when raw materials enter the plants and continue throughout fabricating operations. Finished components and end products undergo thorough testing and inspection, frequently including operation for a period of time, before shipment.

In end-product manufacturing plants, testers use voltmeters, oscilloscopes, and other test meters to make certain that components, subassemblies, and end products conform to specifications. Many of these workers have job titles that indicate the type of work they do, such as analyzer, final tester, tuner tester, and operational tester.

Some testing jobs require technically trained workers who have had several years of experience in electronic testing. These jobs are commonly found in research and development work, where elec-



Inspector tests power supply module.

tronics technicians test, adjust, and align circuits and systems as part of their overall responsibility. These jobs also found in complex production work, such as the manufacture of missiles and spacecraft.

In component manufacturing plants, components are checked manually by testers using various types of test meters or routed mechanically through automatic test equipment. Some automatic equipment can check a large number of component characteristics, produce a punched tape of test results, and sort the components into batches for shipping. Although many of these workers simply are called component testers, others have job titles which reflect the type of components they test, such as transformer tester, coil tester, and magnetic component tester. Workers who feed or monitor automatic test equipment often are called test-set operators or testing-machine operators.

The work of inspectors in end-

product plants varies from checking incoming materials to inspecting subassemblies and final products for flaws in circuit assembly, etching, plating, painting, and labeling. *Electronic assembly inspectors* (D.O.T. 722.281) examine assembled electronic units to make certain that they conform to blueprints and specifications, and check wire routing, electrical connections, and quality of units. Mechanical and precision inspectors check mechanical assemblies and precision parts. Inspectors in end-product plants may use tools such as measuring scales, micrometers, calipers, and magnifying glasses in their work.

Inspectors in component manufacturing plants check incoming raw materials and subassemblies before, during, and after fabricating and processing operations. They may inspect wire leads on diodes for straightness or length, wire winding on coils for evenness or breakage, and completed tubes for loose wires, scratched paint, corrosion, defective etches, and identifying labels. Some inspectors make repairs on defective components.

Tools used by inspectors in components plants may include magnifying lenses, micrometers, calipers, tweezers, and, in some circumstances, microscopes. These inspectors may have job titles that indicate the work they do, such as incoming materials inspector, plating inspector, power tube inspector, coil inspector, machine parts inspector, and precision inspector.

Maintenance occupations. Many maintenance workers who have different types of training are employed in electronics manufacturing plants to maintain machinery and equipment. Skilled electricians are responsible for the proper operation of electrical equipment. Machine and equip-

ment repairmen perform mechanical repairs. Hydraulic mechanics specialize in maintaining hydraulic equipment. Maintenance machinists and welders build and repair equipment, jigs, and fixtures. Air-conditioning and refrigeration mechanics are employed in electronics plants which are air-conditioned and have special refrigerated and dust-free rooms. Painters, plumbers, pipefitters, carpenters, sheet-metal workers, and other building maintenance craftsmen also are employed in electronics plants.

Other plant occupations. *Parts changer* (D.O.T. 729.381) is an other important occupation in electronic manufacturing plants. These workers repair assembled electronic products which have been tagged for replacement of defective parts. Women frequently are employed as parts changers.

Many workers are employed in materials movement and handling. These workers include operators of plant trucks and tractors; forklift operators who stack crates and load and unload trucks and boxcars; and truckdrivers who handle transportation outside the plant. Other occupations include boiler operator and stationary engineer.

(Detailed discussions of professional, technical, mechanical, and other occupations, found not only in electronics manufacturing plants but also in other industries, are given elsewhere in the *Handbook* in sections covering the individual occupations.)

Training, Other Qualifications, and Advancement

Electronic manufacturing plants employ many engineers, scientists, and technicians because of the technical nature of plant production operations and the great emphasis on research

and development work. Beginning engineering jobs usually are filled by recent graduates of engineering colleges (some with advanced degrees). A small number of workers without college degrees are upgraded to professional engineering classifications from occupations such as engineering assistant and electronics technician. Workers who become engineers in this way usually have taken advanced electronics courses in night school or in other training programs. To keep up with new developments in their fields and to help them qualify for promotion, professional and technical personnel obtain additional training, read technical publications, and attend lectures and technical demonstrations.

Almost all mathematicians, physicists, and other scientists employed in electronics manufacturing plants have college degrees, and many have advanced degrees. Job prospects are usually better for scientists who have at least a master's degree than for those with only a bachelor's degree.

Technicians generally need some specialized training to qualify for their jobs. Most electronics technicians have attended either a public, private, or Armed Forces technical school. Some have obtained their training through apprenticeships, usually of 3 or 4 years' duration. Applicants with a high school education, including courses in mathematics and science, are preferred for these apprenticeships. Some workers become electronics technicians by being upgraded from jobs such as tester and experimental assembler, after they have developed required skills on the job and acquired the necessary knowledge in basic electronics theory, mathematics, drafting, and reading of schematic diagrams. This knowledge usually is

obtained by taking courses in company-operated classes, night school, junior college, technical school, or by correspondence.

Electronics technicians need color vision, manual dexterity, and good eye-hand coordination. As in the case of other technical workers, they must be able to understand technical publications. Some technicians who do final testing that requires the operation of radio transmitting equipment must hold licenses from the Federal Communications Commission as first- or second-class commercial radiotelephone operators.

Laboratory technicians, engineering and scientific aids, and mathematical assistants frequently have had 1 year of college training or more in a scientific or engineering field, but have not completed course requirements for a degree. In other cases, these workers have been upgraded from jobs as lower grade assistants in engineering laboratories or as high-grade testers in production departments. In hiring lower grade assistants, electronics firms give preference to high school graduates who have completed high school courses in mathematics, physics, and chemistry.

Draftsmen usually enter their trade by taking a course in drafting at a trade or technical school; a few have completed a 3- or 4-year apprenticeship. Some qualify for their jobs under an informal arrangement with their employers which provides for both on-the-job training and part-time schooling. Because many draftsmen must understand the basic principles of electronic circuits to do their work, they should study basic electronic theory and circuits and the reading of electronic schematic diagrams.

Technical writers must have a flair for writing and are usually

required to have some technical training. Electronics firms prefer to hire those who have had some technical institute or college training in science or engineering. Some have college engineering degrees. Many have college degrees in English and journalism and have received their technical training on the job and by attending company-operated evening classes. Technical illustrators usually have attended special schools of art or design.

Many tool and die makers, machinists, electricians, pipefitters, carpenters, and other craftsmen in electronics manufacturing learn their trades by completing a 4- or 5-year apprenticeship. Some enter these trades through upgrading from helpers' jobs. Some take courses at vocational schools.

Formal training in electronics usually is not necessary for workers entering plant jobs, but completion of high school frequently is required. Job applicants may have to pass aptitude tests and demonstrate skill for particular types of work. On-the-job training, usually for a short period, generally is provided for workers who have had no previous experience. Assemblers, testers, and inspectors need good vision, good color perception, manual dexterity, and patience.

Requirements for filling administrative and other office jobs are similar to those in other industries. Certain beginning administrative jobs in electronics manufacturing generally are open only to college graduates having degrees in business administration, accounting, or engineering. More and more employers are requiring college training for administrative jobs in advertising, personnel, accounting, and sales. For clerical jobs, employers usually prefer applicants who are high school graduates with spe-

cial training in stenography, typing, bookkeeping, and office machine operation.

Employment Outlook

Electronics manufacturing will provide tens of thousands of job opportunities annually throughout the 1970's. A moderate rate of growth in electronics employment is expected over this period, assuming relatively full employment is in the Nation's economy and the high levels of economic activity needed to achieve this goal. In addition to the many thousands of job opportunities resulting from employment growth, large numbers of job openings will result from the need to replace workers who transfer to other fields of work, retire, or die. Retirements and deaths alone will provide an estimated 31,000 job openings annually.

The rate of employment growth in electronics manufacturing will vary by major product category. The most rapid increase is expected for industrial products. Businessmen are expected to spend increasing amounts for electronic equipment to automate and mechanize data processing and production processes, especially for items such as computers and numerical controls for machine tools. Demand also is expected to grow for navigational, test, educational, and radio communications equipment. Production of electronic equipment for the medical and atomic energy fields also will expand greatly. In addition, many new fields are being explored for applications of electronics devices, including automated highways and railways, and water desalination and purification.

The demand for consumer items also is expected to increase rapidly as population, family for-

mations, and personal spendable incomes rise over the period. The demand for government equipment is expected to continue to grow over the period. This projection is based on the assumption that in the late 1970's the level of defense expenditures, an important determinant of output in this product category, will be somewhat higher than the level prior to the Vietnam buildup; approximately the level of the early 1960's. Moreover, it assumes that expenditures for programs to explore outer space and the ocean depths will continue at approximately current levels. If these assumptions should not be realized, employment levels in this sector of the industry will be affected.

The increase in electronics employment in all product categories probably will not be as great as the expansion in output, however, because technological improvements in production methods are expected to increase output per worker. For example, increasing mechanization of operations formerly done by hand will tend to reduce labor requirements, particularly in plants where products are mass-produced, such as television and radio sets, and components. However, mechanized manufacturing processes are difficult to adapt to the fabrication of many types of highly complex electronic products.

Although employment in electronics manufacturing is expected to grow at a moderate pace through the 1970's, the rates of growth will vary among occupational groups and individual occupations. For example, the demand for skilled maintenance personnel, particularly instrument repairmen, is expected to rise at a rapid rate, because of the need to maintain and repair the increasing amounts of complex machinery. On the other

<i>Type of product</i>	<i>Average hourly earnings</i>	<i>Average weekly earnings</i>
All manufacturing industries	\$3.01	\$122.51
Major electronics manufacturing industries:		
Military-space and industrial-commercial electronics end products	3.21	132.25
Electron tubes	2.51	97.64
Radio and television receiving sets, and phonographs	2.77	108.86
Semiconductors and other components, except tubes	2.51	99.40

hand, employment of semiskilled workers is anticipated to rise slowly because of the growing mechanization and automation of assembly line operations.

The overall demand for engineers, scientists, and technicians is expected to increase because of continued high expenditures for research and development, and the continuing trend toward the production of complex equipment. Among professional and technical workers, the greatest demand will be for engineers having advanced degrees, particularly those who have a background in certain specialized fields, including quantum mechanics, solid-state circuitry, product design, and industrial engineering. The demand for engineers possessing selling ability will rise rapidly because the increasing complexity of industrial and commercial equipment will require salesmen with highly technical backgrounds. The demand for mathematicians and physicists will be particularly great because of expanding research in computer and laser technology.

Earnings and Working Conditions

Average hourly and weekly earnings of production workers in electronics manufacturing industries vary considerably by type of product produced. As shown in the accompanying tabulation, production workers in industries making military-space and industrial-commercial products had higher average earnings

in 1968 than those in industries producing other types of electronic products.

Earnings of individual production workers may differ from the averages shown above, since such earnings depend not only on the type of plant in which they work but also on factors such as skill level and experience, length of service, geographic location, and amount of overtime.

Electronics workers generally receive premium pay for overtime work and for work on Sundays and holidays. Virtually all plants provide extra pay for evening and night shift work.

Many workers in electronics manufacturing plants receive 2 or 3 weeks' vacation with pay, depending on their length of service, and from 6 to 8 paid holidays a year. Almost all electronics workers are covered by health and life insurance plans; many are covered by pension plans and other fringe benefits.

Working conditions in electronics manufacturing compare favorably with those in other industries. Plants are usually well lighted, clean, and quiet. Many plants are relatively new and are located in suburban and semi-rural areas. Most plant departments are air conditioned where dust-free conditions or air temperature control is necessary for the manufacture of certain types of electronic equipment. The work in most electronics occupations is not strenuous. Many assembly line operations are repetitious. Music during working

hours, cafeterias, recreational facilities, and social programs are provided for employees by some electronics manufacturing firms.

The frequency of injuries in electronics manufacturing is far below the average in manufacturing as a whole, and injuries are usually less severe.

Many workers in electronics manufacturing are covered by la-

bor-management agreements. The principal unions involved are the International Union of Electrical, Radio and Machine Workers; International Brotherhood of Electrical Workers; International Association of Machinists and Aerospace Workers; and the United Electrical, Radio and Machine Workers of America (Ind.).

Sources of Additional Information

Further information concerning careers in electronics manufacturing can be obtained from the public relations department of individual electronics manufacturing companies and from:

Electronic Industries Association,
2001 Eye St. NW., Washington,
D.C. 20006.

OCCUPATIONS IN THE INDUSTRIAL CHEMICAL INDUSTRY

The industrial chemical industry has grown, in just a few decades, into one of the great manufacturing industries of our Nation. An important reason for this growth has been the industry's huge expenditures for research and development activities, which have provided many new and improved products for its customers—mainly other manufacturing industries. A wide variety of industrial chemical products contribute to our everyday needs and comforts, e.g., synthetic fibers are used in clothing and rugs, and plastics in dinnerware and furniture. Also, they are essential for the manufacture of missile and space equipment, rocket propulsion fuels, and for other national defense and space materials.

In 1968, about 530,000 wage and salary workers were employed in the industrial chemical industry in a wide range of occupations. Job requirements varied from graduate college degrees for some scientists and engineers to a few days of on-the-job training for some plant workers.

Nature of the Industry

The industrial chemical industry is made up of plants which manufacture industrial inorganic and organic chemicals, plastic materials and synthetic resins, synthetic rubber and synthetic and other man-made fibers, except glass. These chemicals are used mainly by other companies in the chemical industry, and by other manufacturing industries as raw materials or as processing agents to make their own products. Industrial chemicals are unlike other chemical products,

such as drugs, soaps, detergents, cosmetics, perfumes, paints, and fertilizers, which are sold directly to the consumer without further processing. The latter are not discussed in this statement.

Industrial chemical plants make organic chemicals from raw materials obtained from the remains of prehistoric life such as coal, petroleum, and natural gas, or from living materials such as agricultural and forest products. Some products of organic chemicals such as synthetic fibers, synthetic rubber, and plastics are well known. Among those less well known to the public are coal tar crudes, benzene, acetone, and formaldehyde. The principal users of organic chemicals include the textile, plastics products, rubber, and food-processing industries.

Inorganic chemicals come from nonliving matter, such as salt, sulfur, mineral ores, and limestone. They are basic materials for making, or helping to make, other chemicals as well as finished products, such as steel, glass, paper, and gasoline. In at least one respect, the manufacture of chemicals differs from the manufacture of most other products—the ingredients which are used to make chemicals undergo reactions which produce compounds vastly different in nature and appearance from those of the original raw materials. For example, by rearranging and combining the molecules of coal, air, and water, the chemists can produce nylon, a product having no similarity to its raw materials.

A modern chemical plant is made up of huge towers, tanks, and buildings linked together by a network of pipes. These struc-



Operator descends after completing maintenance inspection of reactor unit.

tures contain the various types of equipment needed to process raw materials into chemical products. Raw materials go through several processing operations such as drying, heating, cooling, mixing, evaporating, and filtering. Between each operation, the materials, which may be liquid, solid, or gas, are transported by pipes or conveyors. Throughout these operations, automatic control devices regulate the flow of materials, the combination of chemicals, and the temperature, pressure, and time needed for each operation. These control devices make it possible for tons of material to be processed in one continuous operation with very little manual handling of materials.

Approximately 2,800 plants in the United States make industrial chemicals. About two-thirds of the plants have fewer than 50

employees each. However, more than one-half of industrial chemical workers are employed in very large plants of 500 or more employees each. Chemical plants are usually located on the outskirts of industrial centers. Sometimes plants are built near the sources of raw material; for example, plants which produce chemicals made from petroleum and natural gas are located near the oilfields and refineries of Texas, California, and Louisiana.

Although industrial chemical workers are employed in most States, more than 60 percent of the employees and more than one-half the plants are in the following 10 States: New Jersey, Texas, New York, Tennessee, Virginia, Pennsylvania, Delaware, West Virginia, Michigan, and Ohio.

Occupations in the Industry

Workers with many different levels of skills and education are employed in the plants, offices, and laboratories of industrial chemical firms. More than 3 out of every 5 employees are engaged in processing operations, maintenance duties, or other plant-related activities. A large number of scientists, engineers, and other technical personnel are also employed because of the highly technical nature of chemical products and the methods used to produce them. Administrative and professional employees, such as purchasing agents, salesmen, accountants, lawyers, and personnel officers, make up another sizable segment of the industry's work force. In addition, large numbers of clerical workers, such as bookkeepers, stenographers, typists, and office machine operators, are employed.

About 1 out of every 8 workers in the industrial chemical indus-

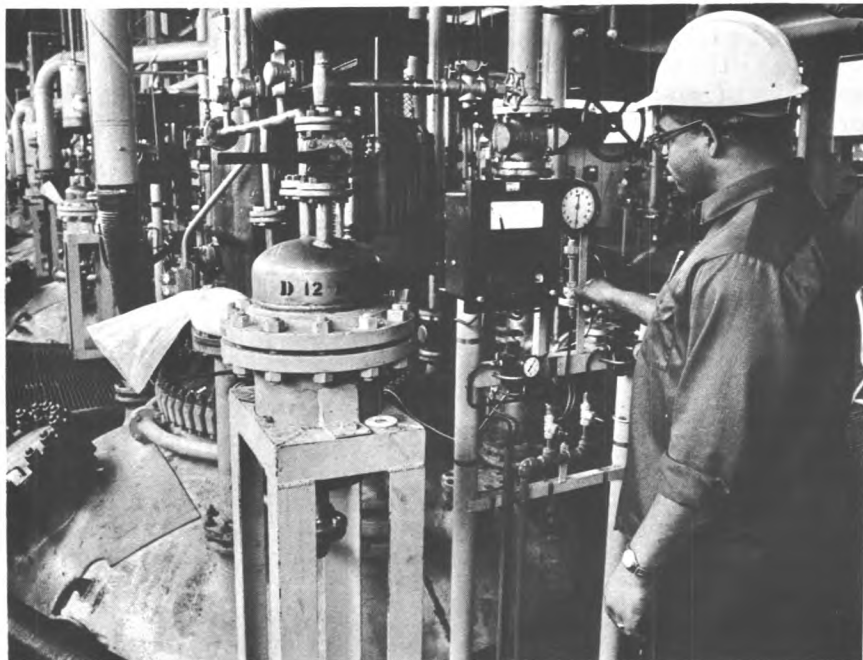
try is a woman. Most women in this industry work in clerical jobs, although some work in chemical laboratories as research chemists or as laboratory technicians and assistants. In a few industrial chemical plants, women are employed as chemical operators or as packers.

Plant Occupations. Plant workers, who represent 3 out of every 5 employees in the industrial chemical industry, can generally be divided into three major occupational groups: Processing workers, who operate the chemical-processing equipment; maintenance workers, who maintain, install, and repair machinery, pipes, and equipment; and other plant workers, such as stock clerks, material handlers, and truckdrivers.

Process equipment operators and their helpers are the largest occupational group in the industrial chemical industry. Many of these operators are highly skilled workers. *C h e m i c a l o p e r a t o r s*

(D.O.T. 558.885 and 559.782) control the various pieces of equipment which convert raw materials into chemical products. Operators are responsible for carrying out instructions given to them by the supervisor in charge. Operators set dials on devices that measure the exact amount of materials to be processed and control temperature, pressure, and flow of materials. They keep a record of operations and report any sign of breakdown of equipment. They may use instruments which measure and test chemicals or they may send samples of chemicals to laboratory technicians in the testing laboratory. They may be assisted by chemical operators of less skill, as well as by helpers. Sometimes chemical operators are classified according to the type of equipment they operate, such as filterer, grinder, or mixer.

The industry employs many skilled maintenance workers to prevent interruptions of its highly automated production proc-



Operator monitors control of process reactors.



Technician examines manmade fiber during production process.

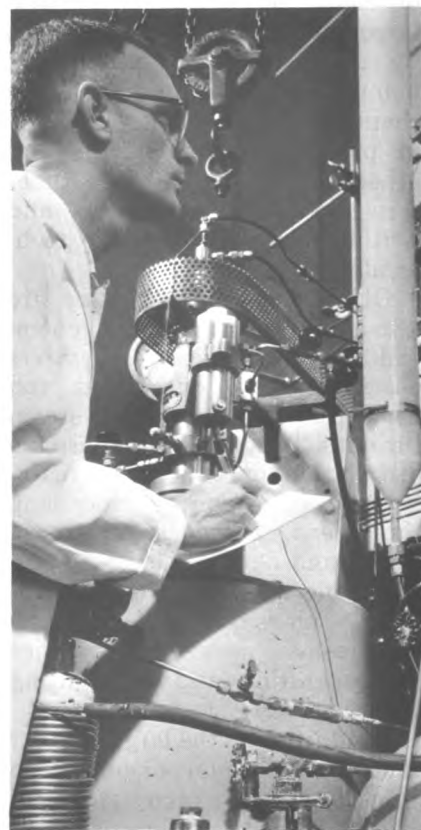
esses. Maintenance skills are also very important because of the extremes of temperature, pressure, and corrosion to which pipes, vats, and other plant equipment are subjected. Included among maintenance workers are *pipefitters*, who lay out, install, and repair pipes and pipefitting; *maintenance machinists*, who make and repair metal parts for machines and equipment; *electricians*, who maintain and repair wiring, motors, switches, and other electrical equipment; and *instrument repairmen*, who install and repair electrical and electronic instru-

ments and control devices. In some chemical plants, the duties of several maintenance jobs may be combined into a single job and performed by one maintenance man.

Plant workers who do not operate or maintain equipment perform a variety of other tasks in industrial chemical plants. Some drive trucks and tractors to make deliveries to various parts of the plant; some load and unload materials on trucks, trains, or ships; and other workers keep inventory records of stock and tools. The industry also employs custodial

workers, such as guards, watchmen, and janitors, whose duties are similar to those of such workers in other industries.

Scientific and Technical Occupations. The industrial chemical industry is one of the Nation's largest employers of scientific and technical personnel. About 1 out of every 6 employees in this industry is in some activity requiring scientific, engineering, or technical training. About 40 percent of these employees work in laboratories, developing new chemical products and new methods of production as well as performing basic research. About one-third are involved in the production of chemicals and in other plant operations. The remaining scientific and technical personnel are in analysis and testing work, and in



Chemist conducts research on polymers.

administrative or sales positions requiring technical background.

Chemists and chemical engineers make up the largest proportion of scientific and technical personnel in the industrial chemical industry. Many *chemists* work in research and development laboratories. A large number work in production departments, analyzing and testing chemicals in order to control their quality during processing. Some chemists are supervisors of plant workers; others are technical salesmen, technical writers, or administrators whose positions require technical knowledge.

Chemical engineers apply their knowledge of both chemistry and engineering to the design, construction, operation, and improvement of chemical equipment and plants. They convert processes developed in a laboratory into large-scale production methods, by using the most economical manufacturing techniques. Some chemical engineers are employed in production departments and others are in selling, customer service, market research, and writing jobs which require technical knowledge and skill.

Other types of engineers are also employed in industrial chemical firms. *Mechanical engineers* design and lay out power and heating equipment, such as steam turbines. They often supervise the installation, operation, and maintenance of chemical processing equipment. *Electrical engineers* design and develop electrical and electronic machinery and equipment, such as control devices and instruments, as well as facilities for generating and distributing electric power.

In addition to the large number of such professional personnel, the industry employs many technical assistants such as laboratory technicians, draftsmen, and engineer-



Chemical engineer checks plant designer's calculations.

ing aids. *Laboratory technicians* assist chemists and engineers in research and development work and in quality control. They may perform simple routine tests or experiments, or do highly technical testing and analyses of chemical materials, depending on

their training and experience. Much of the work of laboratory technicians consists of conducting tests and recording the results—often in the form of simple reports, charts, or graphs—for interpretation by chemists and chemical engineers.

Administrative, Clerical and Related Occupations. About 1 out of every 5 employees in the industrial chemical industry is an administrative, clerical, or other white-collar worker. Many high-level administrative and management positions are filled by men with training in chemistry or chemical engineering. At the top of the administrative group are the executives who make policy decisions concerning matters of finance, types of products to manufacture, and location of plants. To make such decisions, executives require the help of a large body of specialized personnel in the company. Some of these workers are accountants, purchasing agents, sales representatives, lawyers, and personnel employed in activities such as industrial relations, public relations, transportation, advertising, and market research. Other workers are required to assist these specialized administrative workers. For example, clerical employees keep records on personnel, payroll, raw materials, sales, shipments, and plant maintenance.

(Detailed discussions of professional, technical, mechanical, and other occupations found not only in the industrial chemical industry but in other industries as well are given elsewhere in this *Handbook* in the sections covering the individual occupations. See index for page numbers.)

Training, Other Qualifications, and Advancement

The industrial chemical industry generally hires inexperienced workers for processing and maintenance jobs and trains them on the job. Companies in the industry prefer to hire young workers who are high school graduates.

In many plants, a new worker is sent to a labor pool from which

he is assigned to jobs such as filling barrels and moving materials. After several months, he may be transferred to one of the processing departments when a vacancy occurs. As he gains experience, he moves to more skilled jobs in his department. Thus, he may advance from laborer to chemical operator helper, to assistant chemical operator, and then to skilled chemical operator. Skilled processing workers are rarely recruited from other plants.

Many industrial chemical companies have on-the-job training programs, which may last from their maintenance shops. These programs, which may last from a few months to several years, include some classroom instruction related to the trainees' particular work. Instrument repair trainees often learn how to assemble and repair instruments in the factories which manufacture them. Many companies encourage skilled maintenance workers as well as trainees to take courses related to their jobs in local vocational schools and technical institutes, or to enroll in correspondence courses. Upon the successful completion of these courses, workers are reimbursed for part or all of the tuition.

A bachelor's degree in engineering, chemistry, or one of the other sciences is the minimum educational requirement for entry into scientific and engineering jobs in the industrial chemical industry. For jobs in research laboratories, applicants with advanced degrees are generally preferred. Some companies have formal training programs for young college graduates with engineering or scientific backgrounds. These men work for brief periods in the various divisions of the plant to gain a broad knowledge of chemical manufacturing operations before being as-

signed to a particular department. Other firms immediately assign junior chemists or engineers to a specific activity such as research, process development, production, or sales.

Technicians in the industrial chemical industry qualify for their jobs in many different ways. Companies prefer to hire men and women who have obtained a formal education in technical institutes or junior colleges. However, most workers become technicians through on-the-job training and experience. Generally, industrial chemical firms select young men from their labor pool and give them training while they work at one of the technician jobs. Sometimes, technicians may be sent to a technical institute for training, usually at company expense. Students who have not completed all requirements for a college degree, especially those who have received some education in mathematics, science, or engineering, are often employed in technician jobs.

Laboratory technicians begin their work in routine jobs as assistants and advance to jobs of greater responsibility after they have acquired additional experience and have shown their ability to work without close supervision. Inexperienced draftsmen usually begin as copyists or tracers. With additional experience and training, they may advance to more skilled and responsible jobs as draftsmen.

Administrative positions frequently are filled by men and women who have college degrees in business administration, marketing, accounting, economics, statistics, industrial relations, or other specialized fields. Some companies have advanced training programs in which they give their new employees additional training in their chosen specialties.

Clerks, bookkeepers, stenographers, and typists in industrial chemical firms generally have had commercial courses in high school or business school. Although the qualifications and duties of administrative sales, clerical, and related occupations in this industry are similar to those in other industries, a knowledge of chemistry is often helpful. This is especially true of those sales jobs in which it is necessary to give technical assistance to customers.

Employment Outlook

The growing industrial chemical industry is expected to provide many thousands of job opportunities for new workers each year through the 1970's.

In addition to a moderate growth in employment in the industry, large numbers of job openings will be created by retirements, deaths, or transfers to jobs in other fields of work. Retirements and deaths alone probably will provide, on the average, more than 10,000 openings each year through the 1970's.

The industrial chemical industry's emphasis on research and development is expected to continue to stimulate the growth of this dynamic industry, which has far outstripped most other major industries in the development of new products. Some of these products, such as plastics and synthetic fibers, have not only created completely new markets, but also have competed successfully in markets previously dominated by wood, natural textile fibers, and metals. They are expected to continue to make inroads into these markets. A plentiful supply of the raw materials used in chemical manufacturing is also favorable to the industry's future growth.

The atomic energy field is an area where continued growth, in civilian as well as military applications, will favorably affect the demand for industrial chemicals. These chemicals are used in various aspects of atomic energy work, such as the processing and purification of uranium ores and the development and operation of nuclear reactors.

Although industrial chemical production has grown rapidly, employment has increased at a much slower rate. Since 1958, the number of industrial chemical workers has grown about 26 percent in contrast with output, which has more than doubled. The major reason for this difference is the industry's emphasis on improved methods of making chemicals. The widespread use of automatic processing and control equipment has enabled the industry to increase its production considerably with a relatively small increase in labor. Increases in output per worker are expected to continue in the years ahead, as new plants with the latest equipment are constructed and more modern devices are installed in the older plants.

Some occupational groups in the industry are expected to grow faster than others. For example, the number of professional and administrative jobs is expected to increase more rapidly than the number of plant (processing and maintenance) workers if recent trends in this industry continue. Emphasis on research and development and greater complexity of products and processes are expected to increase the need for chemists, engineers, technicians, and other technical personnel.

Most of the demand for additional plant workers will be for skilled maintenance workers, such as instrument repairmen, pipefitters, electricians, and maintenance machinists, because

of the increasing use of instrumentation and automatic equipment in processing operations. Process equipment operators will continue to be the largest occupational group in the industry, although employment of these workers is not expected to increase as much as employment of maintenance workers.

Earnings and Working Conditions

Production workers in the industrial chemical industry are among the higher paid factory workers. Average earnings are relatively high because of the large proportion of workers in skilled occupations. In 1968 production workers in plants producing industrial inorganic and organic chemicals had average earnings of \$152.76 a week or \$3.62 an hour and those in plants producing plastics materials and synthetic rubber, resins, and fibers had average earnings of \$136.53 a week or \$3.22 an hour. In comparison, average earnings in 1968 for production workers in manufacturing industries as a whole were \$122.51 a week or \$3.01 an hour.

Entry salaries for inexperienced chemists and chemical engineers in the industrial chemical industry are among the highest in American industry, according to a 1968 survey conducted by the American Chemical Society. In this industry, the median starting salary was \$725 a month for chemists with a bachelor's degree and \$800 a month for chemical engineers with a bachelor's degree. Chemists and chemical engineers with graduate degrees received higher starting salaries.

Paid vacations are universal in this industry and are generally based on length of service. For example, workers in many plants receive a 1-week vacation after

1 year of employment, 2 weeks after 3 years, 3 weeks after 10 years and 4 weeks after 20 years.

Most workers are covered by insurance plans. These plans include life, sickness, accident, hospitalization, and surgical insurance. Practically all plants have pension plans.

Many chemical workers are employed in plants that operate around the clock—three shifts a day, 7 days a week. Owing to the widespread industry practice of rotating shifts, processing workers can expect to work the second or third shift at one time or another. Nearly all workers receive extra pay for shift work, about 10 cents more an hour for the second shift, and about 15 cents more an hour for the third or night shift. Very few maintenance workers are employed on these shifts. Work in the industry has little seasonal variation and regular workers have year-round jobs.

Except for work performed by laborers and material handlers, most industrial chemical jobs re-

quire little physical effort. Much of the plant work involves tending, inspecting, repairing, or maintaining machinery and equipment, since most of the process operations are controlled automatically or semiautomatically. Duties require some workers to climb stairs and ladders to considerable heights. Other jobs are performed out of doors in all kinds of weather.

In some plants, workers may be exposed to dust, disagreeable odors, or high temperatures. Chemical companies, however, have reduced the discomforts arising from these conditions by installing ventilating or air-conditioning systems. Safety measures, such as protective clothing and eye glasses (usually provided by the company), warning signs, showers and eye baths near dangerous work stations, and first-aid stations, have also reduced hazards. These measures have helped to make the injury-frequency rate (number of disabling injuries for each million man-hours worked) in the industrial

chemical industry less than half that for all manufacturing industries.

Most production workers in the industrial chemical industry are members of labor unions. The leading unions are the International Chemical Workers Union; Oil, Chemical and Atomic Workers International Union; and District 50, United Mine Workers of America (Ind.).

Sources of Additional Information

Further information concerning careers in the industrial chemical field may be obtained from the public relations department of individual industrial chemical manufacturing companies and from:

American Chemical Society, 1155
16th St. NW., Washington, D.C.
20036.

Manufacturing Chemists' Association, Inc., 1825 Connecticut Ave.
NW., Washington, D.C. 20009.

OCCUPATIONS IN THE IRON AND STEEL INDUSTRY

Steel is the backbone of any industrialized economy. There is hardly a product in daily use that has not been made from steel or processed by machinery made of steel. In 1968, United States steelmakers produced approximately 130 million tons of steel—about one-fourth of the world's output.

The iron and steel industry is one of the Nation's largest employers. About 630,000 wage and salary workers were on the payrolls of the industry's more than 700 plants in 1968. Employees work in a broad range of jobs requiring a wide variety of skills—from unskilled to technical and professional jobs. Many of these jobs are found only in iron and steelmaking or finishing.

The iron and steel industry, as discussed in this chapter, consists of blast furnaces, steelmaking furnaces, and rolling mills, including mills engaged in finishing and rolling steel products from purchased sheets, strips, bars and rods, and other materials. The production of iron and steel consists of a closely related series of production processes. First, iron ore is converted to molten iron in blast furnaces. The molten iron is poured into "hot metal cans" and either transported directly to the steelmaking furnace or cast into "pigs" (iron in rough bar form) for use by foundries or by steel mills that do not produce their own iron. See chart 31.) Molten iron or pig iron is then converted into steel in various types of steelmaking furnaces, including open hearth, basic oxygen, and electric furnaces. The steel then is rolled into basic products, such as plates, sheets, strips, rods, bars, rails, and struc-

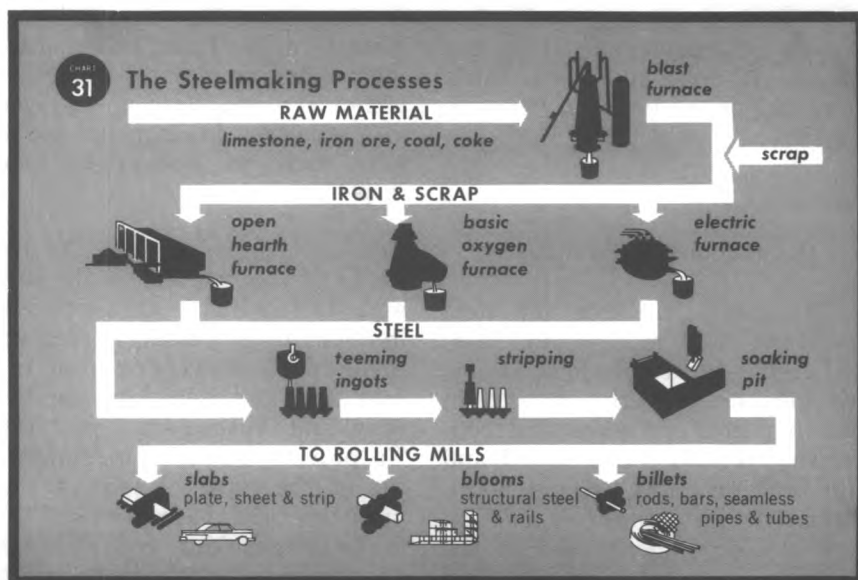
tural shapes. Many plants carry the manufacturing processes beyond the primary rolling stage to produce finished products such as tinplate, pipe, and wire products. (This chapter does not describe the mining of coal, iron ore, limestone, and other raw materials used to make steel, or the casting, stamping, forging, machining, or fabrication of steel. These activities are not considered to be in the iron and steel industry. Employment opportunities in foundry, forging, and machining occupations are discussed elsewhere in the *Handbook*.)

Steel companies differ in the number of operations they perform. Many of them, known as integrated companies, produce their own coke from coal, reduce ore to pig iron, make steel, and form the steel into products by rolling and other finishing methods. These companies account for the bulk of total steel production and employ most of the industry's

workers. Another group of companies make various types of steel from steel scrap and pig iron purchased from other companies. A third group rolls and finishes purchased raw steel. A fourth type makes only pig iron to be sold to small steel plants and foundries.

Most of the basic products made by steel mills are shipped to the plants of other industries, where they are made into thousands of different products. Some steel mill products, however, such as rails, pipe, and nails, are produced in their final form at the mills. The leading steel consuming industries are automobile, construction and building materials, machinery and machine tools, containers, and household appliances.

Steel sheets are made into automobile bodies, household appliances, and metal furniture. Steel bars are used to make parts for automobiles and machinery and to reinforce concrete in building and highway construction. Steel plates become parts of ships, bridges, heavy machinery, railroad cars, and storage tanks. Strip steel is used in the manufacture of items such as pots and



pan, automobile body parts, razor blades, and toys. Tin coated steel, known as "tinplate," is used primarily to make "tin" cans.

Individual plants in this industry typically employ a large number of workers. About 70 percent of all the industry's employees work in plants which have more than 2,500 wage and salary workers. A few plants have more than 20,000 employees. However, many plants employ fewer than 100 workers, particularly those plants which make highly specialized steel products.

Iron and steel producing plants are located mainly in the northern and eastern parts of the United States. There are large plants located on the south shore of Lake Michigan; at Cleveland and Youngstown, Ohio; Buffalo, N.Y.; and Pittsburgh, Johnstown, Bethlehem, and Morrisville, Pa. The Nation's largest steel plant is located at Sparrows Point near Baltimore, Md. Much of the steelmaking in the South is in the vicinity of Birmingham, Ala., and Houston, Tex. Important steelmaking facilities also are located in the Far West.

About 7 out of 10 of the industry's workers are employed in five States—Pennsylvania, Ohio, Indiana, Illinois, and New York. Nearly 3 out of 10 are in Pennsylvania.

Occupations in the Industry

Workers in the iron and steel industry hold more than 1,000 different types of jobs. Some workers are directly engaged in making iron and steel and converting it into semifinished and finished products. Others maintain the vast amount of machinery and equipment used in the industry, operate cranes and

other equipment which move raw materials and steel products about the plants, or perform other kinds of work. In addition, many workers are needed to do the clerical, sales, professional, technical, administrative, and supervisory work connected with the operation of steelmaking plants.

Four-fifths of all employees in the iron and steel industry in 1968 were production and maintenance workers. These workers were directly concerned with the production and finishing of iron and steel, the maintenance of plant equipment, and movement of materials within and among plant departments. The remaining employees were employed in clerical, sales, professional, technical, administrative, research, managerial, and supervisory occupations.

Men constitute 96 percent of all employees in the iron and steel industry, and an even higher proportion of the industry's production workers since much of the production work is strenuous. However, the physical labor involved in steelmaking has been reduced through mechanization. About two-thirds of all the women employed in the industry work in clerical and other office jobs, including research and other technical work. Women employed in production departments are in jobs such as assorter and inspector.

Processing Occupations. The majority of the workers in the iron and steel industry are employed in the many processing operations involved in converting iron ore into steel and then into semifinished and finished steel products. To provide a better understanding of the types of jobs in this industry, brief descriptions of the major steelmaking and finishing operations and of the more impor-

tant occupations connected with them are given below.

Blast furnaces. The blast furnace is used to reduce iron ore to molten iron. Calculated mixtures of iron ore, coke, and limestone are fed into the top of the furnace. Hot air, blown in from the bottom of the furnace, rises through the mass of material and causes combustion. The gases formed by the burning of the coke combine with and remove the oxygen from the ore.

Molten iron trickles down through the charge and collects in a pool at the bottom of the furnace. At the same time, the intense heat calcines the limestone which combines with silica and other impurities in the iron ore and coke and forms molten "slag," a useful byproduct. This, too, trickles down through the charge and floats on top of the heavier molten iron. The slag and molten iron ore are separately tapped or "cast" from the blast furnace.

A blast furnace operates continuously, 24 hours a day, 7 days a week, unless it has to be shut down for repairs or other reasons. Molten iron is removed every 3 to 4 hours; slag is removed more frequently. The charging of iron ore, coke, and limestone into the furnace is a continuous operation. A single blast furnace may produce up to 4,500 tons of molten iron in a 24-hour period. Output can be increased to over 5,000 tons per day if pre-reduced iron pellets are used.

The raw materials used in blast furnaces are stored in a stock house below furnace level. Here *stockhouse men* or *stockhouse larrymen*. (D.O.T. 919.883) load traveling stock or larry cars with raw materials from storage bins. They weigh all raw materials according to a prearranged schedule, determined by the kind of hot metal desired. The loaded stock

cars are emptied into waiting "skip cars," which carry the materials up tracks to the top of the blast furnace where they are automatically dumped. Other stockhouse men or *skipmen* (D.O.T. 921.883), stationed on the ground below, control the skip cars through electric and pneumatic controls. *Stove tenders* (D.O.T. 512.782) and their assistants operate huge, bricklined stoves which heat air for the blast furnace. They regulate valves to control the heating cycle of the stoves and regulate the flow of heated air to the furnace.

The men responsible for the quantity and quality of iron produced are called *blowers* (D.O.T. 519.132). They direct the operation of one or more blast furnaces, including loading and tapping the furnace, and regulating the air blast and furnace heat. Blowers carefully check the metal produced, periodically sending samples of the molten iron and slag to the laboratory where quality tests are made and the results reported to the blower. *Keepers* (D.O.T. 502.884), under the direction of the blower, are responsible for tapping the furnace. They direct their helpers and *cindermen* or *slaggers* (D.O.T. 519.887) in lining (with special refractory sand) the troughs and runners through which the molten iron and slag are run off into waiting cars.

Steel furnaces. The second major step in steelmaking is to convert the iron into steel. This is done in several types of furnaces: Open hearth; basic oxygen; and electric.

Open-hearth steel, which accounts for slightly over half of all steel produced in the United States, is produced by adding molten pig iron to previously charged and heated steel scrap and limestone and melting the mixture in furnaces. It is possible



Blower takes sample of molten pig iron for quality tests.

to make from about 125 to more than 600 tons of steel per load or "heat", depending upon the size of the furnace. Most of the open-hearth steelmaking facilities now use oxygen in the refining operation to speed up the process.

A *melter* (D.O.T. 512.132) is in charge of one open-hearth furnace or more and is responsible for the quality and quantity of the steel produced. The melter makes the steel to the desired specifications by varying the proportions of limestone, iron ore, scrap steel, and molten pig iron in the furnace, and by adding small amounts of other materials such as manganese, silicon, or copper. He supervises three grades of helpers—*first* (D.O.T. 512.782), *second* (D.O.T. 502-

884), and *third* (D.O.T. 519.887). These helpers prepare the furnaces for the heat, regulate furnace temperatures, take samples of molten steel for laboratory tests, direct the adding of various alloying materials, and tap the molten steel from the furnace into a ladle. One first helper is responsible for each open-hearth furnace.

The *charging machine operator* (D.O.T. 512.883) runs an electrically controlled machine with a long steel arm which picks up, one by one, long steel boxes full of limestone, scrap, and other materials. The machine pushes each box through the open furnace doors, turns it upside down to discharge its contents, and then withdraws it. The *hot metal craneman* (D.O.T. 921.883) oper-

ates a large overhead crane that picks up ladles of molten iron and pours the contents into the open-hearth furnaces.

When the heat of steel is ready to be tapped, the furnace crew knocks out a plug at the back of the furnace with a "jet tapper" (small explosive charge which is fired into the plug) which allows the molten metal to flow into a ladle. The slag, which floats to the top of the ladle, overflows into a smaller ladle called a slag pot.

The molten steel then is teemed from the ladle into ingot molds (hollow cast iron forms). A *ladle craneman* (D.O.T. 921.-883) operates an overhead crane which picks up the ladle and moves it over a long row of ingot molds resting on flat-bottom cars. The *steel pourer* (D.O.T. 514.-884) operates a stopper on the bottom of the ladle to let the steel flow into the molds.

As soon as the steel in the molds has solidified sufficiently, an *ingot stripper* (D.O.T. 921.-

883), operates an overhead crane, which removes the molds from the still hot blocks of steel, called ingots, and places them on "ingot buggies" (four-wheel carts running on rails) for movement to the soaking pits.

Over one-third of all steel produced in 1968 was made in basic-oxygen furnaces (BOF), and the proportion is expected to increase rapidly in the years ahead. Basic oxygen furnaces can make steel faster than any other type of furnace currently in use, and continual displacement of the open-hearth steelmaking process by the basic oxygen method is expected. Some basic oxygen furnaces can produce more than 6,000 tons of steel in a 24-hour period. In this steelmaking process, oxygen is "blown" into the furnace through vertical pipes, or "lances," after it has been loaded with steel scrap and molten pig iron. Limestone and other slag forming materials are added to remove impurities from the steel. The use of oxygen speeds the steelmaking process because it is blown directly onto the molten metal forcing a faster chemical reaction and a higher bath temperature. BOF's are often computer controlled to increase the quality of the steel produced and to speed up the steel-making process.

Electric furnaces accounted for about 12 percent of all steel produced in 1968. In electric furnaces, steelmaking can be controlled very closely. Consequently, such furnaces are used to produce high quality and high alloy steel, such as tool and stainless steels, as well as the more common steels.

Rolling and finishing. The three principal methods of shaping metal in steel plants are rolling, casting, and forging. About three-fourths of all steel products are shaped by the rolling process. In this method, heated steel ingots



Molten metal is poured into basic oxygen furnace.

are squeezed longer and flatter between two cylinders or "rolls." Before ingots of steel are rolled, they are heated to the temperature specified by the plant's metallurgist. The heating is done in large furnaces called "soaking pits," located in the plant floor. A *heater* (D.O.T. 613.782) controls the soaking pit operation. He directs helpers in heating the ingots to the specified temperature and, with the help of control equipment, determines when they are ready for rolling. A *soaking pit craneman* (D.O.T. 921.883) operates an overhead crane, by means of electrical controls, to lift the stripped ingots from an ingot car and place them into the soaking pit. When the ingots are sufficiently "soaked" with heat, the heater opens the furnace covers and the craneman removes the ingots and places them on an ingot buggy, which carries them to the rolling mill. Here, the ingots are rolled into semifinished shapes—blooms, slabs, or billets. Blooms are generally more than 6 inches wide and 6 inches thick. Slabs are much wider than blooms. Billets are the smallest of these three shapes.

The rolling of blooms illustrates the semifinishing process. In the blooming mill, as in other rolling mills, the ingot moves along on a roller conveyor to a machine which resembles a giant clothes wringer. A "two-high" blooming mill has two heavy grooved rolls which revolve in opposite directions. The rolls grip the approaching ingot and pull it between them, squeezing it thinner and longer. When the ingot has made a "pass" through the rolls, the rolls are revolved in the opposite direction, and the ingot is fed back through them. Throughout the rolling operation, the ingot is periodically turned 90 degrees by mechanical devices called "manipulators," and passed between

the rolls again so that all sides are rolled. Guides, located on each side of the roll table, properly position the ingot for entry into the rolls. This operation is repeated until the ingot is reduced to a bloom of the desired size. The bloom then is ready to be cut to specified lengths.

A *blooming mill roller* (D.O.T. 613.782), the man in charge of the mill, works in a glass-enclosed control booth, or "pulpit," located above or beside the roller line. His duties, which appear to consist principally of moving levers and pushing buttons, look relatively simple. However, the quality of the product and the speed with which the ingot is rolled depend upon his skill. The roller regulates the opening between the rolls after each pass. Long experience and a knowledge of steel characteristics are required for a worker to become a roller. A *manipulator operator* (D.O.T. 613.-

782) sits in the pulpit beside the roller and coordinates his controls over the ingots direction with those of the roller.

Upon leaving the rolling mill, the red-hot bloom moves along a roller conveyor to a place where a *shearman* (D.O.T. 615.782) controls a heavy, hydraulically operated shear which cuts the steel into desired lengths.

In a blooming mill with automatic (electronic) process controls, a rolling mill attendant is given a card which has been punched with a series of holes. The holes represent coded information and directions as to how the ingot is to be rolled. The attendant inserts the card into a card "reader," then presses a button that starts the rolling sequence. The information in punched-card form governs the setting of the roll opening, the speed of the rolls, the number of passes to be made, and the number of times the ingot must be turned. When the automatic process is used, the roller's function is shifted from operating the rolling controls to directing and coordinating the entire rolling process. This consists of heating, rolling, and shearing.

Of increasing use in steel shaping is the continuous casting process. In this process, which eliminates the necessity of conventional pouring pits to produce large ingots that in turn must be put through huge blooming and slabbing mills, molten steel is poured into a water-cooled mold of the desired product shape located at the top of a tower. As the mold is filled, the steel solidifies along the bottom and lower sides. The mold bottom is then withdrawn and the slab or billet starts its descent through the tower. As the ribbon emerges from the mold, additional molten steel is continuously added at the top. Continuing downward, it



Mill operator controls cold reducing process.

passes through a spray chamber where it is further cooled by a water spray to solidify the still liquid core. Pinch rolls control its descent and support its weight. Finally, the slab or billet is cut into lengths as it emerges from the rolls. In some continuous casting installations, a curved mold is used so that the product comes out horizontally rather than vertically.

After the steel is rolled into semifinished shape—blooms, slabs, or billets—most of it is put through “finishing” operations. For example, steel slabs may be reduced and shaped into plates and sheets. Even after additional rolling, some steels must be worked further. Some rods, for instance, are reduced to wire by drawing. Wire can be further processed into wire rope, nails, fencing, or other end products. Much sheet steel is reduced further by cold-rolling, and then it may be run through galvanizing or tinplating lines.

Equipment operator, inspector, and assorter are among the major occupations in finishing operations; women frequently are employed in these jobs.

An important occupation in wire making is the *wire drawer* (D.O.T. 614.782). This worker pulls the pointed end of a steel rod through a die (a block of hard steel or sintered carbide with a tapered hole in it). The rod end then is attached to a reel which, while revolving, pulls the rest of the rod through the die. As the rod passes through the die it is made thinner and longer and becomes wire, which is coiled automatically around the revolving reel. If extensive reduction of the rod is required, it is passed through a series of dies, each die reducing the diameter of the wire slightly.

Pipe, both welded and seamless, is also an important steel mill

product. In making welded pipe, the flat steel is fed into a machine which through a series of forming rolls converts it into tube shape; then the edges of the pipe are fused by continuous welding.

Seamless pipe and tubing are formed from a solid billet of steel, called a tube round. In the seamless operation, the *piercer-machine operator* (D.O.T. 613.885) passes a preheated tube round between two barrel-shaped rolls. The revolving rolls spin the tube round and force one end against a piercing plug or “mandrel.” The combined rolling action and the pressure of the rolls tend to make the steel draw apart providing space for the mandrel to enter. The mandrel smooths the inside walls and makes the diameter of the hole uniform.

Tinplate is another important steel product. To make tinplate, thin gauge steel in coil form is fed continuously through an electrolytic bath where a coat of tin is deposited on the steel.

Maintenance, Transportation, and Plant Service Occupations. Large numbers of workers are required in steel plants to support processing activities. Some maintain and repair machinery and equipment, and others operate the equipment which provides power, steam, and water. Other groups of workers move material and supplies and perform a variety of service operations.

In the machine shops, machinists and machine tool operators make and repair metal parts for machinery or equipment. Die-makers use machine tools to form dies, such as those used in wire drawing units. *Roll turners* (D.O.T. 613.780) use lathes, grinders, and other machine tools to finish steel rolls to desired shapes and sizes for use in the rolling mills.

Millwrights in this industry maintain mechanical equipment.

They overhaul machinery and repair and replace defective parts. Electricians install electric wiring and fixtures and “hook up” electrically operated equipment. Electrical repairmen (motor inspectors) keep wiring, motors, switches, and electrical equipment in good operating condition and make repairs when electrical equipment breaks down.

Electronic repairmen install, repair, and adjust the increasing number of electronic devices and systems used in steel manufacturing plants. Typically, this equipment includes communication systems such as public address systems; closed-circuit television installations; electronic computing and data recording systems; and measuring, processing, and control devices such as X-ray measuring or inspection equipment.

Bricklayers repair and rebuild the brickwork in furnaces, soaking pits, and coke ovens, as well as mill buildings and offices. Pipefitters lay out, install, and repair piping that is used to carry the large amount of water, gas, steam, oil, air, oxygen, and acetylene used in the steelmaking process. Boilermakers test, repair, and rebuild heating units, storage tanks, stationary boilers, and condensers. Locomotive engineers and other train crew members operate diesel or electric trains used to transport materials and products in the vast yards of iron and steel plants. Welders operate welding equipment to join metal parts in repairing and rebuilding plant machinery and in fabricating steel products. Skilled workers run the various boilers, turbines, and switchboards in the powerplants which provide the large amounts of electric power needed in steel-making.

Other types of maintenance and service workers found in steel plants include carpenters, oilers,

painters, instrument repairmen, scale mechanic, loaders, riggers, greasers, janitors, and guards. Many laborers are employed to load and unload materials and do a variety of cleanup operations. *Administrative, Clerical, and Technical Occupations.* Professional, technical, administrative, clerical, and sales workers accounted for one-fifth of the industry's total employment in 1968. Of these, the majority were clerical workers, such as secretaries, stenographers, typists, accounting clerks, and general office clerks.

Engineers, scientists, and technicians made up a substantial proportion of the industry's "white-collar" employment. Several thousand of these workers were engaged in research and development to improve existing iron and steel products and processes, and to develop new products and processes.

The technical specialists in iron and steel plants also include mechanical engineers, whose principal work is the design, construction, and operation of mill machinery and material handling equipment. Many mechanical engineers work in operating units where their jobs include, for example, determination of roll size and contour, rolling pressures, and operating speeds. Others are responsible for plant and equipment maintenance. Metallurgists and metallurgical engineers work in laboratories and production departments where they have the important task of testing and controlling the quality of the steel during its manufacture. They also develop and improve the industry's products and processes through research. Civil engineers are engaged in the layout, construction, and maintenance of steel plants, and the equipment used for heat, light, and transportation. Electrical engineers de-

sign, lay out, and supervise the operation of electrical generating distribution facilities that provide the power essential in modern steel mill operation. These engineers also are concerned with the operation of electrical machinery and electrical and electronic control equipment.

Chemists work in the laboratories, making chemical analyses of steel and raw materials used in steel manufacture. Laboratory technicians do routine testing and assist chemists and engineers. Draftsmen prepare working plans and detailed drawings required in plant construction and maintenance.

Among the employees in administrative, managerial, and supervisory occupations were office managers, labor relations and personnel managers, purchasing agents, plant managers, and industrial engineers. Working with these personnel were several thousand professional workers, other than scientists and engineers. By far, the largest group of these professional employees were accountants, but there were also many nurses, lawyers, economists, statisticians, and mathematicians. In addition, the industry employed several thousand workers in sales positions.

(Detailed discussions of professional, technical, mechanical, and other occupations found in the iron and steel industry, as well as in many other industries, are given elsewhere in the *Handbook*.)

Training, Other Qualifications, and Advancement

New workers in processing operations usually are hired at the unskilled level as laborers. Openings in higher rated jobs usually are filled by promoting workers from lower grade jobs. Factors

considered when selecting workers for promotion are ability to do the job, physical fitness, and length of service with the company.

Training for processing occupations is done almost entirely on the job. Workers move to operations requiring progressively greater skill as they acquire experience. A crane operator, for example, first is taught how to operate relatively simple cranes, and then he advances through several steps to cranes much more difficult to run, such as the hot-metal crane.

In selecting workers for processing jobs, steel companies generally give preference to high school graduates. To help them advance in their work, many workers take part-time courses in subjects such as chemistry, physics, and metallurgy. In some cases, this training is provided by the steel companies and may be given within the plant. Other workers take evening courses in high schools, trade schools, or universities in their communities or enroll in correspondence courses.

Workers in the various operating units usually advance along fairly well-defined lines of promotion within their department. Examples of possible lines of advancement in the various operating units are described in the next paragraph.

To become a blast furnace blower, a worker generally starts as a laborer, advancing to cinderman or slagman, keeper's helper, keeper, blower's helper, and finally, to blower. In the open-hearth department, a man may begin by doing general cleanup work around the furnace and then advance to third helper, second helper, first helper, and eventually, to melter. A possible line of job advancement for a roller in a finishing mill might be

pitman, roll hand, manipulator, rougher, and finish roller. Workers can be trained for skilled jobs, such as blower, melter, and roller (which are among the highest rated steelmaking jobs), in a minimum of 4 or 5 years, but usually they have to wait a much longer time before openings occur.

Most companies conduct some type of apprenticeship program to meet the needs of their maintenance shops. There are apprentice training programs for more than 20 different crafts in the steel industry. The apprenticeship programs for maintenance workers usually are of 3 or 4 years' duration and consist mainly of shop training in various aspects of the particular jobs. In addition, classroom instruction in related technical subjects usually is given, either in the plant or in local vocational schools.

Steelmaking companies have different qualifications for apprentice applicants. Generally, employers require applicants to be high school or vocational school graduates. In most cases, the minimum age is 18 years; sometimes an upper age limit is specified. Some companies give aptitude and other types of tests to applicants to determine their suitability for the trades. Apprentices generally are chosen from among qualified young workers already employed in the plant. The following occupations are among those most often included in apprentice training programs in iron and steel plants: Blacksmith, boilermaker, bricklayer, coremaker, carpenter, electrician, instrument repairman, lead burner, machinist, molder, patternmaker, pipefitter, rigger, roll turner, sheet-metal worker, tool and die maker, and welder.

Applicants for jobs as helpers to skilled maintenance workers usually are given aptitude tests. Helpers receive on-the-job train-

ing and may be promoted to jobs requiring greater skill as openings occur. However, vacancies in these higher grades may not occur for several years, depending on the rate of turnover.

The minimum requirement for engineering and scientific jobs is usually a bachelor's degree with an appropriate major. Practically all the larger companies have formal training programs for college-trained technical workers in which the trainees work for brief periods in various operating and maintenance divisions to get a broad picture of steelmaking operations before they are assigned to a particular department. In other companies, the newly hired scientist or engineer is assigned directly to a specific research, operating, maintenance, administrative, or sales unit. Engineering graduates frequently are hired for sales work, and many of the executives in the industry have engineering backgrounds. Engineering graduates, as well as graduates of business administration and liberal arts colleges, are employed in jobs in sales, accounting, and labor-management relations, as well as in managerial positions.

Completion of a business course in high school, junior college, or business school usually is preferred for entry into most of the office occupations. Office jobs requiring special knowledge of the steel industry generally are filled by promoting personnel already employed in the industry.

Employment Outlook

A moderate increase in the production of iron and steel is expected during the decade ahead. The growing population and rising levels of personal disposable income will result in greater de-

mand for products that require large amounts of steel such as automobiles, houses, household appliances, and highways. New machinery also will be needed to produce the growing quantity of goods needed to feed, clothe, and otherwise satisfy the requirements of an expanding population.

Because of the expected increase in output per worker, and the fact that in recent years imports of steel have absorbed much of the growth of the market for steel, total employment in the industry is expected to decrease slowly below the 1968 level of approximately 630,000. Nevertheless, the iron and steel industry will hire many thousands of workers through the 1970's. Retirements and deaths alone in this large industry should provide about 13,000 job openings annually.

Despite the expected decline in overall employment, employment in some occupations, or occupational groups, still is expected to rise. Among white-collar workers, for example, employment of engineers, chemists, physicists, mathematicians, laboratory aids, and other technical personnel will increase, because of the industry's expanding research and development programs. Job opportunities for electronic technicians, electronic computer programmers, and other personnel trained in the preparation of data for use in these machines also are expected to increase. Among skilled plant personnel, maintenance workers (particularly instrument and electronic repairmen) are expected to be needed in greater numbers, because of the increasingly complex machinery, instruments, and other equipment used. In contrast, the number of less skilled processing jobs is expected to decline.

*Average Straight-time Hourly Earnings¹ of Workers
In Selected Occupations in Basic Iron and
Steel Establishments, September 1967*

	Median hourly earnings	Middle range
Blast furnaces:		
Larrymen	\$3.69	\$3.39-\$3.84
Stock unloaders	\$3.10	\$2.93-\$3.21
Open hearth furnaces:		
Charging machine operators	\$4.60	\$4.25-\$4.86
First helpers	\$5.61	\$5.08-\$5.94
Basic oxygen furnaces:		
Steel pourers	\$4.85	\$4.12-\$5.26
Furnace operators	\$5.02	\$4.61-\$5.74
Bloom, slab, and billet mills:		
Soaking pit cranemen	\$4.38	\$4.03-\$4.73
Manipulators	\$4.48	\$4.15-\$4.77
Continuous hot-strip mills:		
Assorters	\$2.89	\$2.75-\$2.90
Coilers	\$4.15	\$3.80-\$4.57
Maintenance:		
Bricklayers	\$4.10	\$3.57-\$4.39
Millwrights	\$3.83	\$3.50-\$4.08

¹Excludes premium pay for overtime and for work on weekends, holidays, and late shifts. Incentive payments, such as those resulting from piecework or production bonus systems and cost-of-living allowances, are included.

Earnings and Working Conditions

Earnings of production workers in iron and steelmaking establishments are among the highest in manufacturing. In 1968, their earnings averaged \$154.16 a week or \$3.76 an hour. This compares with average earnings of \$122.51 weekly, or \$3.01 an hour, for all production workers in manufacturing establishments.

Agreements between most steel companies and the United Steelworkers of America include provisions for various fringe benefits such as vacation pay, shift differentials, paid holidays, retirement pensions, and supplemental unemployment benefits. Most workers receive vacation pay ranging from 1 to 4 weeks, depending on length of service. In addition, the top 50 percent of the workers, ranked on the basis of seniority, receive 13-week vacations (including regular vaca-

tion time) every 5 years; and the remaining 50 percent receive 3 extra weeks vacation once in a 5-year period. Professional and executive personnel in a few companies receive similar benefits. Workers may retire on full pension after 30 years of service, regardless of age. Retiring workers are eligible for a company-paid pension, in addition to social security benefits for which they may be eligible. Employees having 2 years or more of service are eligible to receive supplemental unemployment benefits for up to 52 weeks. Other important provisions include accident and sickness, hospitalization, surgical, and life insurance benefits financed by the companies.

The American Iron and Steel Institute estimates wage supplements in 1967 as 28.4 percent of total employment costs or \$1.35 per hour worked.

Working conditions depend upon the particular plant department in which the worker is employed. Maintenance shops generally are clean and cool. Rolling mills, however, generally are hot and noisy. Some plants are developing methods to reduce job discomfort. For example, the use of remote control enables employees to work outside the immediate vicinity of processing operations. In other instances, the cabs in which the men work, while operating mechanical equipment are air conditioned. Some of the workers near blast and steel furnaces are exposed to considerable heat. Because certain processes are operated continuously, some workers are on night shifts or work on weekends.

The iron and steel industry is a leader in the development of safety programs for workers, emphasizing the use of protective clothing and devices on machines to prevent accidents. In recent years, steel plants had an average injury frequency rate (injuries per million hours of work) that was about one-third the rate of all manufacturing.

Most plant workers in the iron and steel industry are members of the United Steelworkers of America.

Sources of Additional Information

American Iron and Steel Institute,
150 East 42nd St., New York,
N.Y. 10017.

United Steelworkers of America,
1500 Commonwealth Building,
Pittsburgh, Pa. 15222.

MOTOR VEHICLE AND EQUIPMENT MANUFACTURING OCCUPATIONS

Few products have had as great an impact on everyday life as the automobiles, trucks, buses, and other vehicles manufactured by the motor vehicle and equipment industry (automobile industry). In 1968, 4 out of 5 families owned at least one automobile, and 1 family out of 4 owned two or more. Altogether, 100 million passenger cars, trucks, and buses traveled the Nation's streets and highways. In addition, the widespread use of motor vehicles has made significant contributions to the Nation's economy by helping to create new industries and develop existing ones. Many businesses, including automotive repair shops, gasoline service stations, and truck and bus transportation facilities have been created as a result of the motor vehicle. Moreover, the automobile industry is a major consumer of many basic commodities such as steel, rubber, and plate glass.

To manufacture the nearly 10.8 million motor vehicles (mainly automobiles) produced in 1968, the motor vehicle industry (SIC 371) employed approximately 868,000 employees. (In addition, thousands of people, whose employment is not included in this chapter, are employed outside motor vehicle plants in the production of components for the motor vehicle industry. These are persons engaged in the production of tires and tubes, automobile glass, vehicular lighting systems, storage batteries, and many other items.) Like other large industries, the automobile industry offers employment to men and women having widely different backgrounds of education and training. Job requirements vary from the college degree necessary for engineers and other professional and technical personnel to

the few hours of on-the-job training necessary for assemblers, material handlers, and custodial employees. The largest number of employees work in factory (plant) occupations. Plant occupations range from the skilled tool and die maker, millwright, and electrician, to those requiring little skill such as machine tender, assembler, material handler, and custodial worker. A great number of automotive employees also work in office and administrative jobs as clerks, business machine operators, stenographers, purchasing agents, and personnel assistants.

Nature and Location of the Industry

This industry's ability to produce millions of complex motor vehicles is due mainly to mass production of standardized parts and assembly-line manufacturing methods. Thousands of identical parts are produced by employees whose jobs are divided into a limited number of operations on high-speed machinery. These mass-produced parts then are put together by other employees to form the completed vehicle. As a result, new cars can be driven off assembly lines at the rate of more than one a minute.

The motor vehicle industry in 1967 consisted of approximately 2,700 plants that manufactured parts or assembled these parts into cars, trucks, buses, and special-purpose vehicles such as ambulances, fire engines, and taxicabs. The plants ranged in size from huge assembly plants employing thousands of workers to parts plants employing a small number. About 85 percent of the



Worker places weatherstrip around windshield.

industry's workers are employed in establishments with 500 employees or more.

In 1968, about 14 percent of the employees in the industry were engaged in the manufacture of bodies for passenger cars, trucks, and buses, and in the production of truck trailers and truck trailer chassis. The remaining 86 percent were almost equally divided between plants that supply parts for new motor vehicles, and plants that assemble components into the final product.

Hundreds of firms supply parts for new vehicles and also produce replacement parts necessary to keep the millions of vehicles already on the road in operation. These firms often specialize in producing individual parts—for instance, brakes, axles, and transmissions. Relatively few companies assemble complete vehicles.

Seven out of eight workers in the motor vehicle industry are employed in 10 States. Michigan alone accounts for more than 40 percent of the industry's employment; Ohio, Indiana, and New

York account for another 25 percent. The six other leading States are California, Missouri, Wisconsin, Illinois, Pennsylvania, and New Jersey.

The center of the industry is the Detroit metropolitan area where 1 out of 4 motor vehicle workers is employed. Several other cities in the Great Lakes region employing large numbers of motor vehicle workers are Flint, Lansing, and Saginaw, Michigan; Cleveland, Lorain, Toledo, and Cincinnati, Ohio; Indianapolis and Fort Wayne, Ind.; Chicago, Ill.; Buffalo, N. Y.; and Milwaukee and Kenosha, Wis.

Much of the motor vehicle manufacturing on the East Coast is centered in the New York-Northeastern New Jersey-Philadelphia industrial area in localities such as Newark, Paterson, Linden, and New Brunswick, N.J.; and New York, N.Y.

Leading automobile manufacturing centers in the Pacific Coast region are Los Angeles and San Francisco, California.

How Motor Vehicles Are Made

Automobiles and other motor vehicles are produced in three steps; preliminary designing and engineering, production of motor vehicle parts and subassemblies, and final assembly of parts into complete vehicles.

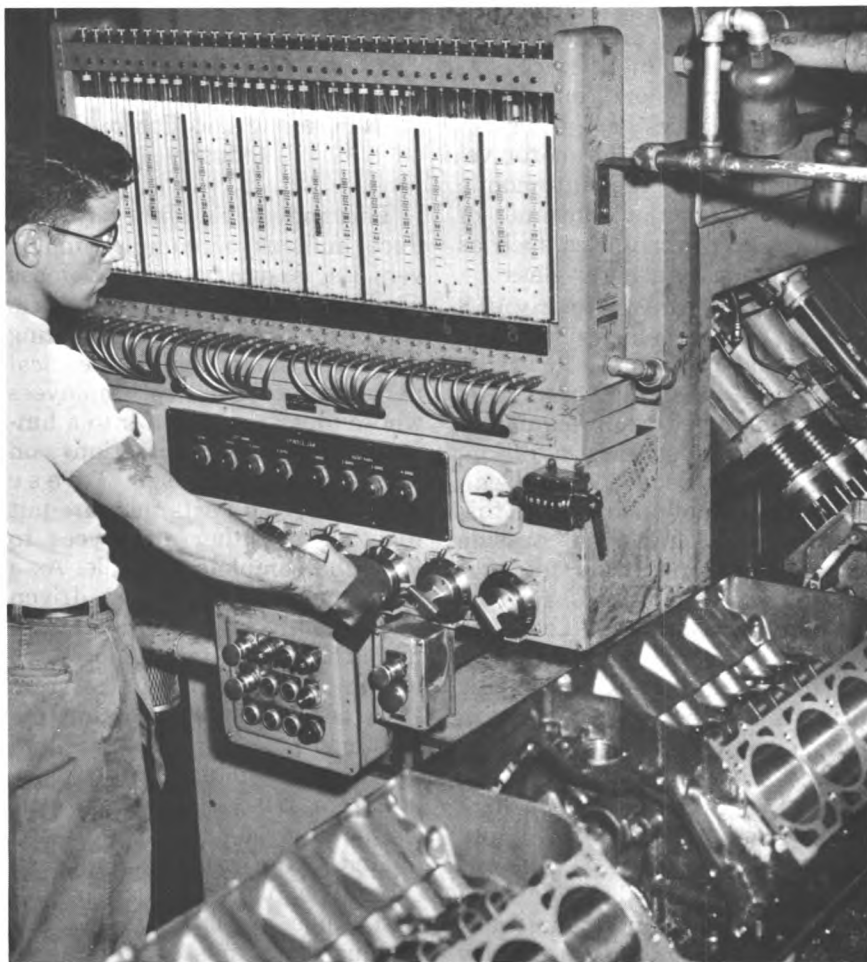
Preliminary Designing and Engineering. Approximately 2 to 3 years of designing, planning, and testing often precede the actual production of each year's model. Stylists constantly strive to improve the appearance of the automobile. They work closely with engineers and other technical personnel concerned with improving mechanical operation, design, and safety. The stylists' creative designs are transferred to blue-

prints, from which skilled model-makers make clay, wood, and plaster models. From these models, refinements in styling and design of the new car are developed. In order to mass-produce the car, master dies based on the finally accepted model are made.

In recent years, computers have played an increasingly important role in engineering and have been linked with numerically controlled drafting machines. These machines, automatically operated by a tape containing instructions prepared on a computer, produce engineering drawings. Another recent technique is the use of photographic

equipment to record points on a clay model which the computer then converts into full scale drawings. These methods have enabled the manufacturers to shorten the lead time required to prepare new models for production.

Production of Motor Vehicle Parts. After the design and engineering phases have been completed, thousands of component parts that later will later be assembled into a complete motor vehicle must be produced. A large variety of materials are used, the most common being steel, aluminum, copper, zinc, plastic, rubber, fabric, glass, iron, and lead.



Operator monitors machine that checks accuracy of cylinder bores.

The large number of metal parts are shaped by several different methods, depending on the purpose and size of the part and the metal being used. The casting process is used to produce bulky parts such as engine blocks. Parts which must withstand great stress, such as axles and wheel spindles, are produced by the forging process. Huge presses form the sheet metal and aluminum that compose the exterior body. Metal parts requiring precise dimensions, such as pistons and engine blocks, undergo further machine processing. These various processes are explained more fully under plant occupations.

The production of parts does not entirely consist of metalworking operations. Many parts are painted; seat cushions are prepared; engines are test run; and parts are stored or shipped to other plants. Throughout the production of parts, numerous inspections are made to insure that the quality of assembled vehicles will meet established standards.

Assembling the Final Product.

The last stage of motor vehicle manufacturing occurs on the final assembly line. Final assembly is the process of putting together in sequence the individual parts and subassemblies, after which the completed vehicle is driven off the line.

A conveyor carries the motor vehicle forward while men at work stations attach the necessary parts and subassemblies in proper sequence. Generally, large and heavy subassemblies, such as the engine and body, are lowered by hoists into position on the chassis as it is moved forward. Near the end of the assembly line, accessories, such as hubcaps and floor mats, are added; gasoline is pumped into the fuel tank; and the new vehicle is driven off the

line. Finally the headlights and wheels are aligned, and after the finished vehicle is inspected, it leaves the factory.

As the chassis moves along the assembly line, "banks" of parts and subassemblies located in aisles along the line are continually fed to assemblers according to a careful system of scheduling arranged by the production control departments. Behind the movement of parts and subassemblies to the assembly line is the work of materials control men who, months before, coordinated the delivery of parts from suppliers with a planned production schedule.

The sequence of models to be built may be transmitted to the various stations along the line by either teletype or telautograph. Information on color and special equipment desired in each car is obtained from orders placed by automobile dealers. By this scheduling program, cars of different colors and types follow each other on the assembly line—for example, a blue sedan may be followed by a beige station wagon.

Occupations in the Industry

The motor vehicle industry's 868,000 employees in 1968 worked in hundreds of occupations. Semiskilled plant workers, such as assemblers, inspectors, and material handlers, made up about one-half of all employees. An additional one-quarter were employed as foremen, mechanics and repairmen, machinists, tool and die makers, and in other skilled occupations. Clerical employees made up about one-tenth of the total. The remaining workers were employed in professional, technical, sales, and managerial occupations, and as unskilled workers and guards. More than 90 percent of the in-



Employees cut, sew, and fit upholstery.

dustry's employees are men. Of the women employed about half are in production jobs in which the work is not physically strenuous, such as assembling, inspecting, machine operating, and sewing and stitching; the rest are in clerical and other office jobs, including research and technical work.

The duties and training requirements of some of the important occupations are described briefly below. (Detailed discussions of professional, technical, mechanical, and other occupations found in the automobile industry, as well as in many other industries, are given in the sections of the *Handbook* covering individual occupations.)

Professional and Technical Occupations. The modern automobile is a product of the research, design, and development work of thousands of engineers, chemists, metallurgists, physicists, mathe-

maticians, draftsmen, and other professional, scientific, and technical personnel employed by the motor vehicle companies. About 26,000 scientists and engineers were employed in the motor vehicle industry in 1968. Engineers make up the largest group of professional and technical workers in the industry. Motor vehicle companies hire engineers specializing in mechanical, electrical, industrial, and other fields. The mechanical engineer seeks ways of improving the engine, transmission, or other parts of the automobile through research and development. The electrical engineer designs electrical parts, such as ignition systems, voltage regulators, and generators. The industrial engineer concentrates on the layout of plant equipment, improved processes, and production scheduling. The industry also employs civil, chemical, and ceramic engineers, and metallurgists.

About two-fifths of the scientists and engineers are engaged principally in research and development. Others may supervise technical production jobs. For example, metallurgists may supervise the melting operations in the precision casting and forging departments, and chemists may head the testing and analytical laboratory.

The industry also employs thousands of technicians, such as draftsmen, engineering aids, and laboratory assistants, to assist professional engineers and scientists.

Administrative, Clerical, and Related Occupations. Various skills are necessary to perform a great variety of administrative functions. Executives determine how many vehicles to produce, what styles to make, what prices to charge, which parts the company should produce or buy, and where to locate plants. Other administrative personnel, such as person-

nel managers and purchasing agents, direct individual departments or special phases of operations. Among those assisting the administrators are accountants, lawyers, market analysts, economists, statisticians, and industrial relations experts. Many supervise specific groups of office or plant employees.

The large staff of clerical workers, many of whom are women, includes secretaries, stenographers, bookkeepers, clerk-typists, key punch operators, and business machine operators.

Plant Occupations. More than three-fourths of the employees in the motor vehicle industry work in production operations. Most plant employees make parts and assemble them into complete vehicles. Other plant employees service and maintain the vast amount of machinery and equipment needed for automobile manufacturing.

Machining Occupations. Machining is the metalworking process generally best adapted for the production of parts to precise sizes. It is a process of cutting or chipping away excess metal from a part or piece of metal by the use of power-driven machine tools such as lathes; boring, grinding, and milling machines; drill presses; and gear cutters.

One of the largest metalworking occupations in the automobile industry is the machine tool operator. These workers operate power-driven machines which hold both the piece of metal to be cut and an instrument, or "tool," that cuts, shapes, drills, or grinds the metal. The job titles of employees, such as engine lathe operator, drill press operator, and milling machine operator, depend on what type of machine tools they operate.

Among the most highly skilled

machining workers are tool and die makers. Toolmakers make cutting tools and the jigs, fixtures, and other accessories that hold the metal being machined. Die-makers construct the dies used in stamping, pressing, forging, and other metalforming operations. Tool and die makers read blueprints, set up and operate machine tools, use precision-measuring instruments, and make shop computations.

The motor vehicle industry has taken the lead in developing continuous automatic production for many machining operations. This approach to production depends on a variety of instruments to direct and control manufacturing processes. As a step in the automation of machining processes, automobile manufacturers have linked automatic machine tools to perform various operations. Less labor is required because the parts or pieces being machined are not handled manually.

For example, in an automated engine plant, a rough engine block goes through hundreds of different cutting, drilling, and grinding operations using little direct manual labor. The engine block is moved into and out of work stations mechanically and is machined automatically by a battery of machine tools. Much of the inspection is automatic. The machine tools, conveyors, and inspection equipment often are controlled by electronic, hydraulic, or air control mechanisms. Workers tend the automated lines by watching control panels for interruptions of the machines' normal functioning.

Other Metalworking Occupations. Large numbers of workers are employed in other metalworking occupations. These include punch press operators who run power-driven presses that vary in size from small presses used for form-

ing brackets, clips, or other small parts to massive presses which form, trim, and pierce holes in automobile doors, body panels, and frames.

Automobile plants employ thousands of welders to join metal parts. Some manual electric-arc welders and gas welders work in production jobs in parts and body manufacturing plants, and others work in maintenance jobs repairing and rebuilding machinery and equipment. Machine (resistance) welders are employed on assembly lines to weld separate parts of bodies and subassemblies.

Foundry Occupations. Castings for automobile parts, such as engine blocks, are produced by pouring metal into molds where it cools and hardens in the shape of the molds. Patternmakers make a wood or metal pattern in the shape of the final casting desired. Coremakers shape the bodies of sand, or "cores," which are placed inside molds to form hollow spaces needed in castings. Machine molders make the sand mold into which the metal is poured.

Many other workers in the foundries are in less skilled occupations. Melters operate electric furnaces and cupolas used to melt metal for castings. The actual pouring is done by metal pourers. After the casting cools, shakeout men remove it from the mold. Other workers clean the castings and remove excess metal.

Forging Occupations. Parts which must withstand great stress, such as axles, are shaped by forging hammers and presses in the forge shop. Hammermen operate drop hammers which pound metal into various shapes between closed dies. The hammermen are assisted by heaters who heat the metal stock in a furnace to prepare it for forging and then pass the stock to the

hammermen. Other forge shop workers are engaged in cleaning, finishing, heat treating, or inspecting forgings.

Inspection Occupations (D.O.T. 806.281; 283; 381; 382; 387; 684 and 687). Automobiles can be massproduced because parts and subassemblies for the same make of automobile are interchangeable. These parts are made to exact measurements and are subject to close quality control and inspection. (The industry employs statisticians and engineers in quality control departments who use statistical techniques designed to control the quantity of the product.)

Inspectors check incoming raw materials, examine parts during the manufacturing stages, and make quality and conformity checks during the subassembly and assembly operations. Micrometers, specially designed gages, and other measuring and testing instruments are used by inspectors and testers in performing their duties.

Assembling Occupations (D.O.T. 806.887). Assemblers, who make up the largest occupational group in the automobile industry, put together small parts to form subassemblies or parts and subassemblies to form the complete motor vehicle (line assemblies). Most



Painters spray truck.

assembly jobs are repetitive and require little skill; however, they do require coordination and may be strenuous. Each employee is assigned a job to be done when the vehicle passes his work station. For example, one employee may start nuts on bolts and the next worker may tighten the nuts.

Finishing Occupations. Many finishing operations must be performed before a car is completed. For example, metal surfaces must be readied for finishing, the exteriors painted, the interiors covered, the seats upholstered, and finally, the finished product must undergo a thorough inspection. Among those employed in finishing departments are metal finishers, platers, sprayers, polishers, sanders, trim cutters, sewing machine operators, and trimmers. *Metal finishers* (D.O.T. 705.884) file and polish rough surface areas of metal parts in preparation for painting. *Platers* (D.O.T. 500.885) put a thin coat of chrome on bumpers and on other parts such as grills, mirrors, and hubcaps. *Sprayers* (D.O.T. 741.887) operate spray guns to apply paint or other finishes to the metal parts. *Polishers* (D.O.T. 705.884) rub the finished surfaces by hand or polish them with a portable motor-driven buffing wheel.

Cutters, sewing machine operators, and trimmers combine their skills to provide comfortable and attractive interiors. With hand shears or an electric knife, the *cutter* (D.O.T. 781.884) cuts fabric or leather to the specific shape according to a pattern. The *sewing machine operator* (D.O.T. 787.782), using a power-driven machine, sews together the upholstery sections. *Trimmers* (D.O.T. 780.884) arrange and fasten springs and padding or foam rubber for the seats and other upholstered areas, and install the covering material.



Employees lower front and subassembly into place.

Materials Handling, Custodial, and Plant Protection Occupations. The production of motor vehicles by the assembly-line process requires an elaborate system of materials movement to supply the assembly lines and to move finished products. Many power truck operators deliver parts or subassemblies to the assembly line or move materials between plants. Materials handlers load and unload parts from trucks or into and out of contain-

ers. Overhead crane operators use machines to move raw steel stock, heavy dies, and other materials that cannot be lifted by hand.

Many employees are needed to keep the production employees supplied with tools, parts, and materials, and to keep records of materials. Factory clerks, such as checkers, stock chasers, and stock clerks, coordinate the delivery of parts to the proper location on the assembly line. They check, receive, and distribute materials

and keep records of incoming and outgoing shipments.

The industry also employs many workers in plant protection and custodial work. These include workers such as plant patrolmen, gatemen, janitors, and porters.

Maintenance Occupations. A large staff is required to keep machines and equipment in good operating condition and to make changes in the layout of automobile plants. Because breakdowns in assembly lines and highly mechanized machining lines are costly, many skilled maintenance employees service this complicated production system. The maintenance and repair of complex electrical, electronic, and hydraulic equipment require well-trained electricians, electronic technicians, and machinery repairmen. Millwrights move, install, and maintain heavy machinery and mechanical equipment. Plumbers and pipefitters lay out, install, and repair piping, valves, pumps, and compressors. Other maintenance employees include carpenters, stationary engineers, and sheet metal workers.

Training, Other Qualifications, and Advancement

The training requirements for jobs in the motor vehicle industry range from a few hours of on-the-job training to years of preparation. Many plant workers can learn their jobs in a day or two. On the other hand, engineering and scientific jobs, as well as craft jobs, are filled by people who have spent many years in training for their occupations.

The industry's emphasis upon new designs and mechanical improvements has made it an important employer of persons with engineering and scientific backgrounds. The minimum require-

ment for professional engineering jobs is a bachelor of science or a bachelor of engineering degree from a recognized college. Advanced degrees often are required for scientists, particularly those engaged in research and development. Newly hired engineers and scientists often are offered specialized training courses. Many of the industry's top executives have been selected from this professional group.

The requirements for other technical employees vary according to their specialties. For example, many engineering aids, laboratory assistants, and draftsmen are technical institute or junior college graduates. Some automobile companies train their technical employees at company-run schools or subsidize students at local junior colleges or technical institutes. These employees also may take advanced training and acquire engineering degrees.

Administrative positions usually are filled by men and women who have college degrees in business administration, marketing, accounting, industrial relations, or other specialized fields. Some companies have advanced training programs for employees in these specialties. Most of the top administrative jobs are filled by promotion from within the organization.

Most motor vehicle firms hire people who have had commercial courses in high schools or business schools for office jobs such as clerk, bookkeeper, keypunch operator, stenographer, and typist. These people usually have not been trained specifically for jobs in this industry.

Applicants for most plant jobs must be physically able, dependable, and have aptitude for mechanical work. For semiskilled jobs, the industry seeks employees who can do routine work at a steady and fast pace. Assembling

jobs can be learned in a few hours or days. Some of the less skilled machine operating jobs can be learned in a few weeks.

Extensive periods of training are required for craft jobs in the motor vehicle industry. Tool and die makers, patternmakers, electricians, millwrights, and machinery repairmen are some of the highly skilled workers who generally require at least 4 years of training before they can perform their specialized jobs. Although many craft workers acquire the skills of their trade by working for many years with experienced workers, most training authorities agree that apprenticeship is the best way to learn a skilled trade. Automobile firms, in cooperation with labor unions, conduct apprenticeship programs for many of the skilled trades.

Applicants for apprenticeship training generally are required to be graduates of a high school, trade, or vocational school. Training authorities stress that young people interested in apprenticeship training should prepare themselves by taking courses in mathematics and other sciences. Apprentice applicants are given physical examinations, mechanical aptitude tests, and other qualifying tests.

Apprenticeship training includes both on-the-job and classroom instruction. Mathematics, blue print reading, shop theory, and specialized subjects are studied in the classroom, and the operation and use of tools of a particular trade are learned in the shop.

Motor vehicle companies select most foremen from among workers already employed. Frequently, persons who have completed apprentice training in a company are selected for supervisory jobs after they have acquired further experience. Applicants for foreman jobs, if select-



Assembly line employee mounts wheels and tires with impact wrench.

ed, go through a training period when promoted to the foreman level.

Employment Outlook

The motor vehicle industry is expected to provide thousands of job openings annually through the 1970's, mainly to replace experienced workers who transfer to other industries, retire, or die. Retirements and deaths alone should provide about 15,000 job openings annually. On the other hand, because of labor-saving technological advances, employment in the industry is expected to show little change from the 1968 level of 868,000, despite anticipated large increases in the

production of motor vehicles and parts.

Production of motor vehicles and parts, and therefore employment, have fluctuated sharply since the end of World War II, reflecting the industry's sensitivity to changes in general business conditions, consumer preference, availability of credit, and defense production needs. In the future, assuming relatively full employment and the high rates of economic growth necessary to achieve this goal, the demand for motor vehicles and equipment is expected to increase substantially. Other factors that will stimulate demand include a large increase in the driving age population and number of households, growth of multicar ownership, higher incomes, a continuing shift of fami-

lies from cities to the suburbs, and the need to replace vehicles that wear out.

As noted earlier, employment is not expected to keep pace with demand because of technological innovations that increase output per man hour. In the decade ahead, the industry's continued emphasis upon highly technical production methods, such as electrical discharge, electrochemical, and numerically controlled machining, is expected to continue to increase output per worker. The emphasis on research and development of new materials is also likely to continue. Recent examples of innovations resulting from research and development include the use of metal powders to manufacture certain precision parts that reduce the amount of machining formerly required, and the substitution of plastics for many metal parts. New and modernized plants also are expected to lead to further efficiencies in production. However, some of the increased production efficiency will be offset by the greater number of man-hours required to produce an increasing variety of models and to provide additional equipment, such as improved safety devices, air conditioners, power brakes, and exhaust control devices.

The occupational distribution of employment in the motor vehicle industry has been changing as a result of the industry's emphasis upon research and development, and its increasing use of automatic manufacturing operations. Following recent occupational trends, the number of engineers, scientists, and other professional and technical personnel is expected to increase because of the anticipated expansion in research and development activities. Moreover, this emphasis upon research and development will create more job opportunities

for engineers and scientists having advanced degrees. The industry is expected to expand its use of electronic data-processing equipment in the future, and systems analysts and programmers will be employed in greater numbers. Employment of clerical and administrative workers is expected to remain at about the present level. Although the introduction of data-processing equipment may reduce the number employed in some clerical occupations, a slight increase in the number of stenographers and typists is anticipated.

The employment of skilled workers, as a group, may decline very slightly. Although some skilled occupations, including millwright, pipefitter, and machinery repairman, are expected to increase, others, including machinist and upholsterer, are expected to decline. The number of semiskilled workers is expected to remain relatively stable.

Earnings and Working Conditions

The earnings of production workers in this industry are among the highest in manufacturing. In 1968, production workers in the motor vehicle industry earned, on the average, \$167.66 for 43.1 hours a week, or \$3.89 an hour. This compares with average earnings of \$122.51 for a 40.7 hour week, or \$3.01 an hour, for production workers in all manufacturing industries.

In addition to wages and salaries, employees in the industry receive a wide range of benefits, most of which are paid for entirely by employers. These in-

clude life insurance; accidental death and dismemberment benefits; and hospitalization, surgical, and medical benefits.

Most employees also receive paid vacations (or payments in lieu of vacations) ranging from 2 to 4 weeks, depending on length of service; and an average of 10 paid holidays a year. Most companies provide for automatic increases in hourly wages when the cost of living rises beyond a given amount. Employees are paid at one and one-half their normal rate for working more than 40 hours a week or for working on Saturdays. They receive double the hourly rate for working on Sundays or holidays.

Supplemental unemployment benefit plans (paid for solely by the employers) cover the majority of workers. These plans also provide supplementary pay benefits (short workweek benefits) to help stabilize the income of hourly rated employees and some salaried employees when they are required to work less than a normal week. In addition, during layoff, provisions are included for hospitalization, surgical, and medical benefits; life and accident insurance; survivor income benefit coverage; separation payments for those laid off 12 continuous months or more; and relocation allowances.

A great majority of the motor vehicle workers are covered by pension programs, almost all of which are paid for entirely by the employer. Retirement benefits vary with length of service. In a typical case, an employee, age 65, and having 30 years' service, who retires in 1969, will receive a monthly company pension of \$180, in addition to Federal social security benefits. Many pension programs also include pro-

visions for voluntary retirement as early as age 55.

Usually within 40 days of their hiring date, most hourly rated workers and some salaried workers in the industry are required to join a specific union as a condition of continued employment. The great bulk of the production and maintenance workers in assembly plants, and a majority employed in the parts plants belong to the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America. In some parts plants, the International Union, Allied Industrial Workers of America is the bargaining agent for the employees. Other unions with membership in the automobile industry include the International Association of Machinists and Aerospace Workers; the Pattern Makers' League of North America; the International Molders' and Allied Workers' Union of North America; the Metal Polishers, Buffers, Platers and Helpers International Union; the International Union, United Plant Guard Workers of America (Ind.); the Mechanics Educational Society of America; the International Brotherhood of Electrical Workers; and the International Die Sinkers' Conference (Ind.)

Most motor vehicle workers are employed in plants which are relatively clean and free from dust, smoke, and fumes. Some work surroundings, however, particularly in the foundry and forge departments, may be hot, and the worker may be exposed to noise, dust, and fumes. Working conditions in foundries and forge departments have been greatly improved by the introduction of larger, more efficient ventilation systems.

Motor vehicle plants are, on the whole, comparatively safe

places to work, although safety conditions vary somewhat among the individual departments or facilities. The rate of disabling injuries in motor vehicle plants has been less than half that of all manufacturing industries in recent years. Some automobile plants have fully equipped hospital facilities with doctors and nurses in attendance.

Sources of Additional Information

Further information on specific employment opportunities in motor manufacturing can be obtained from local offices of the State employment service; personnel departments of individual motor manufacturing firms; locals of the labor unions noted above; and from:

International Union, United Automobile, Aerospace and Agricultural Implement Workers of America, 8000 East Jefferson Ave., Detroit, Mich. 48214.

Automobile Manufacturers Association, Inc., 320 New Center Building, Detroit, Mich. 48202.

OCCUPATIONS IN THE PAPER, AND ALLIED PRODUCTS INDUSTRIES

In 1968, the paper and allied products industry employed almost 700,000 people to produce thousands of paper products such as newsprint, business forms, facial tissue, building board, paper bags, writing paper, and paperboard containers and boxes. Consumption of paper and paperboard in 1968 averaged approximately 530 pounds for each person in the Nation. The industry employs workers in occupations ranging from unskilled to highly specialized technical and professional jobs, many found only in the paper industry.

More than 150,000 women were employed in this industry in 1968. Many worked in plant jobs, mainly as machine operators and inspectors in paper finishing and converting plants; others worked in office jobs. Few women were employed in the actual production of pulp or paper.

Nature and Location of the Industry

The paper industry is highly mechanized. Pulp, paper, and many finished paper products are manufactured by machines—some as long as a football field—in a series of nearly automatic operations that require very little handling of material by workers. Manufacturing plants in the paper industry are engaged in one or more of three different operations. The production of pulp (the basic ingredient of paper) from wood, reused fibers, or other raw materials; the manufacture of paper or paperboard (thick paper) from pulp; or the conversion of rolls of paper or paperboard into finished products.

The largest group of employees in the industry in 1968 worked in mills that produced pulp, paper, or paperboard. The next largest group was employed in plants that produced paperboard boxes and containers; the remainder worked

in plants that produced a variety of other paper products.

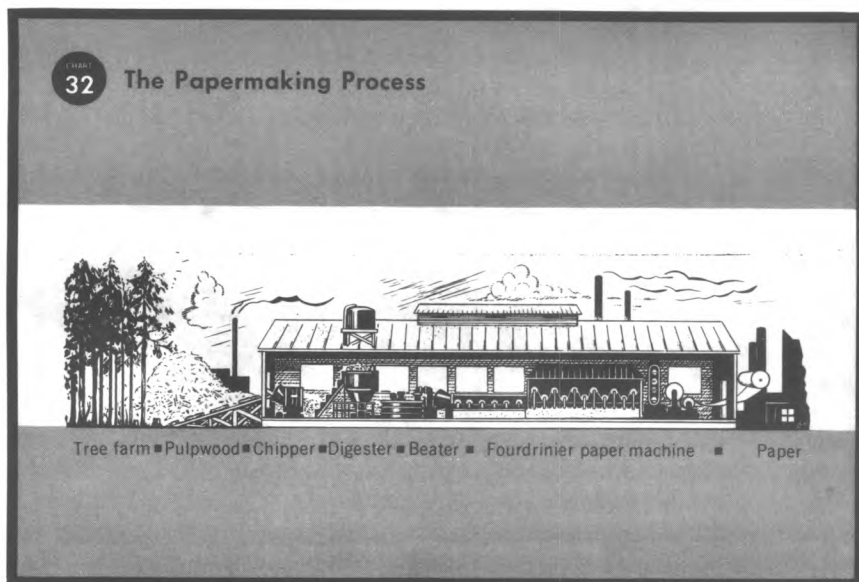
More than 80 percent of the paper and allied products employees worked in factories employing 100 workers or more.

Workers in this industry are located throughout the country, although more than half are employed in eight States: New York, Pennsylvania, Wisconsin, Ohio, Illinois, Massachusetts, California, and New Jersey. Other States having large numbers of paperworkers are Michigan, Minnesota, Georgia, Washington, Maine, Alabama, Florida, and Louisiana.

Occupations in the Industry

Workers in the paper industry are employed in a wide variety of occupations, requiring a broad range of training and skills. Many workers operate and control specialized papermaking, finishing, and converting machines. Some workers install and repair equipment such as papermaking machinery, converting equipment, motors, pumps, pipes, and measuring instruments. Truck and tractor drivers make deliveries to and from plants, and other workers load and unload trucks, trains, and ships. Guards, watchmen, and janitors do custodial work. Other workers keep inventory records of stock and tools.

The industry employs many workers in clerical, sales, and administrative occupations. For example, it employs purchasing agents, personnel managers, salesmen, office clerks, stenographers, bookkeepers, and business machine operators. Also, because of the complex processes and equipment used, the industry employs many people in professional and technical occupations such as chemical and mechanical engineers, chemists, laboratory technicians, and pulp and paper testers. (Detailed discussions of pro-





Women are frequently employed as carton inspectors.

fessional, technical, and mechanical occupations, found not only in the paper industry but in other industries, are given elsewhere in the *Handbook* in sections covering individual occupations. See index for page numbers.)

Production Jobs. More than three-fourths of all employees in the industry in 1968 worked in production jobs. The simplified description of papermaking occupations and processes that follows applies to a plant which combines the production of pulp, paper, and finished paper products into one continuous operation. (See chart 32.)

After pulpwood logs are received at the pulp mill, the bark is removed. One machine used for this operation is a large revolving

cylinder known as a "drum barker." Logs are fed mechanically into this machine by a semiskilled worker called a *barker operator* (D.O.T. 533.782). The machine cleans bark from the logs by tumbling them against each other and also against the rough inner surface of the drum. Next, pulp fibers in the logs are separated from other substances not used in papermaking. This is done by a chemical or mechanical process, or both, depending on the type of wood used and the grade of paper desired.

In the mechanical process, pulpwood is held against a fast-revolving grindstone that separates the fibers. In the more commonly used chemical process,

pulpwood is carried on conveyor belts to a chipper machine operated by a *chipperman* (D.O.T. 668.885). The machine cuts the pulpwood into chips about the size of a quarter. These wood chips are "cooked" with chemicals under high temperature and pressure in a "digester," a kettlelike vat several stories high. The digester is operated by a skilled worker called a *digester operator* (D.O.T. 532.782) (also known as a "cook"). He determines the amount of chemicals to be used, the cooking temperature and pressure, and directs the loading of the digester with wood chips and chemicals. By checking an instrument panel, he makes certain that proper conditions are being



Barker operator controls machine that removes bark from logs.

maintained. When the pulp fibers are removed from the digester, they are washed to remove chemicals, partially cooked chips, and other impurities. These fibers, called pulp, resemble wet, brown cotton.

To turn pulp into paper, the pulp is mixed thoroughly with water and further refined in a machine operated by a skilled worker called a *beater engineer* (D.O.T. 530.782). The kind and amount of chemicals and dyes he uses and the length of time he "beats" the solution determines the color and strength of the paper.

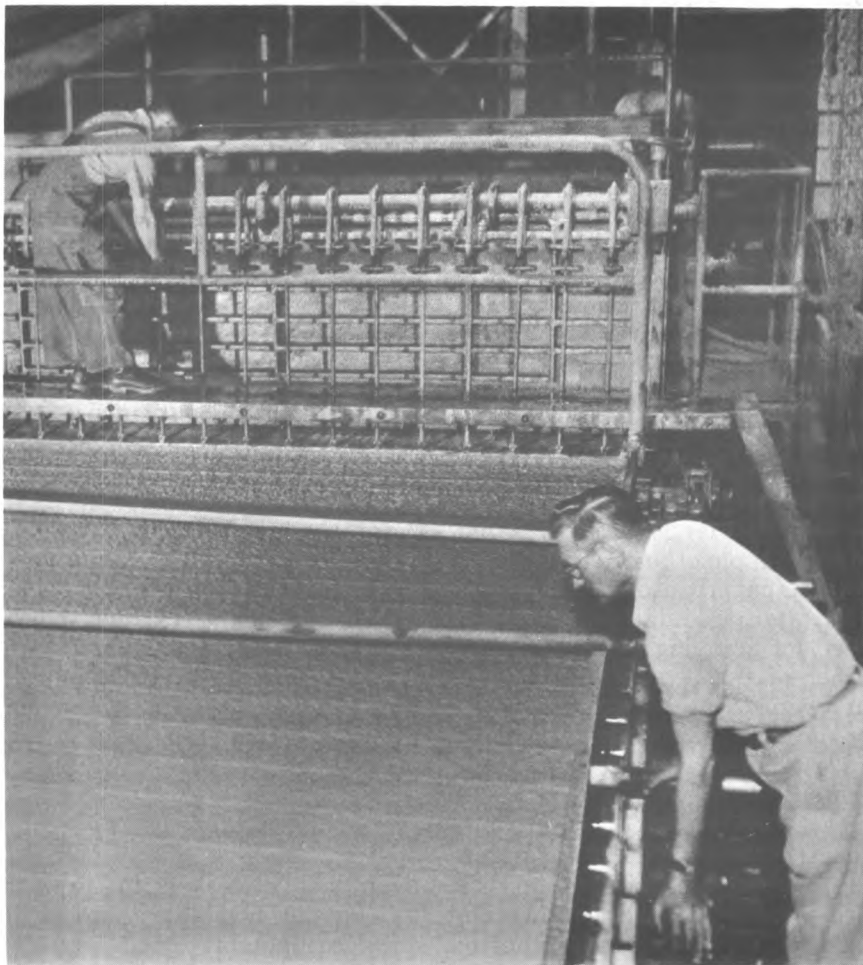
The pulp solution, now more than 99 percent water, is turned into paper or paperboard by machines which are among the largest in American industry. The machines are of two general types. One is the Fourdrinier machine, by far the most commonly used; the other is the cylinder machine used to make particular type of paper such as building and container board. In the Fourdrinier, the pulp solution pours into a continuously moving and vibrating belt of fine wire screen. As the water drains, millions of pulp fibers adhere to one another, forming a thin wet sheet of paper. After passing through presses that squeeze out more water, the newly formed paper passes through the dryer section of the papermaking machine to evaporate remaining water.

Papermaking machines are operated by a *paper machine operator* (D.O.T. 539.782) (also called a "machine tender"). The quality of the paper produced largely depends on the skill of this worker. His principal responsibility is to control the "wet-end" of the papermaking machine, where paper of a specified thickness, width, and physical strength is formed. He checks control-panel instruments to make certain that the

flow of pulp and the speed of the machine are coordinated. The paper machine operator also determines whether the paper meets required specifications by interpreting laboratory tests or, in some instances, by visually checking or feeling the paper. He supervises the less skilled workers of the machine crew and, with their help, keeps the paper moving smoothly through the machine. The paper machine operator and his crew also may replace worn felts and wire screens. The *backtender* (D.O.T. 532.885), who is supervised by the paper machine operator, controls the "dry-end" of the papermaking machine, where paper is dried and prepared

either for shipment or conversion into finished products. He controls the pressure and temperature of the rolls that dry and finish the paper and give it the correct thickness, inspects the paper for imperfections, and makes sure that it is being wound tightly and uniformly into rolls. The backtender also adjusts the machinery that cuts the rolls into smaller rolls and, with the help of assistants, may weigh and wrap the rolls for shipment.

Paper mills that produce a fine grade of paper for books, magazines, or stationery usually maintain finishing departments. Most workers in these departments are either semiskilled or unskilled.



Paper machine operator and helper inspect and adjust flow of wet stock.

One semiskilled worker, the *super-calender operator* (D.O.T. 534.-782), aided by several helpers and by mechanical handling equipment, places huge rolls of paper onto a machine that gives the paper a smooth and glossy finish. He also inspects the finished paper to make sure that specifications have been met. Another semiskilled worker in the finishing department, the *paper sorter and counter* (D.O.T. 649.-687), inspects sheets of paper for tears, dirt spots, and wrinkles, counts them, and may fill customer orders.

In converting plants, machines operated by semiskilled or skilled workers convert paper and paperboard into products such as envelopes, napkins, corrugated shipping containers, and folding or rigid boxes. Occupations in converting plants differ widely, depending largely on the product being manufactured. An example of a semiskilled worker in an envelope-making plant is the *envelope machine operator* (D.O.T. 641.885) who feeds and tends an automatic machine that makes envelopes from either rolls of paper or prepared envelope blanks. An example of a skilled worker in a converting plant is the *corrugator operator* (D.O.T. 643.782) who regulates the speed of the machine that glues together pieces of paperboard into corrugated paperboard (paperboard with alternate ridges and grooves) used for shipping containers. Another of the few skilled workers in a converting plant is the *printer-slotter operator* (D.O.T. 651.-782) who sets, adjusts, and operates a machine that cuts and creases corrugated or paperboard sheets and prints designs or lettering on them. He also positions the printing plates and cutting devices and turns keys to control the distribution of printing ink, pressure of rollers, and speed of



Backtender and assistant remove new roll of paper from dry end of paper machine.

the machine. Another skilled worker is the *die maker* (D.O.T. 739.381) who makes cutting dies used on machines that produce folding cartons (the familiar collapsible cartons used by clothing stores to pack purchases).

Converting plants employ thousands of workers to print text, designs, and lettering on paper products, such as cartons, bags, labels, wallpaper, and envelopes. Among these are skilled compositors who set type, and pressmen who prepare and operate printing presses.

Maintenance Jobs. The paper industry employs many skilled maintenance workers to care for its complex machinery and electrical equipment.

Millwrights maintain, install, and repair machinery and equip-

ment and examine paper machine rolls, bearings, and pumps to insure that they are in good working condition. They also take apart and reassemble machines and equipment when they are moved about the plant.

Instrument repairmen install and service electrical, electronic, and mechanical instruments that measure and control the flow of pulp, paper, water, steam, and chemical additives. The job of instrument repairman is becoming increasingly important with the greater use of automatic control equipment in pulp and paper manufacturing.

Other important maintenance employees include *electricians*, who repair wiring, motors, control panels, and switches; *maintenance machinists*, who make replacement parts for mechanical equipment; and *pipefitters*, who lay out, install, and repair pipes.

Stationary engineers are employed to operate and maintain powerplants, steam engines, boilers, air compressors, motors, and turbines.

Professional and Technical Occupations. The complexity of pulp and paper manufacturing requires thousands of workers who have engineering, chemical, or other technical training and education. More than 15,000 scientists and engineers and 6,000 technicians were employed by the paper industry in 1968.

Many *chemists* are employed to control the quality of the product by supervising the testing of pulp and paper. In research laboratories, chemists study the influence of various chemicals on pulp and paper properties. In addition, some chemists and engineers are employed as salesmen, supervisors of plant workers, or as administrators in positions requiring technical knowledge.

Chemical and mechanical engineers design, construct, operate, control, and improve pulp and paper making equipment. They transform new pulp and paper-making techniques, developed in the laboratory, into practical production methods. Some chemical engineers are employed in plant jobs to supervise the application of pulp and paper technology to the production process.

Electrical engineers are employed to supervise the design, development, and operation of electrical and electronic instruments and power-generating and distributing equipment.

Packaging engineers (D.O.T. 019.187) design and supervise the production of paper and paper-board containers and packages. A few box manufacturers also employ artists who develop letterings, designs, and colors for containers.

Professionally trained *foresters* manage large areas of timberland and assist in the wood-buying operations of pulp and paper companies. They map forest areas, plan and supervise the harvesting and cutting of trees, and seed or plant new trees to assure continuous production of timber.

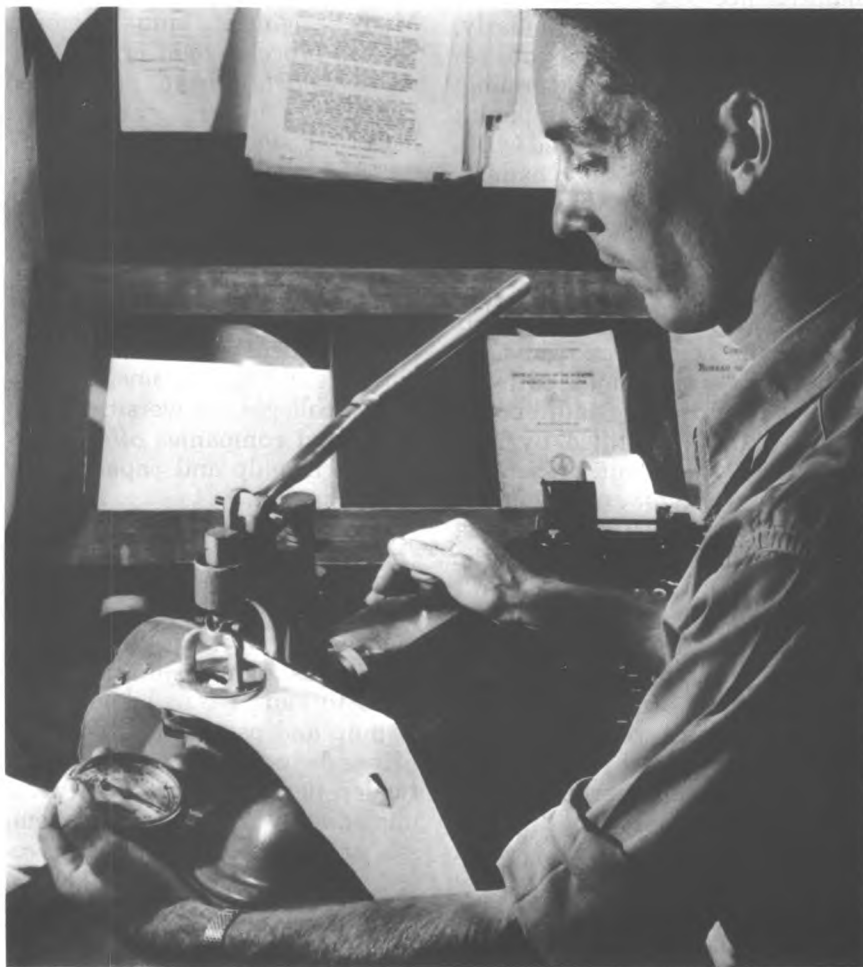
Systems analysts and computer programmers are becoming increasingly important to this industry. They analyze business and production problems and convert them to a form suitable for solution by automatic data-processing equipment. Computers are used to coordinate portions of the complex papermaking process by collecting and analyzing data on chemical mixtures, pulp flows, temperatures, pressures, and machine speeds. Computers also are used to perform quality control tests. Much accounting and management statistical data are processed by computers.

Frequent tests are performed during the manufacture of pulp

or paper to determine whether size, weight, strength, color, and other properties of the material meet specified standards. Some testing is done by machine operators, but in many mills, testing technicians are employed. These employees, who have job titles such as *laboratory technician, paper tester, pulp tester, paper inspector, and chemical analyst*, work in plant laboratories. They use chemicals and laboratory testing equipment when performing tests. They also assist professional engineers and chemists in research and development activities. Depending on their training and experience, technicians may perform simple, routine tests or

do highly skilled technical or analytical work. Technicians working in laboratories conduct tests and record results on charts or graphs for interpretation by engineers and chemists.

Administrative, Clerical and Related Occupations. The paper industry employs many administrative, clerical, and other office personnel. Executives, many of whom are technically trained, plan and administer company policy. To work effectively, executives require information from a wide variety of personnel, including accountants, purchasing agents, sales representatives, lawyers, and personnel employed in activities



Technician tests bursting strength of paper sample.

such as industrial relations, public relations, transportation, advertising, and market research. Clerical employees, such as bookkeepers, secretaries, and shipping clerks, keep records of personnel, payroll, inventories, sales, shipments, and plant maintenance.

Training, Other Qualifications, and Advancement

Training for new workers in the paper and allied products industry ranges from a few days to years. Many operating jobs can be learned in a few days of on-the-job training. On the other hand, maintenance jobs, some machine operating jobs, and, particularly, engineering and scientific jobs require years of specialized training.

Paper and pump companies generally hire inexperienced workers for processing and maintenance jobs and train them on the job. Many companies prefer to hire high school graduates between the ages of 18 and 25. Production workers usually start as laborers or helpers and advance along fairly well-defined paths to more skilled jobs. Maintenance jobs generally are filled by men trained in the plant. When no qualified workers are available, however, jobs are filled by hiring experienced men from outside the plant.

Most companies in this industry do not have formal apprenticeship programs to meet the needs of their own maintenance shops. In recent years, however, some large plants that make pulp, paper, and paperboard have started formal apprenticeship programs that require 3 to 4 years or more of training. Under these programs, young men are trained for skilled maintenance jobs such as machinist, electrician, millwright, and pipefitter. Generally,

an applicant is given a physical examination, mechanical aptitude tests, and similar qualifying tests. Apprentice training includes both on-the-job training and classroom instruction related to the occupation. For example, the machinist apprentice receives classroom instructions in mathematics, blueprint reading, shop theory, and specialized subjects. During shop training, the apprentice learns the use and care of the tools of his trade.

A bachelor's degree from a recognized college is usually the minimum educational requirement for scientists, engineers, foresters, and other specialists. For research work, persons with advanced degrees are preferred. Many engineers and chemists (called *process engineers* and *paper chemists*) have specialized training in paper technology. A list of schools offering such training is available from the American Paper Institute, 260 Madison Ave., New York, N.Y. 10016. Many companies hire students specializing in papermaking for summer work, and upon graduation, frequently hire them on a permanent basis. Some associations, colleges, universities, and individual companies offer scholarships in pulp and papermaking technology.

Some companies have formal training programs for college graduates having engineering or scientific backgrounds. These employees may work for brief periods in various plant operating divisions to gain a broad knowledge of pulp and paper manufacturing before being assigned to a particular department. Other firms immediately assign junior chemists or engineers to a specific research operation or maintenance unit.

Generally, no specialized education is required for laboratory assistants, testing technicians, or

other kinds of technicians. Some employers, however, prefer to hire those who have had training in a technical institute or junior college. Training usually is given on the job. Laboratory assistants, for example, begin in routine jobs and advance to positions of greater responsibility after they have acquired experience and demonstrated ability to work with minimum supervision.

Administrative positions are filled frequently by men and women who have college degrees in business administration, marketing, accounting, industrial relations, or other specialized business fields. A knowledge of paper technology is helpful for administrative, sales, and related occupations. This is true especially for sales jobs, where customers often require technical assistance. Most pulp and paper companies employ clerks, bookkeepers, stenographers, and typists who have had commercial courses in high school or in business school.

Factors affecting advancement of plant workers include the length of time a worker has held a plant job, how well he performs his job, and his physical condition. Promotion generally is limited to jobs within a "work area," which may be a department, section, or an operation on one type of machine. To become a paper machine tender, for example, the worker may start as a laborer, wrapping and sealing finished rolls of paper as they come off the papermaking machine. As he gains experience and skill, he moves to more difficult assignments, finally becoming a machine tender in charge of operating a machine. These promotions may take years, depending on the availability of jobs. Experience gained within a work area usually is not transferable; unskilled or semiskilled workers who transfer to jobs outside their seniority

area or to other plants usually must start in entry jobs.

Many plant foremen and supervisors are former production workers. In some plants, qualified workers may be promoted directly to foreman or other supervisory positions. In others, workers are given additional training before they are eligible for promotion to higher level jobs. This training often is continued after the worker is promoted—through conferences, special plant training sessions, and sometimes by taking courses at universities or trade schools. Most firms provide some financial assistance for employees who take training courses outside their plant.

Employment Outlook

Employment in the paper and allied products industry is expected to increase moderately through the 1970's. In addition to the thousands of jobs that will arise from industry growth, thousands of additional job opportunities will occur annually to replace experienced workers who retire, transfer to other fields of work, or die. Deaths and retirements alone are expected to provide about 15,000 job openings annually.

Employment in this industry is expected to continue to grow fastest in the South and West. Employment prospects, however, will remain good in the Northeast and North Central areas because of the need to replace large numbers of experienced workers.

Production of paper is expected to increase substantially during the 1970's to meet increased demand resulting from population growth, business expansion, and new uses of paper. For example, rising population will create a greater demand for textbooks, writing papers, periodicals, and

newspapers. Business expansion will increase the need for paper products, such as business forms and packaging. The greater use of paper products, such as disposable garments, stretchable grocery bags, carpet backing, and refuse bags also is expected to stimulate paper production. Employment will increase at a slower rate than production, however, because of the increasing use of more efficient, labor-saving machinery and automatic control equipment.

Occupational groups in the industry are expected to increase at different rates. The numbers of engineers, scientists, technicians, and skilled workers, such as electricians, machinery repairmen, instrument repairmen, pipefitters, and millwrights, are expected to increase faster than other occupational groups in the industry. Scientific and technical personnel will be needed as research and development activities increase, and more skilled maintenance and repair men will be required to service the growing inventory of complex machinery. The employment of administrative and clerical workers also is expected to increase at a faster pace than total employment. On the other hand, employment of semiskilled workers will grow more slowly, while the number of helpers, laborers, and other unskilled plant workers is expected to remain about the same or decline slightly as more automatic machinery is introduced.

Earnings and Working Conditions

Production workers in the paper and allied products industry had average earnings of \$3.05 an hour, or \$130.85 for a 42.9 hour workweek in 1968. In the same year, earnings of production workers in all manufacturing indus-

tries averaged \$3.01 an hour or \$122.51 for a 40.7 hour workweek.

Average straight-time hourly earnings of production workers in a number of occupations in pulp, paper, and paperboard mills in late 1967 are shown in the accompanying table. These rates are based on the Nation as a whole, whereas local wage rates may differ, depending on geographic location, type and size of mill, and kinds of machines used.

	<u>Pulp plants</u>	<u>hourly rates</u>
Woodyard and wood preparation occupations:		
Crane operator	\$3.48	
Barker, drum	2.68	
Chipperman	2.82	
Pulpmaking occupations:		
Digester operator (cook)	3.62	
Grinderman	2.78	
Screenman	3.13	
Bleacherman	3.43	
Pulp tester	2.86	
<u>Paper and paperboard plants</u>		
Stock preparation occupations:		
Head stock preparer (beater engineer)	3.22	
Beaterman	2.71	
Hydrapulper operator	2.63	
Machine room occupations:		
Paper machine tender	3.62	
Backtender	3.27	
Third hand	3.00	
Fourth hand	2.80	
Paper tester	2.82	
Finishing occupations:		
Supercalendar operator	3.12	
Rewinder operator	2.87	
Rewinder helper	2.64	
Cutters	2.80	
Miscellaneous occupations:		
Pipefitter	3.56	
Machinists	3.50	
Electrician	3.56	
Oiler	2.92	
Truck, power	2.74	
Janitor	2.50	

Most workers in pulp and paper producing operations work in plants that operate around the clock—three shifts a day, 7 days a week. Owing to the widespread industry practice of rotating shifts, production workers can expect to work on evening or night shifts from time to time. Mainte-

nance workers, for the most part, are employed on the regular day shift. Many plants pay between 5 and 11 cents more an hour for work on the evening shift and between 9 and 15 cents extra an hour for the night shift. Most workers have year-round employment because paper production is not subject to seasonal variations.

A work schedule of 40 hours a week is in effect in most mills. A few plants have a standard work-week of 36 hours or less.

Paid vacations almost always are provided and generally are based on length of service. In most mills, workers receive 1 week of vacation after 1 year of employment, 2 weeks after 3 to 5 years, and 3 weeks after 8 to 10 years. Many companies give 4 weeks' vacation to employees who have been with them 20 years and 6 weeks after 30 years. Nearly all workers receive 6 to 11 paid holidays annually.

Insurance or pension plans, financed completely or partially by employers, are in effect in most plants. These plans generally include life, sickness, accident, hospitalization, and surgical insurance benefits for the employee and, in some cases, his dependents. Employee stock-purchase and savings plans, to which the

company makes contributions, are in effect in some firms.

Most pulp and papermaking jobs do not require strenuous physical effort. Some employees, however, work in hot, humid, and noisy areas. They also may be exposed to disagreeable odors from chemicals used in the papermaking process. Pulp and paper companies have made intensive efforts in recent years to improve working conditions.

The rate of disabling injuries in this industry in recent years has been about the same as the rate for all manufacturing. Protective clothing, warning signs in danger areas, locking devices on potentially dangerous equipment, guards and rails around moving machinery, and instruction in safe practices have been important in reducing the accident rate. Some of the more hazardous jobs are located in converting plants where many cutting tools and moving equipment are used.

A majority of production workers in this industry are members of trade unions. A large number belong to the International Brotherhood of Pulp, Sulphite and Paper Mill Workers, the United Papermakers and Paperworkers, or the Association of Western Pulp and Paper Workers. Many print-

ing workers in the industry belong to the International Printing Pressmen and Assistants' Union of North America. Some maintenance workers and other craftsmen belong to various craft unions.

Sources of Additional Information

Further information about job opportunities and working conditions in the paper and allied products industry is available from local offices of the State employment service and from:

American Forest Institute, 1835 K St. NW., Washington, D.C. 20006.

American Paper Institute, 260 Madison Ave., New York, N.Y. 10016.

Fibre Box Association, 224 South Michigan Ave., Chicago, Ill. 60604.

International Brotherhood of Pulp, Sulphite, and Paper Mill Workers, Department of Research and Education, Box No. 247, Port Edward, N.Y. 12828.

National Paper Box Manufacturers Association, Inc., 121 North Broad St., Philadelphia, Pa. 19107.

PETROLEUM REFINING

The petroleum industry provides about 75 percent of all the energy fuels consumed in this country. Products refined from crude oil supply the fuels and lubricants used for nearly all cars, trucks, buses and trains; military and civilian aircraft; and ships. Oil and gas provide much of the heat for homes, factories, and commercial establishments, as well as the fuel for over one-quarter of the electric power generated in this country. In addition, basic petroleum compounds are essential in the manufacture of hundreds of products in every day use, such as synthetic rubber, plastics, and fertilizer.

In 1968, about 150,000 workers, who have a wide range of educational backgrounds and skills, were employed in the various activities that make up the petroleum refining industry. This chapter deals with the jobs and activities involved in refining oil. The *Handbook* discusses in a separate chapter occupations concerned with petroleum and natural gas production and processing.

Nature and Location of the Industry

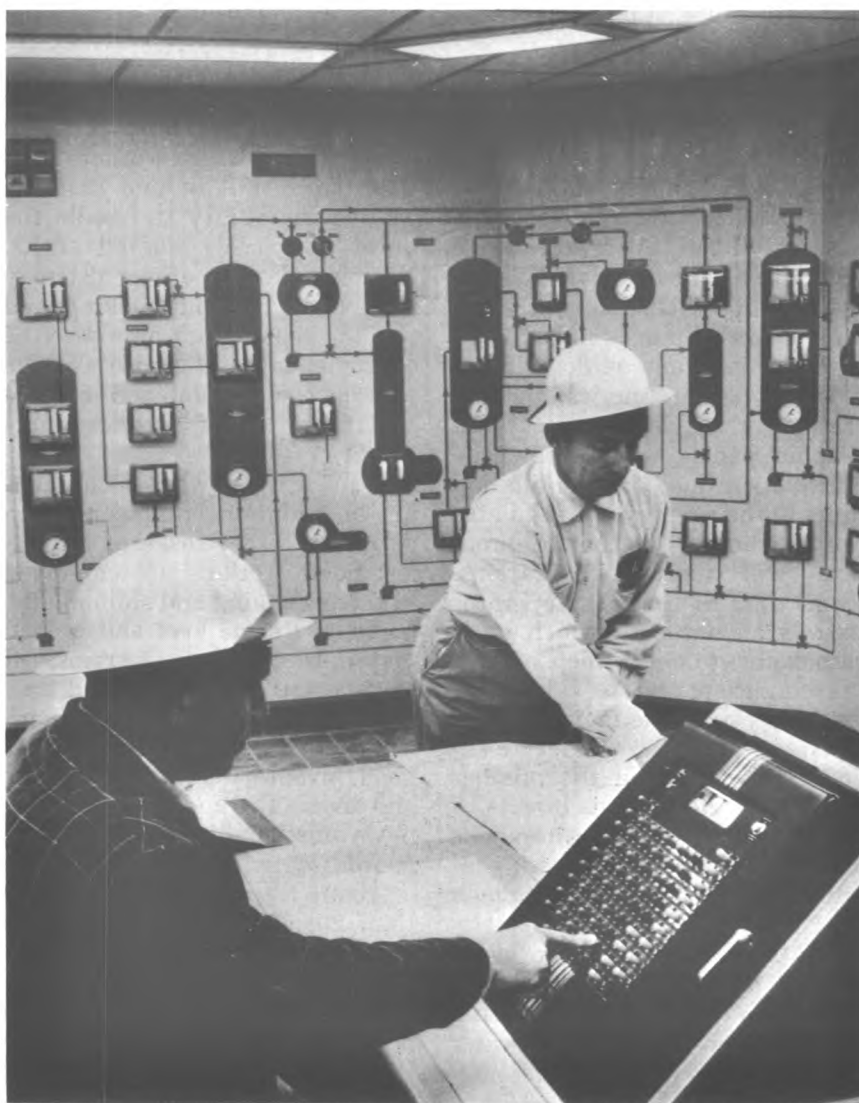
Petroleum refining changes crude oil into gasoline, kerosene, fuel oil, lubricants, and other products for use in homes and industry. The modern refinery is a complicated structure made up of tanks and towers connected by a maze of pipes. From the time crude oil enters the refinery to the shipment of finished products, the flow of production is continuous. The refining process is highly automated and is controlled by instruments which measure and regulate the flow, temperature, and pressure of liquids and gases

going through the pipes and tanks. Manual handling of materials is virtually eliminated in the modern refinery.

Briefly, the first step in petroleum refining consists of heating crude oil as it flows through a series of pipes in a furnace. The vapors from the heated oil pass into a tower where the various "fractions," or parts, of crude oil

are condensed. The heaviest parts (for example, asphalt) are drawn off along the bottom of the tower where temperatures are highest; lighter parts (kerosene) are drawn off along the middle of the tower; and the lightest (gasoline and gases) are taken off at the top where temperatures are lowest. Further processing, by more complicated methods combines or modifies compounds obtained through fractionating.

About 260 refineries were in operation in this country in 1968. They ranged in size from small



Operators regulate processing of crude oil from central controls.

plants which employed fewer than 50 employees to plants which employed several thousand employees. Although refineries are located in most states, approximately 9 out of every 10 barrels of crude oil were refined in only 10 states: Texas, California, Louisiana, Illinois, Pennsylvania, Indiana, Oklahoma, Ohio, Kansas, and New Jersey. Refineries usually are located near oil fields, consuming centers, and deepwater ports where tankers can dock.

Occupations in the Industry

About one out of every four workers in refineries are operators. A key worker in converting crude oil into usable products is the *stillman* (D.O.T. 542.280), or chief operator. He is responsible for the efficient operation of one distillation unit or more. The operator watches instrument readings for any changes in temperature, pressure, and oil flow. In the more modern refineries, the operator can watch instruments on graphic panels which show the entire operation of all distillation units in the refinery. He regulates the instruments so that oil products will meet specifications. From time to time, the operator patrols all units for which he is responsible to check their operating condition and to take samples for testing. He may have one *assistant* or more (D.O.T. 542.782), depending on the number and size of the units he directs.

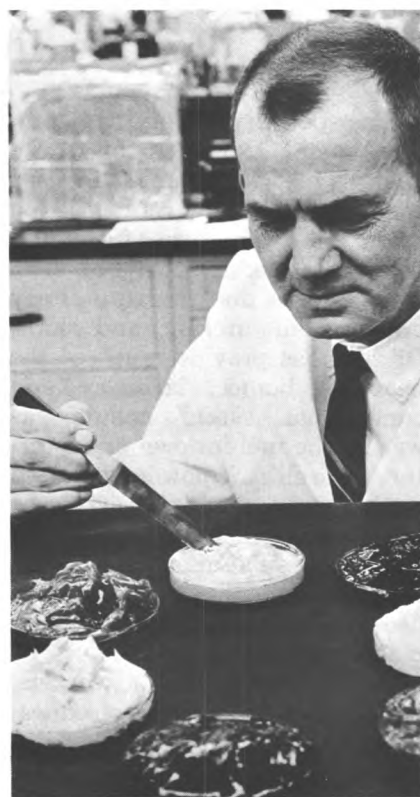
Other plant workers whose jobs are related to the processing of crude oil include *pumpmen* (D.O.T. 549.782) and their *helpers* (D.O.T. 549.884), who maintain and operate power-driven pumps which circulate petroleum products, chemicals, and water through units during processing; and *treaters* (D.O.T. 549.782), who operate equipment to remove

impurities from gasoline, oil, and other petroleum products.

In many refineries, a large percentage of the plant workers repair, rebuild, and clean the highly complicated refinery equipment. In other plants, maintenance work is contracted to companies outside the petroleum industry. A large number of maintenance workers are needed because high heat and pressure and corrosion quickly wear out equipment. Included among these are skilled boilermakers, carpenters, electricians, instrument repairmen, lead burners, machinists, masons, painters, pipefitters, insulators, riggers, sheetmetal workers, and welders. Many helpers and trainees are also in these trades. Some skilled workers have a primary skill in one craft as well as the ability to handle the duties of closely related crafts. For example, a pipefitter also may be able to do boilermaking and welding repair work on a piece of equipment. Maintenance workers who have such combined jobs are sometimes called *refinery mechanics*.

Plant workers who do not operate or maintain equipment do a variety of other tasks in refineries. Some workers are employed in the packaging and shipping department; some load and unload materials on trucks, trains, or ships; some drive trucks and tractors to deliver materials to various parts of the plant; and others keep inventory records of stock and tools. The industry also employs custodial workers such as guards, watchmen, and janitors.

About 13 percent (slightly less than 20,000), of the workers in petroleum refining are scientists, engineers, and technicians, compared with about one-tenth in petroleum production. Among these professional and technical refinery workers are chemists, chemical engineers, mechanical



Research technician views special purposes greases developed from petroleum.

engineers, petroleum engineers, laboratory technicians, and draftsmen. Chemists and laboratory technicians control the quality of petroleum products by making tests and analyses to determine chemical and physical properties. Some chemists are engaged in research and development activities to discover new products and to improve those already produced. Laboratory technicians also assist chemists in research projects or do routine testing and sample taking. Some engineers design chemical processing equipment and plant layout and others supervise refining processes. Draftsmen prepare detailed plans and drawings needed in refinery construction and maintenance.

Many administrative, clerical, and other white-collar personnel

are employed by refining companies. A large number of top administrative and management positions are filled by technically trained men, many of whom are chemists or engineers. Sales engineers also are technically trained. Other specialized workers in the field of administration include accountants, purchasing agents, lawyers, and personal training specialists. Many typists, stenographers, secretaries, bookkeepers, and business machine operators are employed to assist these specialized workers. (Detailed discussions of professional, technical, mechanical, and other occupations found not only in the petroleum refining industry but also in other industries are given in the section of this *Handbook* covering the individual occupations. See index for page numbers.)

Training, Other Qualifications, and Advancement

Petroleum refineries typically require new plant workers to have a high school or vocational school education. In large refineries, aptitude and psychological testing and interviewing are used in selecting employees. Usually, a new worker begins in a labor pool where he does such jobs as moving materials, packing cartons, or filling barrels. Depending on his particular aptitudes and seniority he may be transferred to the processing department or maintenance shop when a vacancy occurs.

A worker newly assigned to a processing department learns to operate processing equipment under the supervision of experienced workers. As he gains experience and know-how, he moves to the more skilled jobs in his department. For example, one line of

advancement for a processing worker may be from helper to assistant operator to chief operator. Formal training courses frequently are provided to assure thorough and current knowledge in a variety of operations.

An inexperienced worker who is assigned to a maintenance shop receives training on the job under the supervision of the foreman. In some refineries, he also may receive classroom instruction related to his particular work. Over a period of 3 or 4 years, he may advance from helper to skilled craftsman in one of the maintenance jobs. Some large refineries have programs under which workers are given training in several related maintenance crafts. For example, a qualified instrument repairman may be given additional training as electrician or machinist.

For scientists and engineers a bachelor's degree in science or engineering usually is the minimum educational requirement. For research jobs, scientists and engineers with advanced degrees are preferred. Laboratory assistants begin their work in routine jobs and advance to positions of greater responsibility as they acquire additional experience and demonstrate ability to work without close supervision. Inexperienced draftsmen begin as copyists or tracers. With additional experience and training, they may advance to more skilled and responsible drafting positions. Administrative positions generally are filled by men and women who have college degrees in business administration, marketing, accounting, industrial relations, or other specialized fields. For positions as clerks, bookkeepers, stenographers, and typists, most refineries employ persons who have had commercial courses in high school or business school.

Employment Outlook

Only a few thousand job openings each year are expected for new workers in petroleum refineries through the 1970's. These will result from the need to replace workers who retire, die, or transfer to other industries. Not all job vacancies created by turnover may be filled, since it is expected that in the future total employment in petroleum refining will continue the moderate decline which began during the early 1950's.

This decline is expected despite the continued expansion of refinery output and anticipated increases in consumption of petroleum products in the years ahead. The lower employment level is expected to result from improved methods of refining crude oil and the trend toward fewer but larger and more highly automated refineries.

Most of the job opportunities created by turnover in petroleum refining will be for professional, administrative, and technical workers, particularly chemists, chemical engineers, and technicians, who are needed for the industry's research and development activities. Among plant workers, most job opportunities will be in maintenance occupations, such as those of instrument repairman, pipefitter, machinist, and maintenance electrician, because of the increasing use of automated equipment and complex control instruments.

Earnings and Working Conditions

Refinery workers are among the highest paid employees in American industry. In 1968, production workers in petroleum refining averaged \$166.27 a week, or \$3.94 an hour for a 42.2 hour workweek. This salary compares

with an average for all manufacturing industries of \$122.51 a week, or \$3.01 an hour. The higher average earnings of production workers in refineries reflect the relatively large proportion of workers in skilled occupations.

Entry salaries for chemical engineers in the petroleum refining industry were among the highest in American industry, according to a survey conducted by the American Chemical Society in 1968. The survey showed that in this industry the average starting salary for chemists who have a bachelor's degree and no experience was \$700 a month and for chemical engineers, \$815 a month.

Most petroleum refinery workers receive a 2-week vacation with pay after 1 year of service; 3 weeks, after 5 years; 4 weeks, after 10 years; and 5 weeks after 20 years. Most refineries have

adopted some type of insurance, pension, and medical and surgical plans for their employees. Employee stock-purchase and savings plans, to which the employer makes contributions, are in effect in many firms.

Because petroleum refining is a continuous round-the-clock operation, operators may be assigned to one of the three shifts, or they may be rotated on various shifts and be subject to Sunday and holiday work. Employees usually receive 15 to 30 cents an hour additional pay when they work on the second or third shift. Most maintenance workers are on duty during the day shift; only a few work at night to handle emergencies. Work in the industry has little seasonal variation and regular workers have year-round jobs.

Most refinery jobs require only moderate physical effort. A few

workers, however, have to open and close heavy valves and climb stairs and ladders to considerable heights in the course of their duties. Others may work in hot places or may be exposed to unpleasant odors. Refineries are relatively safe places in which to work. The injury-frequency rate is about half that of manufacturing as a whole.

A majority of refinery plant workers are union members. A large number of refineries have been organized by the Oil, Chemical and Atomic Workers International Union. Some refinery workers are members of other AFL-CIO unions or of various local unions not affiliated with the AFL-CIO.

See petroleum and natural gas production and processing chapter for Sources of Additional Information.

TRANSPORTATION, COMMUNICATION, AND PUBLIC UTILITIES

The transportation, communication, and public utilities industries make possible the smooth functioning of our society and produce most of the energy that powers, heats, and lights our factories and homes. The transportation industry moves goods and people about the country by air, rail, water and highway; the communications industry provides communication systems such as telephones and radio and TV broadcasting. Other public utilities supply the Nation with electricity and gas, and with sanitation services. Transportation, communication, and public utility firms are all semipublic in character. Some State and local governments operate their own transit lines or electric companies as well as other types of utilities. Privately owned transportation and public utility firms are regulated closely by commissions or other public authorities to make sure they operate in the public interest.

In 1968, 4.3 million persons were employed in the transportation, communication, and public utilities industry group. In addition, more than one-half million persons were employed by State and local governments in publicly owned transit and utility systems. Almost half of the workers in this major industry group were employed in two industries—motor freight (1.0 million workers) which includes local and long-distance trucking, and the communications industries (1.0 million workers) which includes telephone, telegraph, and radio and TV broadcasting. Railroads employed over 660,000 workers in 1968; and about the same number were employed by electric, gas,

and sanitary services companies. Other industries with significant employment included local and interurban passenger transit and air transportation. The remainder of the workers were employed by firms that provided water and pipeline transportation and transportation services.

Nearly one-fifth of the persons employed in transportation, communication, and public utilities are women—a ratio somewhat less than for the economy as a whole. Employment of women varies greatly among the industries that make up the major industry group. For example, they make up only 9 percent of employment in local and interurban passenger transit; however, in the communications industry, where many work as telephone operators, women account for over one-half of the work force.

White-collar workers account for about 2 of 5 workers in transportation, communication, and public utilities, mostly in communications, and electric, gas, and sanitary services. White collar jobs in these industries reflect the many clerical workers in the telephone industry, technicians and managers in radio and TV broadcasting, and engineers and technicians employed throughout the various transportation and public utility industries. Clerical workers make up 1 of 4 workers in the major industry division; over one-half are employed in the communications industry. Professional and technical workers account for about 7 percent of the employment in the industry. Most of these workers are concentrated in the communications industry, where, in addition to large numbers of engineers and technicians,

many actors, entertainers, and writers are employed.

Craftsmen account for 1 of 5 workers, and operatives, 1 of 4. Skilled craftsmen are needed to install, maintain, and repair the large amount of mechanical, electrical, and other types of equipment that are used throughout this industry. Among the major blue-collar occupations are airplane mechanic, motor vehicle mechanic, and telephone lineman; other important skilled occupations are locomotive engineer and fireman, stationary engineer, and foreman. This major industry division is the chief employer of workers in a number of semi-skilled occupations such as bus and truck driver, taxi driver, brakeman and switchman, and sailor and deckhand.

Major occupational group	Estimated employment, 1968 (percent distribution)
All occupational groups	100
Professional, technical, and kindred workers	7
Managers, officials, and proprietors	9
Clerical and kindred workers	25
Sales workers	1
Craftsmen, foremen, and kindred workers	21
Operatives and kindred workers	27
Service workers	3
Laborers	8

NOTE.—Due to rounding, sum of individual items may not add to total.

Employment in transportation and public utilities is expected to increase slowly through the 1970's. In addition to opportuni-

ties resulting from growth in employment, many thousands of job openings are expected each year because of the need to replace workers who die or retire. Transfer of employees to other industries will provide still additional job opportunities. Replacement needs will be particularly high in clerical positions because many women leave the work force each year to take on family responsibilities.

The rising levels of business and consumer income in the years ahead should increase significantly the overall demand for services in this sector and the need for workers to provide them. Employment growth in the individual industries, however, will vary considerably. Rising population, urbanization, and the growth of suburban areas will continue to stimulate employment in local trucking. Although employment in long-distance trucking will continue its long-term growth, competition from rail and air transportation may slow down the rate of growth relative to the recent

past. The increasing popularity of air transportation for both passengers and cargo will continue into the 1970's as rising business activity and more leisure time for travel spur continued rapid growth in this area. On the other hand, not all of the transportation industries will experience rapid employment growth. For example, little employment change is expected in local and interurban passenger transportation (buses, taxis, and subways) because consumers likely will continue to rely heavily on private automobiles.

Employment in communications is expected to grow slowly through the 1970's. Although demand for the services of the communication industry will increase rapidly, rapid advances in technology are expected to limit employment growth. Technological changes are expected to be particularly significant in telephone communications. The computer and other electronic equipment are expected to be applied in-

creasingly to functions that have been performed by workers.

Employment in electric and gas utilities also will be affected strongly by advancing technology and employment will grow slowly despite rapid increase in output. Substantial improvements in electric generating equipment through the increasing use of nuclear power, the growing use of electronic controls, improved coal-handling techniques, and more efficient techniques of constructing and maintaining transmission lines will limit the growth of employment in this important industry. By 1968 about

industry.

The statements that follow cover major occupations in the transportation, communication, and public utility fields. More detailed information about occupations that cut across many industries—for example, stenographers and typists, drivers, and others—appear elsewhere in the *Handbook*. (See index in the back of the book.)

CIVIL AVIATION OCCUPATIONS

The rapid development of air transportation in the past two decades has increased greatly the mobility of the population and has created many thousands of job opportunities in the civil aviation industry. By 1968 about 500,000 persons were employed in a variety of interesting and responsible occupations in this field.

Nature and Location of Civil Aviation Activities

Civil aviation services are provided by many different types of organizations for a variety of purposes. The scheduled airlines (those which operate regularly scheduled flights over prescribed routes) provide transportation for passengers, cargo, and mail. Other airlines, called supplemental airlines, provide charter and non-scheduled flight service for passengers and cargo. A wide range of other civil aviation activities are conducted in the field of general aviation, including the use of company-owned aircraft to transport employees or cargo (business flying); spraying insecticides, fertilizers, or seed on land, crops, or forest (aerial application); charter service in small aircraft, scheduled routes to small airports, mail and light cargo services (air-taxi operations); and inspection of pipelines and powerlines for breaks (industrial flying). In addition to these flying activities, general aviation includes maintenance and repair activities conducted by repair stations licensed by the Government to work on general aviation aircraft (certified repair stations).

Civil aviation activities also in-

clude the regulatory and accident investigation functions of the Federal Aviation Administration (FAA), the Civil Aeronautics Board (CAB), and the National Transportation Safety Board (NTSB)—all part of the Federal Government. The FAA develops air safety regulations, inspects and tests aircraft and airline facilities, provides ground electronic guidance equipment, and gives tests for licenses to personnel such as pilots, copilots, flight engineers, dispatchers, and aircraft mechanics. The CAB establishes policy concerning matters such as airline rates and routes. The NTSB investigates all airlines accidents and aircraft accidents involving fatalities.

The 40 scheduled airlines were the largest employers of air transportation workers in 1968, with about 300,000 workers. Of these, about 80 percent (240,000) were employed to fly and service aircraft and passengers on domestic routes—between cities in the United States. Nearly 54,000 other workers handled the operations of the scheduled airlines which flew international routes. The remaining workers were employed by airlines that handled only cargo. More than half of all scheduled airline employees worked for the four largest domestic airlines.

In addition to scheduled airline employees, several thousand workers—all in ground occupations—were employed in the United States by foreign airlines that operate between overseas points and the United States.

An additional 5,800 workers were employed by 13 supplemental airlines. These workers were in many of the same occupations as scheduled airline workers.

An estimated 25,000 pilots and 50,000 mechanics were employed full-time in general aviation operations in 1968. In addition to full-time workers, 35,000 pilots and a small number of mechanics were employed on a part-time basis.

The FAA employed about 45,000 people and the CAB about 650 in 1968. The largest group of FAA employees worked mainly in occupations relating to the direction of air traffic and the installation and maintenance of mechanical and electronic equipment used to control traffic. CAB workers were employed mainly in administrative and clerical jobs concerned with the economic regulation of the airlines, supervision of international air transportation matters, promotion of air safety, and investigation of accidents.

Civil aviation workers are employed in every State, but an estimated half work in five States; New York, California, Florida, Illinois, and Texas. Some of the reasons for the employment concentration in these States are their large populations and geographic areas; their large numbers of airports and aircraft registrations; and the existence of major airline aircraft overhaul bases.

Civil Aviation Occupations

In addition to employing the largest number of air transportation workers, the scheduled airlines employ workers in a variety of occupations. Of the 300,000 employed by the scheduled airlines in 1968, about 4 out of 5 worked in ground occupations.

Mechanics and other aircraft maintenance personnel was the largest occupational category, representing 18 percent of scheduled airline employment. About 14 percent of all scheduled airline workers were traffic agents and

clerks, and only about 2 percent worked at airline ground stations as communications personnel and dispatchers. The remaining workers in ground occupational categories (about 47 percent) were employed as cargo and freight handlers, custodial and other aircraft-servicing personnel, and office, administrative, and professional personnel.

Flight occupations accounted for the other one-fifth of airline employment. Stewardesses and stewards represented the largest flight occupation, including over 9 percent of all airline workers; pilots and copilots constituted another 8 percent; and flight engineers accounted for the remainder (3 percent).

More than 50 percent of general aviation workers were pilots or copilots, and about 45 percent were aircraft mechanics. The great majority of the mechanics were employed in certificated repair stations. The remaining general aviation workers were employed in clerical or administrative jobs.

In the Federal Government, the largest group of civil aviation workers were in air traffic servicing work. About 19,000 workers were employed in this category. Most of these workers—about 14,600—were air traffic controllers. Another group of about 4,500 workers were flight service station specialists.

A detailed description of the duties, training, qualifications, employment outlook, earnings, and working conditions for each of the following air transportation jobs appear in the later sections of this chapter: (1) Pilots and copilots, (2) flight engineers, (3) stewardesses, (4) aircraft mechanics, (5) airline dispatchers, (6) air traffic controllers, (7) ground radio operators and teletypists, and (8) traffic agents and clerks.

Employment Outlook

The total number of workers in civil aviation occupations is expected to increase very rapidly during the 1970's, but the rates of growth among the major civil aviation divisions will differ.

General aviation employment is expected to show a rapid rise, mainly because the anticipated greater demand for general aviation services will lead to an increase in the number of aircraft. About 215,000 general aviation aircraft may be flying by 1980—an increase of about 100,000 over the number in 1967. A significant employment increase will occur in business flying, which will require about 35,500 new employees, mainly well qualified pilots. Even more new job openings will occur in air-taxi operations, largely because of the demand for air transportation in cities not serviced by the scheduled airlines. These jobs will be about equally divided between qualified pilots and copilots and aircraft mechanics. An estimated 52,000 job openings—practically all for aircraft mechanics—will occur in certificated repair stations because of the need for additional maintenance and repair services by a larger general aviation fleet.

The number of operators who give flight instruction and engage in patrol and survey flying will grow very rapidly by 1980, requiring thousands of additional pilots.

Use of aircraft for aerial application, which includes the distribution of chemicals or seeds in agriculture, fire fighting, and the restocking of fish and other wild life, will require a few thousand additional employees, mainly pilots.

A slow increase is expected in the employment of civil aviation workers by the Federal Government. Openings that occur will

be primarily those resulting from retirements, deaths, and transfers to other fields of work. Although employment declines may occur in some occupations, increasing employment opportunities are expected for those who maintain and repair the increasing array of visual and electronic aids to air traffic.

Airline employment growth will result from anticipated increases in passenger and cargo traffic. By 1980, the scheduled airlines will fly about three times the number of revenue passenger miles flown in 1963. An even larger increase is expected in air cargo traffic which, however, represents a relatively small percent of total traffic. Among the factors which will contribute to increased air travel are a larger population, increased consumer purchasing power, the trend toward longer vacations, the greater use of air travel by businessmen, faster flights on jet aircraft which will save considerable time in long-distance travel, and more economy-class passenger services.

As in the past, airline occupations will grow at different rates. Occupations, such as stewardess and cargo and baggage handler, which provide services for passengers and cargo directly, will grow very rapidly. However, employment in these occupations is not expected to increase as fast as the increases in air traffic for several reasons. For example, more widespread installation of mechanical equipment, such as conveyors, will permit airlines to move greatly increased amounts of baggage and cargo without comparable growth in employment of baggage and cargo handlers. Economy flights, which offer fewer in-flight services than first-class flights, will permit airlines to fly greatly increased numbers of passengers without a

corresponding rise in employment of flight attendants.

The rapid growth in some airline occupations, particularly those concerned with the operation and maintenance of aircraft, will result from a substantial increase in the number of aircraft in service. Continuing replacement of present equipment by faster, larger capacity jet planes and the eventual introduction of supersonic aircraft will accommodate part of the increased traffic, but a significant increase in the total number of aircraft in service also will be necessary. In addition to the growth of the industry in creating jobs, replacement needs will remain high throughout the 1970's because of retirements and deaths.

Earnings and Working Conditions

Earnings among various civil aviation occupations vary greatly because of factors such as skill requirements, length of experience, and amount of responsibility for safe and efficient operations. Within particular occupations, earnings vary according to the type of civil aviation activity. The statements on individual occupations which follow contain detailed discussions of earnings.

As a rule, airline employees and their immediate families are entitled to a limited amount of free or reduced-fare transportation on their companies' flights, depending on the employees' length of service. In addition, they may fly at greatly reduced rates with other airlines. Flight personnel may be away from their home bases about one-third of the time or more. When they are away from home, the airlines provide either living accommodations or pay expenses.

Airlines operate flights at all hours of the day and night. Personnel in some occupations,

therefore, often have irregular work schedules. Maximum hours of work per month for workers in flight occupations have been established by the FAA as a safety precaution against fatigue. In addition, union-management agreements often stipulate payment for a minimum number of hours each month to guarantee a substantial proportion of normal earnings.

Ground personnel who work as dispatchers, mechanics, traffic agents, communications operators, and in administrative jobs usually work a 5-day, 40-hour week. Their working hours, however, often include nights, weekends, or holidays. Air traffic controllers work a 5-day, 40-hour week; they are periodically assigned to night, weekend, and holiday work. Ground personnel generally receive extra pay for overtime work or compensatory time off.

In domestic operations, airline employees usually receive 2 to 4 weeks' vacation with pay, depending upon length of service. Most flight personnel in international operations get a month's vacation. Employees also receive paid sick leave, retirement benefits, life insurance, and long-term disability hospitalization benefits. FAA and CAB employees are entitled to the same benefits as other Federal personnel, including from 13 to 26 days of annual leave and 13 days of sick leave a year, as well as retirement, life insurance, and health benefits.

Many of the workers in air transportation are union members. These unions are identified in the statements covering the individual occupations.

Sources of Additional Information

Information about job openings in a particular airline, and the

qualifications required may be obtained by writing to the personnel manager of the company. Addresses of individual companies are available from the Air Transport Association of America, 1000 Connecticut Ave. NW., Washington, D.C. 20036.

Inquiries regarding jobs with the Federal Aviation Administration should be addressed to the Personnel Officer, Federal Aviation Administration, at any of the following addresses:

Eastern Region.	Federal Building, John F. Kennedy International Airport, Jamaica, Long Island, N.Y. 11430.
Southwest Region.	P.O. Box 1689, Fort Worth, Tex. 76101.
Southern Region.	P.O. Box 20636, Atlanta, Ga. 30320.
Central Region.	601 E. 12th St., Kansas City, Mo. 64106.
Western Region.	5641 West Manchester Ave., Box 90007, Airport Station, Los Angeles, Calif. 90009.
Alaskan Region.	632 Sixth Ave., Anchorage, Alaska 99501.
Pacific Region.	P.O. Box 4009, Honolulu, Hawaii 96812.

Information concerning FAA-approved schools offering training for work as an aircraft mechanic, pilot, or in other technical fields related to aviation may be obtained from the Information Retrieval Branch, Federal Aviation Administration Library, HQ-630, Federal Aviation Administration, Washington, D.C. 20553.

PILOTS AND COPILOTS

(D.O.T. 196.168, .228, .268, and .283)

Nature of the Work

The men who have the responsibility for flying a multimillion

dollar plane and transporting safely as many as 200 passengers or more are the pilot and copilot. The pilot (called "captain" by the airlines) operates the controls and performs other tasks necessary for flying a plane, keeping it on course, and landing it safely. He supervises the copilot, flight engineer, and flight attendants. The copilot is second in command. He assists the captain in air-to-ground communications, monitoring flight and engine instruments, and in operating the controls of the plane.

Both captain and copilot must do a great deal of planning before their plane may take off. They confer with the company meteorologist about weather conditions and, in cooperation with the airline dispatcher, they prepare a flight plan along a route and at altitudes which offer the

best weather and wind conditions so that a safe, fast, and smooth flight may be possible. This flight plan must be approved by Federal Aviation Administration (FAA) air traffic control personnel. The copilot plots the course to be flown and computes the flying time between various points. Prior to takeoff, both men check the operation of each engine and the functioning of the plane's many instruments, controls, and electronic and mechanical systems.

During the flight, the captain or copilot reports by radio to ground control stations regarding their altitude, air speed, weather conditions, and other flight details. The captain also supervises the navigation of the flight and keeps close watch on the many instruments which indicate the

plane's fuel load and the condition of the engines, controls, electronic equipment, and landing gear. The copilot assists in these duties.

Before landing, the captain or the copilot recheck the operation of the landing gear and request landing clearance from air traffic control personnel. If visibility is limited when a landing approach is being made, the captain may have to rely primarily on instruments such as the altimeter, air speed indicator, artificial horizon, and gyro compass and instrument landing system. Both men must complete a flight report and file trip records in the airline office when the flight is ended.

Some pilots, employed by airlines as "check pilots," make at least two flights a year with each captain to observe his proficiency and adherence to FAA flight regulations and company policies. Airlines employ some pilots to fly planes leased to private corporations. Airlines also employ pilots as instructors to train both new and experienced pilots in the use of new equipment.

Although pilots employed in general aviation usually fly planes smaller than those used by the scheduled airlines, their pre-flight and flight duties are similar to those of airline pilots. These pilots seldom have the assistance of flight crews. In addition to flying, they may perform minor maintenance and repair work on their planes. In some cases, such as in business flying, they may mingle with and act as host to their passengers. Pilots who are self-employed, such as airtaxi operators, in addition to flying and doing some maintenance work, have duties similar to those of other small businessmen.



Places of Employment

The scheduled airlines employed over 24,000 pilots and copilots in 1968. In addition, approximately 1,600 pilots were employed by the certificated supplemental airlines (airlines that provide charter and nonscheduled service).

An estimated 25,000 pilots and copilots were employed full-time in general aviation in 1968. Several thousand worked in business flying and air-taxi operations. About 1,500 pilots were employed in aerial application flying. The Federal Government employed approximately 1,200 pilots (about half in the FAA) to perform a variety of services such as examining applicants for pilots' licenses, inspecting navigation facilities along Federal airways, testing planes that are newly designed or have major modifications, enforcing game laws, fighting forest fires, and patrolling national boundaries. In addition, State and local governments employed about 800 pilots. Several thousand pilots were employed by companies to inspect pipelines and installations for oil companies, and to provide other aerial services such as private flight instruction, and flights for sightseeing and aerial photography. A small number worked for aircraft manufacturers as test pilots. In addition, an estimated 35,000 pilots were employed on a part-time basis. These workers were distributed among all the various general aviation activities.

Training, Other Qualifications, and Advancement

To do any type of commercial flying, pilots or copilots must be licensed by the FAA. Airline captains must have an "airline transport pilot's" license. Copilots, and

most pilots employed in general aviation, must have a "commercial airplane pilot's" license. In addition, pilots who are subject to FAA instrument flight regulations or who anticipate flying on instruments when the weather is bad, must have an "instrument rating." Pilots and copilots also must have a rating for the class of plane they can fly (single-engine, multi-engine, or seaplane), and for the specific type of plane they can fly, such as DC-6 or Boeing 707.

To qualify for a license as a commercial pilot, applicants must be at least 18 years old and have at least 200 hours of flight experience. To obtain an instrument rating, applicants must have at least 40 hours of instrument time, 20 hours of which must be in actual flight. Applicants for an airline transport pilot's license must be at least 23 years old and have a total of 1,200 hours of flight time during the previous 8 years, including night flying and instrument flying time.

Before a person may receive any license or rating, he must pass a physical examination and a written test given by the FAA covering subjects such as principles of safe flight operations, Federal Aviation Regulations, navigation principles, radio operation, and meteorology. He also must submit proof that he has completed the minimum flight-time requirements and, in a practical test, demonstrate flying skill and technical competence. His certification as a professional pilot remains in effect as long as he can pass an annual physical examination and the periodic tests of his flying skills required by Government regulation. An airline transport pilot's license expires when the pilot reaches his 60th birthday.

A young man may obtain the

knowledge, skills, and flight experience necessary to become a pilot through military service or from a private flying school. Graduation from flying schools approved by the FAA satisfies the flight experience requirements for licensing. Applicants who have appropriate military flight training and experience are required to pass only the Federal Aviation Regulations examination if they apply for a license within a year after leaving the service. Those trained in the armed services have the added opportunity to gain experience and accumulate flying time on large aircraft similar to those used by the airlines.

As a rule, applicants for a copilot job with the airlines must be between 20 and 35 years old, although preference is given to applicants who are between ages 21 and 28. They must be 5 feet 6 inches to 6 feet 4 inches tall and weigh between 140 and 210 pounds. All applicants must be high school graduates; some airlines require 2 years of college and prefer to hire college graduates. Physical requirements for pilots, especially in scheduled airline employment, are very high. They must have at least 20/100 vision corrected to 20/20, good hearing outstanding physical stamina, and no physical handicaps that would prevent quick reactions. Since flying large aircraft places great responsibilities upon a pilot, the airlines use psychological tests to determine an applicant's alertness, emotional stability and maturity, and his ability to assume responsibility, command respect, and make quick decisions and accurate judgments under pressure.

Men hired by the scheduled airlines (and by some of the larger supplemental airlines) usually start as flight engineers, although they may begin as co-

pilots. An applicant for a flight crew member job with a scheduled airline often must have more than the FAA minimum qualifications for commercial pilot licensing. For example, although the FAA requires only 200 flying hours to qualify for such a license, the airlines generally require from 500 to 1,000 flying hours. Airlines also require a "restricted" radio-telephone operator permit, issued by the Federal Communications Commission, which allows the holder to operate the plane's radio.

Pilots employed in business flying are required to have a commercial pilot's license. In addition, some employers require their pilots to have instrument ratings, and some require pilot applicants to have air transport pilot ratings. Because of the close relationship between pilots and their passengers, employers look for job applicants who have pleasant personalities.

All newly hired airline copilots go through company orientation courses. In addition, some airlines give beginning copilots or flight engineers from 3 to 10 weeks of training on company planes before assigning them to a scheduled flight. Trainees also receive classroom instruction in subjects such as flight theory, radio operation, meteorology, Federal Aviation Regulations, and airline operations.

The beginning copilot generally is permitted only limited responsibility, such as operating the flight controls in good weather over a route that is easy to navigate. As he gains experience and skill, his responsibilities are increased gradually, and he is promoted to copilot on larger, more modern aircraft. When he has proved his skill, accumulated sufficient experience and seniority; and passed the test for an airline transport pilot's license,

a copilot may advance to captain as openings arise. A minimum of 2 or 3 years' service is required for promotion but, in actual practice, advancement often takes at least 5 to 10 years or longer. The new captain works first on his airline's smaller equipment and, as openings arise, he is advanced to larger, more modern aircraft.

A few opportunities exist for captains who have administrative ability to advance to chief pilot, flight operations manager, and other supervisory and executive jobs. Most airline captains, however, spend their entire careers flying. As they increase their seniority, they obtain a better selection of flight routes, types of aircraft, and schedules which offer higher earnings. Some pilots may go into business for themselves if they have adequate financial resources and business ability. They may operate their own flying schools or air-taxi and other aerial services. Pilots also may shift to administrative and inspection jobs in aircraft manufacturing and Government aviation agencies, or become dispatchers for an airline when they are no longer able to fly.

Employment Outlook

A rapid rise in the employment of airline pilots is expected through the 1970's. In addition to those needed to staff new positions, several thousand job openings will result from the need to replace pilots who transfer to other fields of work, retire, or die. Although larger, faster, and more efficient jet planes are likely to be used in the years ahead, increased passenger and cargo miles may exceed substantially the increase in capacity realized from the new equipment. Therefore, employment of pilots is likely to increase to the extent that

increased growth of traffic exceeds increased capacity.

Employment of pilots in general aviation activities is expected to continue to grow very rapidly, particularly in business flying, aerial application, air-taxi operations, and patrol and survey flying. Growth in these areas will result from the greater use of aircraft to perform these general aviation activities.

Earnings and Working Conditions

Captains and copilots are among the highest paid wage earners in the Nation. Those employed by the scheduled airlines averaged about \$21,000 a year in domestic air transportation and nearly \$25,000 in international operations in 1967. Most of the senior captains on large aircraft earned well over \$25,000 a year; those assigned to jet aircraft may earn as much as \$37,000. Pilots employed by the scheduled airlines generally earn more than those employed elsewhere, although pilots who work for supplemental airlines may earn almost as much. Some experienced copilots were earning as much as \$21,000 a year in domestic flying and more than \$23,000 in international flying in 1967.

The earnings of captains and copilots depend on factors such as the type, size, and speed of the planes they fly, the number of hours and miles flown, and their length of service. They receive additional pay for night and international flights. Captains and airline copilots who have at least 3 years of service are guaranteed minimum monthly earnings which represent a substantial proportion of their earnings.

Under the Federal Aviation Act, airline pilots cannot fly more than 85 hours a month; some un-

ion-management contracts, however, provide for 75-hour a month maximums. Though pilots and copilots, in practice, fly approximately 60 hours a month, their total duty hours, including before- and after-flight activities and layovers before return flights, usually exceed 100 hours each month.

Some pilots prefer shorter distance flying usually associated with local airlines and commercial flying activities, such as air-taxi operations, because they are likely to spend less time away from their home bases and fly mostly during the daytime. These pilots, however, have the added strain of making more takeoffs and landings daily.

Although flying does not involve much physical effort, the pilot often is subject to stress because of his great responsibility. He must be constantly alert and prepared to make decisions quickly. Poor weather conditions also can make his work more difficult.

Most airline pilots are members of the Airline Pilots Association, International. The pilots employed by one major carrier are members of the Allied Pilots Association.

Sources of Additional Information

Air Line Pilots Association, International, 1329 E St., NW., Washington, D.C. 20004.

(See the introductory section for additional sources of information and for general information on supplementary benefits and working conditions.)

FLIGHT ENGINEERS

(D.O.T. 621.281)

Nature of the Work and Places of Employment

The flight engineer monitors the operation of the different mechanical and electrical devices aboard the airplane. Before take-offs, he may inspect the tires and other outside parts of the plane and make sure that the plane's fuel tanks have been filled properly. Inside the plane, he assists the pilot and copilot in making preflight checks of instruments and equipment. Once the plane is airborne, the flight engineer watches and operates many instruments and devices to check the performance of the engines and the air-conditioning, pressurizing, and electrical systems. In addition, he keeps records of engine performance and fuel consumption. He reports any mechanical difficulties to the pilot and, if possible, makes emergency repairs. Upon landing, he makes certain that mechanical troubles that may have developed are repaired by a mechanic. Flight engineers employed by the smaller airlines may have to make minor repairs themselves at those few airports where mechanics are not stationed.

Flight engineers or second officers are required by the Federal Aviation Administration (FAA), to be on almost all three- and four-engine aircraft and some two-engine jet aircraft. An evaluation of the aircraft and the functions to be performed by the crew determines the need for a flight engineer. In 1968 about 8,000 workers were employed to perform flight engineers' duties. Most of them worked for the major scheduled airlines and were



stationed in or near large cities where long-distance flights originate and terminate.

Training, Other Qualifications, and Advancement

All flight engineers must be licensed by the FAA. A man can qualify for a flight engineer's certificate if he has had 2 years of training or 3 years of work experience in the maintenance, repair, and overhaul of aircraft and engines, including a minimum of 6 months' training or a year of experience on four-engine piston and jet planes. He also may qualify with at least 200 hours of flight time as a captain of a four-engine piston or jet plane, or with 100 hours of experience as a flight engineer in the Armed Forces. The most common method of qualifying is to complete a course of ground and flight instruction approved by the FAA.

In addition to such experience or training, an applicant for a license must pass a written test on flight theory, engine and aircraft performance, fuel requirements, weather as it affects engine operation, and maintenance procedures. In a practical flight test on a four-engine plane, he must demonstrate his skill in performing preflight duties and normal and emergency in-flight duties and procedures. He also must pass a rigid physical examination every year. Most scheduled airlines now require applicants for flight engineer positions to have a commercial pilot's license. This qualification generally is not required by the nonscheduled airlines.

Young men can acquire the knowledge and skills necessary to qualify as airline flight engineers through military training as aircraft pilots, mechanics, or flight engineers. They also may attend a civilian ground school and then gain experience as an airplane mechanic.

For jobs as flight engineers, airlines generally prefer men 21 to 35 years of age, from 5 feet 6 inches to 6 feet 4 inches tall, and in excellent physical condition. They require a high school education but prefer men who have 2 years of college or more. Airlines prefer to hire young men who already have a flight engineer certificate and a commercial pilot's license, although they do select applicants who have only a commercial pilot's license and give them additional training.

A flight engineer can become a chief flight engineer for his airline. Advancement possibilities usually depend on his qualifications and the seniority provisions established by airline union-management agreements. The flight engineer with pilot qualifications, generally called the second officer, advances on the basis of his

seniority to copilot, and then follow the regular line of advancement open to other copilots. Flight engineers without pilot qualifications can advance from less desirable to more desirable routes and schedules as they gain seniority.

Employment Outlook

Employment of flight engineers is expected to increase rapidly during the 1970's as the number of heavier jet-powered aircraft, requiring flight engineers, increases. This development will contribute to employment growth in this field, since, in most cases, the third required crew member will be a qualified pilot serving as a flight engineer until his promotion to copilot. (See also the *Handbook* statement for Pilots and Copilots.)

Earnings and Working Conditions

The earnings of flight engineers in 1968 ranged from \$600 to \$625 a month for new employees to approximately \$2,200 for experienced flight engineers on jet aircraft on international flights. Many flight engineers earned between \$1,200 and \$1,800 a month. Average monthly earnings for all flight engineers in domestic operations was nearly \$1,500; those employed on international flights averaged nearly \$1,800. The earnings of flight engineers depend upon factors such as size, speed, and type of plane; hours and miles flown; length of service; and the type of flight (such as night or international). Engineers are guaranteed minimum monthly earnings, which represent a substantial proportion of their total earnings. Their flight time is restricted, under the Federal Aviation Act, to 85 hours a

month. Flight engineers in international operations are limited to 100 hours a month, 300 hours every 90 days, or 350 hours every 90 days, depending on the size of the flight crew.

Most flight engineers who are not qualified pilots belong to the Flight Engineers' International Association or the International Association of Machinists and Aerospace Workers. Those who are qualified pilots (Second Officers) are represented by the Air Line Pilots Association, International.

Sources of Additional Information

Flight Engineers' International Association, 100 Indiana Ave. NW., Washington, D.C. 20001.

(See the introductory section for additional sources of information and for general information on supplementary benefits and working conditions.)

STEWARDESSES

(D.O.T. 352.878)

Nature of the Work and Places of Employment

Stewardesses or stewards (sometimes called flight attendants) are aboard almost all passenger planes operated by the commercial airlines. Their job is to make the passengers' flight safe, comfortable, and enjoyable. Like other flight personnel, they are responsible to the captain.

Before each flight, the stewardess attends the briefing of the flight crew. She sees that the passenger cabin is in order, that supplies and emergency passenger gear are aboard, and that necessary food and beverages are in the

galley. As the passengers come aboard, she greets them, checks their tickets, and assists them with their coats and small luggage. On some flights, she may sell tickets.

During the flight, the stewardess makes certain that seat belts are fastened and gives safety instructions when required. She answers questions about the flight and weather, distributes reading matter and pillows, helps care for small children and babies, and keeps the cabin neat. On some flights, she heats and serves meals that have been previously cooked. On other flights, she may prepare, sell, and serve cocktails. After the flight, she completes flight reports. On international flights, she also gives customs information, instructs passengers on the use of emergency equipment, and repeats instructions in an appropriate foreign language to accommodate foreign passengers.



About 28,500 stewardesses and 1,500 stewards worked for the scheduled airlines in 1968. About 80 percent were employed by the domestic airlines, and the rest worked for international lines. Nearly all stewards were employed on overseas flights. Airlines generally carry 1 to 6 flight attendants, depending on the size of the plane and what proportion of the flight is economy or first-class. Most flight attendants are stationed in major cities at the airlines' main bases. A few who serve on international flights are based in foreign countries.

Training, Other Qualifications, and Advancement

Because stewardesses are in constant association with passengers, the airlines place great stress on hiring young women who are attractive, poised, tactful, and resourceful. As a rule, applicants must be 19 to 27 years old, from 5 feet 2 inches to 5 feet 9 inches tall, with weight in proportion to height (but not exceeding 140 pounds), and in excellent health. They also must have a pleasant speaking voice and good vision. The major airlines require that stewardesses be unmarried when hired but permit girls to work as stewardesses after they marry.

Applicants for stewardess' jobs must have at least a high school education. Those having 2 years of college, nurses' training, or experience in dealing with the public are preferred. Stewardesses who work for international airlines generally must be able to speak an appropriate foreign language fluently.

Most large airlines give newly hired stewardesses about 5 weeks' training in their own schools. Girls may receive free transportation to the training centers and also may receive an allowance

while in attendance. Training includes classes in flight regulations and duties, company operations and schedules, emergency procedures and first aid, and personal grooming. Additional courses in passport and customs regulations are given trainees for the international routes. Toward the end of their training, students go on practice flights and perform their duties under actual flight conditions.

A few airlines that do not operate their own schools may employ graduates who have paid for their own training at private stewardesses' schools. Girls interested in becoming stewardesses should check with the airline of their choice before entering a private school to be sure that they have the necessary qualifications for the airline, and that the school's training is acceptable.

Immediately upon completing their training, stewardesses report for work at one of their airline's main bases. They serve on probation for about 6 months, and an experienced stewardess usually works with them on their first flights. Before they are assigned to a regular flight, they may work as reserve flight attendants, during which time they serve on extra flights or replace stewardesses who are sick or on vacation.

Stewardesses may advance to jobs as first stewardess or purser, supervising stewardess, stewardess instructor, or recruiting representative. Advancement opportunities often come quickly because stewardesses work only about 2 or 3 years, on the average, and then resign to get married.

Employment Outlook

Young women will have several thousand opportunities to get jobs as stewardesses each year

during the 1970's. Most of these openings will occur as girls marry or leave the occupation for other reasons. (About 30 percent of the employed stewardesses leave their jobs each year.) In addition, total employment of stewardesses will grow very rapidly as a result of the anticipated large increase in passenger traffic.

Young women interested in becoming stewardesses should realize that thousands of girls apply for this type of work each year because of the glamour attached to the occupation. Despite the large number of applicants, the airlines find it difficult to obtain enough young women who can meet their high standards of attractiveness, personality, and intelligence.

Earnings and Working Conditions

An examination of union-management contracts covering several large domestic and international airlines indicates that in 1968, beginning stewardess earned approximately \$433 to \$532 a month for 80 hours of flying time. Stewardesses having 2 years' experience earned approximately \$493 to \$689 a month.

Stewardesses employed on domestic flights averaged \$435 a month in late 1968; those working on international flights averaged about \$557.

Since commercial airlines operate around the clock, 365 days a year, stewardesses usually work irregular hours. They may work at night, on holidays, and on weekends. They usually are limited to 80 hours of flight time a month. In addition, they devote up to 35 hours a month to ground duties. As a result of irregular hours and limitations on the amount of flying time, some stewardesses may have 15 days or more off each month. Of course,

some time off may occur between flights while away from home.

Airlines generally use the seniority bidding system for assigning home bases, flight schedules, and routes. Stewardesses who have the longest service, therefore, get the more desirable flights.

The stewardess' occupation is exciting and glamorous, with opportunities to meet interesting passengers and see new places. However, the work can be strenuous and trying. A stewardess may be on her feet during a large part of the flight. She must remain pleasant and efficient during the entire flight, regardless of how tired she may be.

Most flight attendants are members of either the Air Line Stewards and Stewardesses Association of the Transport Workers Union of America or the Stewards and Stewardesses Division of the Air Line Pilots Association, International.

(See introductory section for general information on supplementary benefits and working conditions.)

AIRCRAFT MECHANICS

(D.O.T. 621.281)

Nature of the Work

Aircraft mechanics have the important job of keeping airplanes operating safely and efficiently. Mechanics employed by the airlines work either at the larger airline terminals making emergency repairs on aircraft (line-maintenance work) or at an airline main overhaul base, where they make major repairs or perform the periodic inspections that are necessary on all aircraft.

These mechanics may specialize in work on a particular part of the aircraft such as propellers, landing gear, hydraulic equipment, airborne electronic communications and control equipment, instruments, or on sheet metal sections. They frequently take apart a complex airplane component, replace damaged or worn parts, put the component together again, and test it to make sure that it is operating perfectly.

A line-maintenance mechanic may be instructed by the flight engineer or lead mechanic as to the kinds of repairs to make, or he may examine the aircraft thoroughly to discover the cause of malfunction. He then makes the necessary repairs or adjustments or he may install a new part; for instance, he may replace an entire engine when it cannot be repaired quickly. Line-maintenance mechanics must be all-around mechanics able to make repairs on all parts of the plane. They also may have to do maintenance work such as changing spark plugs or adding fluid to a hydraulic system.

Aircraft mechanics employed in general aviation usually do maintenance and repair work comparable with the work performed by line-maintenance mechanics. However, the planes which these mechanics service are generally smaller and less complex than those flown by the airlines. One mechanic frequently does the entire servicing job with little supervision, and he works on many different types of planes and engines. Mechanics who work for employers such as certificated supplemental airlines, air-taxi operators, and independent repair shops also may do overhaul work. Independent repair shops usually specialize in engine, instrument, or airframe overhaul. (The airframe consists of the plane's



fuselage, wings, landing gear, flight controls, and other parts which are not part of the engine, propeller, or instruments.)

Aircraft mechanics use many different kinds of tools in their work. These may range from simple handtools, such as screwdrivers, wrenches and pliers, to large and expensive machines and equipment designed to diagnose troubles and help the mechanic correct them. Examples of such equipment are propeller grinding machines, electrical circuit testers, and magnetic and black light inspection equipment designed to detect flaws and cracks in metal parts.

Places of Employment

Over 52,000 mechanics were employed by the scheduled air-

lines in 1968. An estimated 50,000 mechanics and supervisory mechanics were employed by independent repair shops. A few thousand mechanics also were employed by certificated supplemental airlines, aerial application and air-taxi firms, and businesses that use their own planes to transport their key employees or cargo. Many other aircraft mechanics work in aircraft manufacturing plants. (These workers, whose duties are somewhat different from those of airline mechanics, are discussed in the chapter on Occupations in the Aircraft, Missile, and Spacecraft Field.)

About 20,000 civilian aircraft mechanics were employed by the Air Force in 1968. Another 12,000 worked for the Navy. The

FAA employs several hundred skilled men with maintenance experience to inspect aircraft manufacturing plants; examine airline and other commercial flying organizations' aircraft maintenance methods, training programs, and spare parts stock; and test applicants for FAA mechanic licenses. This agency also employs approximately 500 aircraft mechanics to maintain its own planes. Most of these men are employed at the FAA Aeronautical Center in Oklahoma City. Some mechanics are employed by other Government agencies, principally the National Aeronautics and Space Administration and the Army.

Most airline mechanics are employed in the larger cities on the main airline routes. Each airline usually has one main overhaul base where more than half of its mechanics are employed. Large concentrations of mechanics are employed in cities such as New York, Chicago, Los Angeles, San Francisco, and Miami, all of which are important domestic and International air traffic centers.

Training, Other Qualifications, and Advancement

Mechanics responsible for any repair or maintenance operation must be licensed by the FAA as either an "airframe mechanic" (to work on the plane's fuselage, covering surface, landing gear, and control surfaces such as rudder or ailerons); "powerplant mechanic" (to work on the plane's engines); "airframe and powerplant mechanic" (to work on all parts of the plane); or as a "repairman" who is authorized to make only specified repairs. Mechanics who maintain and repair electronic communications equipment are required to have at least a Federal Communica-

tions Commission Second Class Radio Telephone Operator License.

At least 18 months' experience working with airframes or engines is required to obtain an airframe or powerplant license, and at least 30 months' experience working with both engines and airframes is required for the combined airframe and powerplant license. However, this experience is not required of graduates of mechanic's schools approved by the FAA. In addition to meeting these requirements, applicants must pass a written test and give a practical demonstration of their ability to do the work. Repairmen licenses are issued to mechanics who are able to perform those maintenance and repair operations for which their employers have received FAA authorization.

Mechanics may prepare for the trade and their licenses by working as trainees or apprentices, or as helpers to experienced mechanics. The larger airlines train apprentices or trainees in a carefully planned 3- or 4-year program of instruction and work experience. Men who have learned aircraft maintenance in the Armed Forces usually are given credit for this training towards the requirements of apprenticeship or other on-the-job training programs.

For trainee or apprentice jobs, the airlines prefer men between the ages of 20 and 30 who are in good physical condition. Applicants should have a high school or trade school education, including courses in mathematics, physics, chemistry, and machine shop. Experience in automotive repairs or other mechanical work also is helpful.

Other mechanics prepare for their trade by graduating from an FAA approved mechanics school. Most of these schools have

an 18- to 24-month program. Several colleges and universities also offer 2-year programs that prepare the student for the FAA mechanic examinations, and for jobs as engineering aids and research and development technicians in aircraft manufacturing.

Mechanics generally are required to have their own handtools which they must pay for themselves. They usually acquire their tools gradually.

Several advancement possibilities are available to skilled mechanics employed by the scheduled airlines. The line of advancement is usually mechanic, lead mechanic (or crew chief), inspector, lead inspector, shop foreman, and, in a few cases, supervisory and executive positions. In most shops, mechanics in the higher grade positions are required to have both airframe and powerplant ratings. In many cases, the mechanic must pass a company examination before he is promoted.

To qualify for jobs as FAA inspectors, mechanics must have broad experience in maintenance and overhaul work, including supervision over the maintenance of aircraft. Applicants for this job also must have both airframe and powerplant ratings or a combined rating.

Employment Outlook

The number of aircraft mechanics employed by scheduled airlines is expected to increase rapidly through the 1970's because of the substantial increase in the number of aircraft in operation. Rapid growth anticipated in general aviation flying will lead to an increase in the number of aircraft. An increase

is expected in the number of mechanics employed both in firms providing general aviation services and in independent repair shops. Employment opportunities for aircraft mechanics in the Federal Government will depend largely on the size of the Government military aircraft program.

In addition to the openings that will arise from employment growth, a few thousand job openings will result annually from the need to replace mechanics who transfer to other fields of work, retire, or die.

Earnings and Working Conditions

Mechanics employed by the scheduled domestic and international airlines earned, on the average about \$700 a month in 1967. Other aircraft mechanics generally had lower average earnings. Airline mechanics work in hangars or in other indoor areas, whenever possible. However, when repairs must be made quickly, which is sometimes the case in line-maintenance work, mechanics may work outdoors.

Mechanics employed by most major airlines are covered by union agreements. Most of these employees are members of the International Association of Machinists and Aerospace Workers. Many others belong to the International Brotherhood of Teamsters, Chauffeurs, Warehousemen and Helpers of America and the Transport Workers Union of America. (See introductory section for sources of additional information and for general information on supplementary benefits and working conditions.)

AIRLINE DISPATCHERS

(D.O.T. 912.168)

Nature of the Work and Places of Employment

Dispatchers (sometimes called flight superintendents) are employed by the airlines to coordinate flight schedules and operations within an assigned area; they also make sure that all Federal Aviation Administration (FAA) and company flight and safety regulations are observed. After examining weather conditions, the dispatcher makes a preliminary decision as to whether a flight may be undertaken safely. He frequently must arrange to notify the passengers and crew if there is any change from the scheduled departure time. The dispatcher confers with the captain about the quantity of fuel needed, the best route and

altitude at which the plane will fly, the total flying time, and the alternate fields that may be used if landing at the scheduled airport is hazardous. The dispatcher and the captain must agree on all details of the flight before the plane leaves the airport. In some instances, the dispatcher is also responsible for keeping records and checking matters such as the availability of aircraft and equipment, the weight and balance of loaded cargo, the amount of time flown by each aircraft, and the number of hours flown by each crew member based at his station.

After the flight has begun, the dispatcher plots the plane's progress as reported at regular intervals by the captain on the radio, and keeps the captain informed of changing weather and other conditions that might affect his flight.

The assistant dispatcher helps the dispatcher plot the progress of flights, secure weather information, and handle communications with aircraft.

In 1968 only about 1,200 dispatchers and assistants were employed in scheduled domestic and international operations, primarily at large airports in the United States. An even smaller number worked for large certificated supplemental airlines, and for private firms which offer dispatching services to small airlines.

Training, Other Qualifications, and Advancement

Dispatchers are required to have an FAA dispatcher certificate. An applicant for such a certificate may qualify if he has spent at least a year engaged in dispatching work under the supervision of a certificated dispatcher. He also may qualify by completing an FAA-approved dispatcher's course at a school or

an airline training center. If an applicant has neither schooling nor experience, he also may qualify if he has spent 2 of the previous 3 years in air traffic control work, or in airline jobs such as dispatch clerk, assistant dispatcher, or radio operator, or in similar work in military service.

An applicant for an FAA dispatcher certificate must pass a written examination on subjects such as Federal aviation regulations, weather analysis, air-navigation facilities, radio procedures, and airport and airway traffic procedures. In an oral test, he also has to demonstrate his ability to interpret weather information, his knowledge of landing and cruising speeds and other aircraft operational characteristics, and his familiarity with airline routes and navigational facilities. A licensed dispatcher is checked periodically by his employer to make sure that he is maintaining the skills required by Federal regulations. All qualified dispatchers are given additional instruction by their airlines at special training centers so that they may become familiar with new flight procedures and with characteristics of new aircraft. Each year, he also is required to "fly the line" as an observer over the portion of the system which he services, to maintain his first hand familiarity with airline routes and flight operations.

For assistant dispatcher jobs, which may not require certification, airlines prefer men who have at least 2 years of college or an equivalent amount of time working in some phase of air transportation, such as communications. Preference is given to college graduates who have had courses in mathematics, physics, and related subjects. Some experience in flying, meteorology, or business administration is also helpful.



Airline dispatcher assists pilot in preflight planning.

Most airlines fill assistant dispatcher positions by promotion or transfer from within the company. Men are preferred who have had long experience in ground operations work. As a result, most openings are filled by men who have been dispatch clerks, meteorologists, or radio operators; a few jobs are filled by men who have been pilots.

Employment Outlook

The number of workers in this very small occupation is not expected to change much during the 1970's. Most new workers will be hired as assistant dispatchers or dispatch clerks. Job openings for dispatchers will be filled mainly by promoting or transferring experienced persons already employed by the airlines.

The need for some additional dispatchers will result from the increase in air traffic, the addition and extension of routes, and the extra difficulties in dispatching jet aircraft. However, these factors will be largely offset by improved radio and telephone communication facilities which allow dispatchers at major terminals to dispatch aircraft at other airports and over large geographic areas. Foreign-flag airlines, which fly between overseas points and cities in the United States, also will provide a few job opportunities for dispatchers.

Earnings and Working Conditions

Beginning dispatchers earned between \$800 and \$850 a month in 1968. Dispatchers having 10 years' service earned between \$1,100 and \$1,500 a month. Assistant dispatchers earned \$550 and over a month to begin and up to \$850 a month after 3 years. Assistant dispatchers who have

FAA certificates may earn \$25 a month extra. Most dispatchers are members of the Air-Line Dispatchers Association.

Sources of Additional Information

Air Line Dispatchers Association,
929 West Broad St., Falls
Church, Va. 22130.

(See introductory section for additional sources of information and for general information on supplementary benefits and working conditions.)

AIR TRAFFIC CONTROLLERS

(D.O.T. 193.168)

Nature of the Work

Air traffic controllers are the guardians of the airways. These employees of the Federal Aviation Administration (FAA) give instructions, advice, and information to pilots by radio to avoid collisions and minimize delays as aircraft fly between airports or in the vicinity of airports. When directing aircraft, traffic controllers must consider many factors, including weather, geography, the amount of traffic, and the size, speed, and other operating characteristics of aircraft. The men who control traffic in the areas around airports are known as *airport traffic controllers*; those who guide aircraft between airports are called *air-route traffic controllers*.

Airport traffic controllers are stationed at airport control towers to give all pilots within the vicinity of the airport weather information and take-off and landing instructions such as which

approach and airfield runway to use and when to change altitude. They must control simultaneously several aircraft which appear as tiny bars on a radar scope. They talk on the radio first to one and then to another of the pilots of these planes, remembering their numbers and their positions in the air, and give each of them different instructions. These workers also keep records of all messages received from aircraft and operate runway lights and other airfield electronic equipment. They also may send and receive information to and from air-route traffic control centers about flights made over the airport.

Air-route traffic controllers are stationed at air traffic control centers to coordinate the movements of aircraft which are being flown "on instruments." They use the written flight plans which are filed by pilots and dispatchers before aircraft leave the airport. To make sure that aircraft remain on course, they check the progress of flights, using radar and other electronic equipment and information received from the aircraft, other control centers and towers, and information from FAA or airline communications stations.

Where Employed

About 14,600 air traffic controllers were employed by the FAA in 1968. Of these, about half were airport traffic controllers, employed at airport control towers located at key airfields. A few of these jobs are located at towers and centers outside the United States. About 7,600 air-route traffic controllers worked in 24 control centers scattered throughout the United States.



Air traffic controllers guide aircraft with radio and radar.

Training, Other Qualifications, and Advancement

Applicants for positions as air-route or airport traffic controller must be able to speak clearly and precisely. They enter the field through the competitive Federal Civil Service system after passing a rigid physical examination, which they must pass every year. Applicants must pass a written test designed to measure their ability to learn, perform the duties of air traffic controller, and meet certain experience, training, and related requirements.

Successful applicants for traffic controller jobs are given approximately 9 weeks of formal training to learn the fundamentals of the airway system, Federal Aviation Regulations, and radar and

aircraft performance characteristics. After completing this training, controllers qualify for a basic air traffic control certificate. At an FAA control tower or center, they receive additional classroom instruction and on-the-job training to become familiar with specific traffic problems. Only after he has demonstrated his ability to apply procedures, and to use available equipment under pressure and stress, may he work as a controller. This usually takes about 2 to 3 years.

Controllers can advance to the job of chief controller. After this promotion, they may advance to more responsible management jobs in air traffic control and to a few top administrative jobs in the FAA.

Employment Outlook

Total employment of air traffic controllers is expected to increase moderately through the 1970's. The number of air traffic controllers is expected to increase despite the greater use of automated equipment.

Additional air traffic controllers will be needed because of the anticipated growth in the number of airport towers that will be built to reduce the burden on existing facilities and to handle increasing airline traffic. More airport controllers also will be needed to provide services to the growing number of pilots outside of the airlines, such as those employed by companies to fly executives.

A number of additional air-route traffic controllers will be needed during the next few years to handle increases in air traffic. However, with the expected introduction of an automatic air traffic control system and a further decline in the number of control centers, employment of air-route traffic controllers is expected to moderate in the long run.

A few hundred openings will occur each year for controller jobs because of the need to replace those workers who leave for other work, retire, or die.

Earnings and Working Conditions

The monthly salary for air traffic controllers during their first 6 to 12 months of training averaged about \$530 in late 1968. Air traffic controllers can earn between \$770 to \$1,500 a month, depending on the type of work they do, the amount of traffic handled at their facility and how long they have been on the job. In addition, all traffic controllers are eligible for periodic

wage increases. In areas that handle extremely large volumes of air traffic, a chief controller may earn more than \$1,648 a month. These employees receive the same annual leave, sick leave, and other benefits provided other Federal workers.

FAA controllers work a basic 40-hour week; however, they may work overtime, for which they receive equivalent time off or additional pay. Because control towers and centers must be operated 24 hours a day, 7 days a week, controllers are periodically assigned to night shifts on a rotating basis. However, an additional 10 percent is paid for work between 6 p.m. and 6 a.m.

Because of the congestion in air traffic, a controller works under great stress. He is responsible for directing as many as 10 to 20 aircraft or more at the same time. He must check simultaneously flights already under his control, know the flight schedules of aircraft approaching his area, and coordinate these patterns with other controllers as each flight passes from his control area to another.

(See introductory section for sources of additional information and for general information on supplementary benefits and working conditions.)

GROUND RADIO OPERATORS AND TELETYPISTS

(D.O.T. 193.282 and 203.588)

Nature of the Work

Ground radio operators and teletypists transmit highly important messages concerning weather conditions and other flight information between ground station personnel and flight personnel. Radio operators

use a radio-telephone to send and receive spoken messages; some operators may use a radio-telegraph to transmit written messages. Radio operators occasionally may make minor repairs on their equipment. Teletypists transmit only written messages between ground personnel. They operate a teletype machine which has a keyboard similar to that of a typewriter.

Flight service station specialists employed by the Federal Aviation Administration (FAA) do some work similar to that of airline ground radio operators and teletypists. They use radio-telephones, radio-telegraph, and teletype machines in their work. In addition to providing pilots

with weather and navigational information before and during flights, these workers relay messages from air traffic control facilities to other ground station personnel and to pilots.

Places of Employment

About 8,200 ground radio operators and teletypists were employed in air transportation in 1967. Flight service station specialists employed by the FAA made up about half of these employees. The scheduled airlines employed about 3,400 radio operators and teletypists. An additional 450 were employed by a cooperative organization which offers the airlines, private pilots,



Ground radio operators and teletypists process messages in radio room.

and corporation aircraft its services over a centralized communications system. A few hundred were employed by the Army and Navy in civilian communications occupations.

FAA flight service station specialists work at stations scattered along the major airline routes; some stations are located in remote places. Ground radio operators and teletypists employed by the airlines work mostly at airports in or near large cities.

Training, Other Qualifications, and Advancement

Applicants for airline radio operator jobs usually must have at least a third-class Federal Communications Commission radio-telephone or radio-telegraph operator's permit. However, a second-class operator's permit is preferred. They also must be high school graduates and have a good speaking voice, the ability to type at least 40 words a minute, and a basic knowledge of the language used in weather reports. Teletypists must be able to type at least 40 words a minute and have had training or experience in operating teletype equipment. Applicants for jobs as radio operators and teletypists also must have a knowledge of standard codes and symbols used in communications.

To qualify for entry positions as FAA flight service station specialists, applicants must pass a written test and meet certain experience requirements. Permanent appointments are made on the basis of Federal civil service examinations.

The airlines usually employ women as teletypists, and an increasing number are being hired as radio operators. Both airline radio operators and teletypists, and FAA flight service station specialists serve probationary periods during which time they

receive on-the-job training. Skill gained in communications is helpful experience for transferring into such other higher paying jobs such as airline dispatcher.

Employment Outlook

Openings for entry positions as radio operators or teletypists will number less than a hundred each year during the 1970's. These openings will occur as workers transfer to other fields of work, retire, or die.

Overall employment of these workers may decline somewhat because of the use of more automatic communications equipment which permits communications for longer distances.

The number of flight service station specialists employed by the FAA is expected to increase slowly in the years ahead. Need for additional workers to perform more services for pilots will be offset by improvements in equipment, and an increase in two-way radios that permit communications between pilots and air traffic controllers. The number of radio operators and teletypists employed by airlines will increase slowly due to communications systems becoming more automatic and centralized.

Earnings and Working Conditions

The beginning salary for airline radio operators who held the minimum third-class permit generally was between \$390 and \$535 a month in 1968. Workers who held a second-class license generally received \$10 to \$25 more a month. The beginning salary for teletypists ranged from \$450 to \$559 a month. Beginning FAA flight service station specialists receive between \$477 and \$581 a month, depending on education and experience; experienced flight service specialists

earn from \$705 to \$1,105 a month.

Radio operators and teletypists in a number of airlines are unionized. The major union in these occupational fields is the Communications Workers of America.

(See introductory section for sources of additional information and for general information on supplementary benefits and working conditions.)

TRAFFIC AGENTS AND CLERKS

(D.O.T. 912.368, 919.368)

Nature of the Work

Selling flight tickets, reserving seats and cargo space, and taking charge of the ground handling of planes are some of the duties of traffic agents and clerks. This group of workers includes ticket or reservation agents and clerks, operations or station agents, and traffic representatives.

Reservation sales agents and clerks give customers flight schedule and fare information over the telephone. Reservation control agents record reservations as they are made and report the reservations by teletype machine to a central computer or to clerks in other cities so that the same space will not be sold twice. They also receive teletype messages informing them of the sale of space. On some of the larger airlines, data processing systems receive, record, and transmit flight space information to personnel at airports and reservations officers throughout the entire airline system at great speeds. Ticket agents sell tickets and fill out ticket forms, including information such as the flight number and the passenger's name and destination.



They also check and weigh baggage, answer inquiries about flight schedules and fares, and keep records of tickets sold. Traffic representatives contact potential customers to promote greater use of the airline services.

Operations or station agents are responsible for the ground handling of airplanes at their stations. They supervise the loading and unloading of the aircraft and sometimes do this work themselves. They see that the weight carried by the planes is distributed properly, compute gas loads and the weight carried by the plane, prepare a list of the cargo, and keep records of the number of passengers carried. They also may make arrival and departure announcements and prepare the weather forms that pilots use when they plan their routes.

Places of Employment

About 41,500 men and women were employed as traffic agents

and clerks by the scheduled airlines in 1968. A few thousand others also were employed by the supplemental airlines, and by foreign-flag airlines that operate between the United States and overseas points.

Traffic staffs are employed principally in downtown offices and at airports in or near large cities where most airline passenger and cargo business originates. Some are employed in smaller communities where airlines have scheduled stops.

Training, Other Qualifications, and Advancement

Traffic agents and clerks must deal directly with the public, either in person or by telephone. For this reason, airlines have strict hiring standards with respect to appearance, personality, and education. A good speaking voice is essential because these employees frequently use the telephone or public address systems. High school graduation generally is required, and college training is considered desirable.

College courses in transportation such as "traffic management" and "air transportation," as well as experience in other areas of air transportation, are helpful for a higher grade job, such as traffic representative. Both men and women are employed as reservation and ticket agents; however, most operations agents are men.

Traffic agents may advance to traffic representative and supervisor. A few eventually may move up to city and district traffic and station manager.

Employment Outlook

Employment of traffic personnel will increase rapidly over the 1970's, mainly because of anticipated growth in passenger and

cargo traffic. In addition to the thousands of opportunities for new workers that will result from this employment growth, additional opportunities will arise as young women leave their jobs to marry or rear children.

Most of the major airlines are installing new machines to record and process reservations, keep records, and perform a variety of other routine tasks. Mechanization will affect the reservation clerks in particular. The employment of ticket agents, however, whose main job involves personal contacts, will not be affected very much, although their paper work will be reduced considerably. The small group of traffic representatives probably will increase substantially as the airlines compete for new business.

Earnings and Working Conditions

Limited wage data collected from union-management contracts covering reservations and ticket agents employed by several airlines indicate that their beginning salaries ranged from \$430 to \$455 a month in 1968. Those workers having 5 years or more of experience earned between \$527 to \$584 a month. Station and operations agents started at about \$475 a month and progressed to about \$624 a month after several years.

Many reservation and transportation agents belong to labor unions. Most of the organized agents belong to the Transport Workers Union of America or the Brotherhood of Railway and Steamship Clerks, Freight Handlers, Express and Station Employees.

(See introductory section for sources, of additional information and for general information on supplementary benefits and working conditions.)

OCCUPATIONS IN THE ELECTRIC POWER INDUSTRY

Nearly every American home, business, and community is dependent upon electricity. There would be no modern communication systems, no highly mechanized industries, and fewer of the appliances that have become an indispensable part of every day life without this most versatile form of energy. Many types of workers are needed to produce electricity, develop additional markets for it, and distribute it to the consumer. These workers include power plant operators, linemen, electricians, engineers, research scientists, salesmen, technicians, meter readers, and office workers. Electric utilities offer interesting jobs and steady employment for men and women in several thousand communities throughout the country.

Nature and Location of the Industry

The electric power industry includes about 3,700 electric utility systems that vary greatly in size and type of ownership. Utilities range from large, interconnected systems serving broad regional areas to small power companies serving individual communities. Many utilities are investor owned (private) or owned by cooperatives; others are owned by cities, counties, and public utility districts, as well as by the Federal Government. Utility systems include power plants, which generate electric power; substations, which increase or decrease the voltage of this power; and vast networks of transmission and distribution lines.

The delivery of electricity to the user at the instant he needs

it is the distinctive feature of the operation of electric power systems. Electricity cannot be stored efficiently but must be used as it is produced. Because a customer can begin or increase his use of electric power at any time by merely flicking a switch, an electric utility system must have sufficient capacity to meet peak consumer needs at any time.

Some utilities generate, transmit, and distribute only electricity; others distribute both electricity and gas. This chapter is concerned with employment opportunities in those jobs relating only to the production and distribution of electric power.

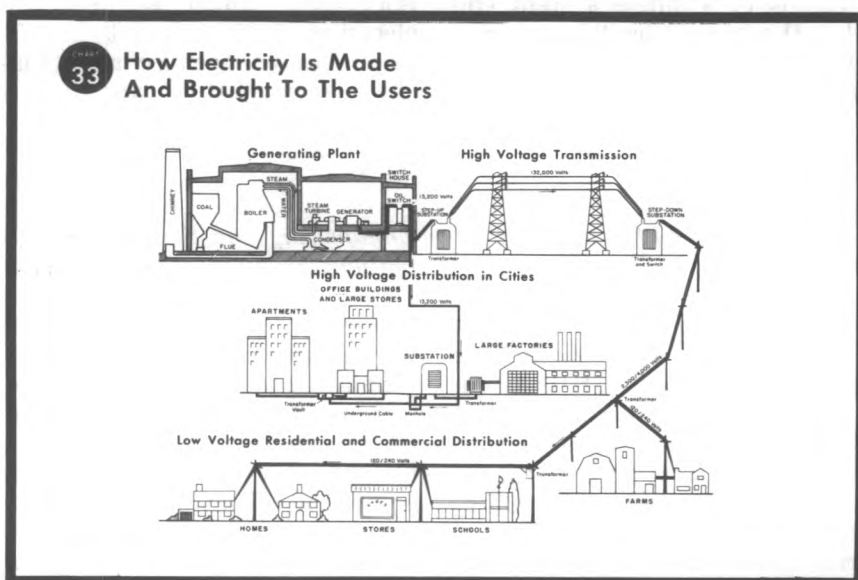
In 1968, private, cooperative, and government utility systems combined employed nearly 475,000 workers. Privately owned utilities and cooperatives employed about 405,000 workers; Federal, and municipal government utilities employed the remaining 70,000. A few large manufacturing establishments, which

produce electric power for their own use, also employ electric power workers.

Three principal groups of consumers—industrial, residential, and commercial—purchased more than 95 percent of all electricity sold in 1968. Industrial customers, such as chemical, steel, aluminum, and automobile plants, purchased almost 45 percent of all the electric power sold. Residential customers purchased nearly 30 percent, and commercial customers, such as stores, hotels, and office buildings, purchased about 20 percent.

Electric utility service now reaches almost every locality and, therefore, electric utility jobs are found throughout the country. Hydroelectric power projects have created jobs even in relatively isolated areas. Most utility jobs, however, are in heavily populated urban areas, especially where there are many industrial users, or where a large utility has its headquarters.

Producing and distributing large quantities of electrical energy involves many processes and activities. Chart shows how electric energy is generated, and how it travels from the generating station to the users. The first step



in providing electrical energy occurs in a generating station or plant, where huge generators convert mechanical energy into electricity. Electricity is produced primarily in steam-powered generating plants which use coal, gas, or oil for fuel. Some new steam generating stations use nuclear energy as a fuel. A considerable amount of electricity also is produced in hydroelectric generating stations which use water power to operate the turbines. Some generators, primarily for use in standby service or to provide electricity for special purposes, are powered by internal combustion and gas turbine engines.

After electricity is generated, it passes through a "switchyard" where the voltage is increased so that the electricity may travel long distances without excessive loss of power. After leaving the generating plant, electricity passes onto transmission lines. These lines carry electricity from the generating plant to substations, where the voltage is decreased and passed on to the distribution networks serving individual customers. Transmission lines tie together the generating stations of a single system and also the power facilities of several systems. In this way, power can be interchanged among several utility systems to meet varying demands.

Electric Utility Occupations

Workers are needed in many different occupations to produce electric power for instant use. About 10 percent of the employees in this industry work in occupations directly related to the generation of electricity. About 20 percent are in jobs related to the transmission and distribution of power to the custom-

ers. Another 20 percent are in maintenance and repair work and in jobs such as guard, watchman, and janitor. Approximately 30 percent are employed in administrative and clerical jobs, 10 percent in customer servicing jobs, and 10 percent in scientific, engineering, and other technical occupations.

In addition to the powerplant, transmission, and customer service occupations (discussed in detail later in this chapter), the electric power industry employs large numbers of workers in maintenance, engineering, scientific, administrative, sales, and clerical occupations. The latter occupations are discussed briefly below. Detailed discussions of these and other occupations in the electric power industry and in many other industries are given in the *Handbook* sections covering the individual occupations.

Maintenance and Other Occupations. A considerable number of workers maintain and repair the equipment used by the electrical utilities. The duties of these skilled craftsmen are similar to those of maintenance workers in other industries. Among the more important skilled workers are electricians, instrument repairmen, maintenance mechanics, machinists, pipefitters, and boiler-makers. Other workers are employed as guards, watchmen, and janitors.

Engineering and Scientific Occupations. Many interesting job opportunities are available for engineers and technical workers in electric utilities. Engineers plan generating plant additions, interconnections of complex power systems, and installations of new transmission and distribution equipment. They supervise construction, develop improved operating methods, and test the effi-

ciency of the many types of electrical equipment. In planning modern power systems, engineers select plant sites, types of fuel, and types of plants. Engineers also help industrial and commercial customers make the best use of electric power for equipment and lighting. They stimulate greater use of electricity by demonstrating the advantages of electrical equipment and suggesting places where electricity can be used more effectively.

Administrative and Clerical Occupations. Because of the enormous amount of recordkeeping necessary to run the business operations, electric utilities employ a higher proportion of administrative and clerical personnel than many other industries. Nearly one-third of the industry's work force is employed in clerical and administrative jobs. Many of these workers are women. Large numbers of stenographers, typists, bookkeepers, office machine operators, file clerks, accounting and auditing clerks, and cashiers are employed. These workers keep records of the services rendered by the company, make up bills for customers, and prepare a variety of statements and statistical reports. An increasing amount of this work in the larger offices now is being performed by electronic data-processing equipment. This generally results in more clerical work being done with the same or fewer employees. The use of this equipment also creates requirements for programmers and computer operators. Administrative employees include accountants, personnel officers, purchasing agents, and lawyers.

Employment Outlook

Employment in the electric power industry is expected to

grow slowly during the 1970's, although the production of electric power is expected to increase substantially. In addition to new jobs created by employment growth, several thousand job opportunities for new workers will occur each year during this period to replace workers who retire, die, or leave the industry for other work.

Industrial customers are expected to use more electricity because of the widening application of electric power to industrial processes. Use of electricity by residential customers is expected to rise because of the continued growth in population and the number of households. In addition, residential customers are expected to increase their use of electricity for heating and air conditioning, and for an increasing number and variety of appliances. The construction of new stores and office buildings and the modernization of existing structures will expand the use of electricity by commercial customers.

However, the growing use of automatic controls in this highly mechanized industry makes possible large increases in the production of electric power with little increase in employment. For example, since operators in generating stations are needed chiefly to check gages and control instruments, improvements in generating equipment have made possible great increases in the industry's capacity and production with only small increases in the number of operators. Continuing development of larger and more highly mechanized equipment with many automatic controls will result in a decline in the number of these operators. The employment of substation operators will continue to decline because of the installation of completely automatic equipment in all but the largest substations. Employ-

ment decreases in these occupations may be offset by the expected growth in the number of maintenance and repair craftsmen needed to keep the industry's increasing amount of complex machinery in operating condition.

The employment of workers in maintenance and repair of transmission and distribution lines is expected to remain relatively stable. Fewer men per crew will be needed to work on electric power lines because of the increasing use of mechanized equipment for setting poles and for stringing and maintaining lines. However, this reduction in jobs per crew may be offset by the larger number of crews needed to service the expanding distribution systems required by the growing number of electric power customers.

Because of the increasing use of electronic data-processing equipment for billing and record-keeping, only a small increase in office employment is expected. However, the relatively high turnover in office jobs will provide many additional openings for new workers each year. Some increase in employment also is expected in administrative jobs; scientific, engineering, and other technical jobs; and in areas such as sales and market development.

Earnings and Working Conditions

Earnings in the electric utility industry generally are higher than in other public utility industries and in many manufacturing industries. In 1968, earnings of nonsupervisory employees in private electric power utilities averaged \$3.71 an hour or nearly \$155 a week.

Many nonsupervisory electric utility workers in production, transmission, and distribution departments are union members.

The bargaining representative for most of these workers is either the International Brotherhood of Electrical Workers or the Utility Workers Union of America. Independent unions represent some utility workers.

Because supplying electricity is a 24-hour, 7-day-a-week activity, some employees work evenings, nights, and weekends. Most union contracts with electric utilities provide a higher rate of pay for evening and night work than the basic day rate. In 1968, most workers on the second shift received from 10 to 20 cents an hour more than the basic day rate, and those on the third shift, from 10 to 25 cents an hour more.

Overtime work often is required, especially during emergencies such as floods, hurricanes, or storms. During an "emergency callout," which is a short-notice request to report to work during nonscheduled hours, the worker generally is guaranteed a minimum of 3 or 4 hours' pay at 1½ times his basic hourly rate. Travel time to and from the job is counted as worktime.

In addition to these provisions which affect pay, electric utilities provide other employee benefits. Annual vacations are granted to workers according to length of service. Usually, contracts or employee benefit programs provide for a 1-week vacation for 6 months to 1 year of service, 2 weeks for 1 to 10 years, and 3 weeks for 10 to 20 years. A number of contracts and programs provide for 4 weeks after 18 years and for 5 weeks after 25 years or more. The number of paid holidays ranges from 6 to 12 days a year. Nearly all companies have benefit plans for their employees. A typical program provides life, hospitalization, and surgical insurance and paid sick leave. Retirement pension plans supplement Federal social security pay-

ments and generally are paid for in full or in part by the employer.

The number of injuries per million man-hours worked is much lower in this industry than in most manufacturing industries. Some occupations are more subject to accidents than others. Accidents occur most frequently among the line and cable splicing crews. Because of the dangers of electrocution and other hazards, electric utilities and unions have made intensive efforts to enforce safe working practices.

Sources of Additional Information

More information about jobs in the electric power industry may be obtained from local electric utility companies, industry trade associations, or from the local offices of unions which have electric utility workers among their membership. Additional information may be obtained from:

Edison Electric Institute, 750 3rd Avenue, New York, New York 10017.

International Brotherhood of Electrical Workers, 1200 15th St. NW., Washington, D.C. 20005.

Utility Workers' Union of America, 1875 Conn. Ave. NW., Washington, D.C. 20006.

POWERPLANT OCCUPATIONS

Nature of the Work

Operators are key workers in a powerplant. They observe, control, and keep records of the operation of various kinds of powerplant equipment. They make sure the equipment functions efficiently and detect any trouble that arises. There are four basic classes

of operators—boiler, turbine, auxiliary equipment, and switchboard operators. In many new steam plants, the duties of these operators are combined, and operators and their assistants are known as steam operators, powerplant operators, or central control room operators. Of increasing importance in this highly mechanized industry are the maintenance men and repairmen, including electrical, instrument, and mechanical repairmen. Other powerplant workers include helpers and cleaners, and the custodial staff, including janitors and watchmen. Coal handlers are employed in steam generating plants that use coal for fuel. Hydroelectric plants employ gate tenders who open and close the headgates that control the flow of water to the turbines. Supervision of powerplant operations is handled by a chief engineer and by his assistants, the watch engineers.

Boiler operators (D.O.T. 950.782) regulate the fuel, air, and water supply in the boilers and maintain proper steam pressure needed to turn the turbines, on the basis of information shown by gages, meters, and other instruments mounted on panel boards. One man may operate one or more boilers. Boiler operators, are employed only where steam is used to generate electricity.

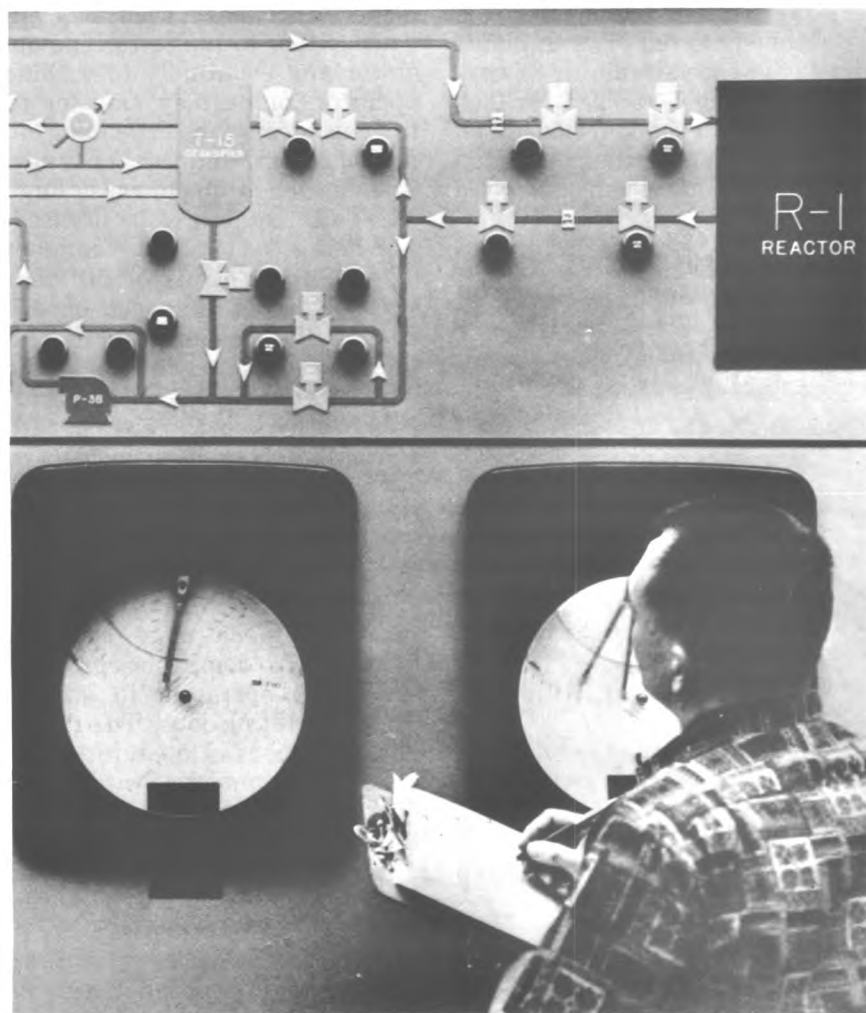
Turbine operators (D.O.T. 952.138) control the operation of steam- or water-powered turbines which drive the generators. (In small plants, they also may operate auxiliary equipment or a switchboard.) Modern steam turbines and generators operate at extremely high speeds, pressures, and temperatures; therefore, close attention must be given the pressure gages, thermometers, and other instruments which show the operations of the turbo-generator unit. Turbine operators record the information shown by

these instruments and check the oil pressure at bearings, the speed of the turbines, and the circulation and amount of cooling water in the condensers which change the steam back into water. They also are responsible for starting and shutting down the turbines and generators, as directed by the switchboard operator in the control room. Other workers, such as helpers and junior operators, assist the turbine operators.

Auxiliary equipment operators (D.O.T. 952.782) check and record the readings of instruments that indicate the operating condition of pumps, fans, blowers, condensers, evaporators, water conditioners, compressors, and coal pulverizers. Since auxiliary equipment may break down occasionally, these operators must be able to detect trouble quickly, make accurate judgments, and sometimes make repairs. Some small plants do not employ auxiliary equipment operators; these duties are performed by turbine operators.

Switchboard operators (D.O.T. 952.782) control the flow of electric power in the generating station from generators to outgoing powerlines. They usually work in a control room equipped with switchboards and instrument panels. Switches control the movement of electricity through the generating station circuits and onto the transmission lines.

Instruments mounted on panelboards show the power demands on the station at any instant, the powerload on each line leaving the station, the amount of current being produced by each generator, and the voltage. The operators use switches to distribute the power demands among the generators in the station, to combine the current from two or more generators, and to regulate the flow of the electricity onto various powerlines to meet the de-



Operator checks instrument readings at nuclear powered generating plant.

mands of the users served by each line. When power requirements on the station change, they order generators started or stopped and, at the proper time, connect them to the power circuits in the station or disconnect them. In doing this work, they follow telephone orders from the load dispatcher who directs the flow of current throughout the system.

Switchboard operators and their assistants also check their instruments frequently to see that electricity is moving through and out of the powerplant properly, and that correct voltage is being maintained. Among their

other duties, they keep records of all switching operations and of load conditions on generators, lines, and transformers. They obtain this information by making regular meter readings.

In most powerplants constructed in recent years, the operation of boilers, turbines, auxiliary equipment, and the switching required for efficient balancing of generator output has been centralized in a single control room. Here, central control room operators or power plant operators, by monitoring instrument panels and manipulating switches, regulate all the power generating

equipment, which in older plants requires specialists such as boiler and turbine operators. Control room operators have several assistants whose duties include patrolling the plant and checking the equipment. The central control room operators report to the plant superintendent or watch engineers when equipment is not operating properly.

Watch engineers (D.O.T. 950-131) are the principal supervisory workers in a powerplant. They supervise the employees responsible for the operation and maintenance of boilers, turbines, generators, auxiliary equipment, switchboards, transformers, and other machinery and equipment. Watch engineers are supervised by a chief engineer or a plant superintendent who is in charge of the entire plant.

Training, Other Qualifications, and Advancement

New powerplant workers generally begin at the bottom of the ladder—usually on cleanup jobs. Such work gives beginners an opportunity to become familiar with the equipment and the operations of a powerplant. They advance to the more responsible job of helper, as job openings occur. Formal apprenticeships in these jobs are rare. Applicants generally are required to have a high school education or its equivalent. Advancement on the job depends primarily on one's ability to master the skills required.

It takes from 1 to 3 years to become an auxiliary equipment operator and from 4 to 8 years to become a boiler operator, turbine operator, or switchboard operator. A person learning to be an auxiliary equipment operator progresses from helper to junior operator to operator. A boiler opera-

tor generally spends from 2 to 6 months as a laborer before being promoted to the job of helper. Depending on openings and the worker's aptitude, the helper may advance to junior boiler operator and eventually to boiler operator, or transfer to the maintenance department and work his way up to boiler repairman. In most large cities, boiler operators, who operate highpressure boilers, are required to be licensed.

Powerplant workers employed in atomic-powered electric plants must have special training to work with fissionable, radioactive fuel, in addition to the knowledge and skills required for the generation of conventional steam generated electric power.

Turbine operators are selected from among auxiliary equipment operators in many plants. The line of advancement in other plants is from laborer to turbine

helper. The helper then may advance either to junior turbine operator and eventually to turbine operator, or he may transfer to turbine repairman, depending on job openings and his aptitude. Turbine operators in most large cities are required to be licensed.

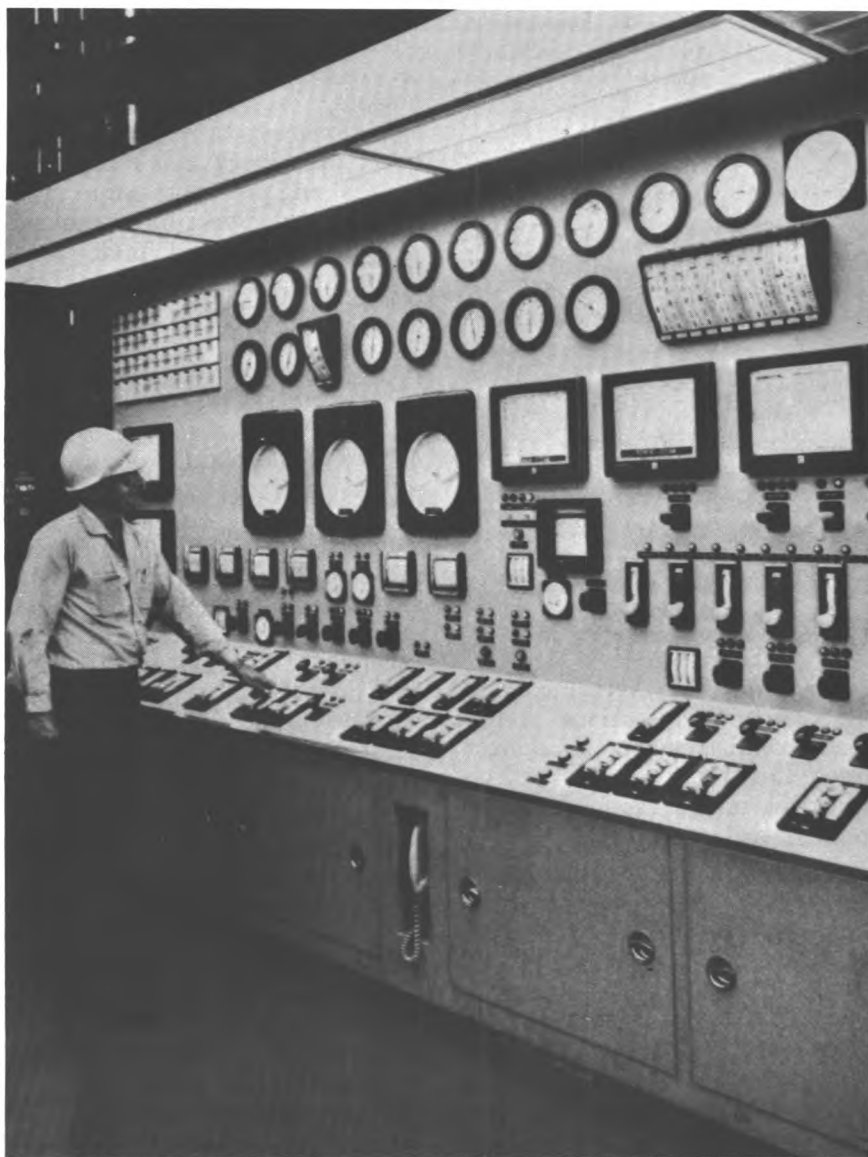
Where a system has a number of generating plants of different size, operators first get experience in the smaller stations and then are promoted to jobs in the larger stations as vacancies occur. New workers in the switchboard operators section begin as helpers, advance to junior operators, and then to switchboard operators. They also may advance from jobs in small stations to those in larger stations where operating conditions are much more complex. Some utility companies promote substation operators to switchboard operating jobs. The duties of both classes of operators have much in common. Switchboard operators can advance to work in the load dispatcher's office.

Watch engineers are selected from among experienced powerplant operators. At least 5 to 10 years of experience as a first-class operator usually are required to qualify for a watch engineer's job.

Employment Outlook

The total number of jobs for powerplant operators is expected to show little change during the 1970's, although the production of electrical energy will increase at a rapid rate. However, several hundred job openings for new workers will occur each year to replace operators who retire, die, or leave the industry for other work.

The use of increasingly larger and more efficient equipment is expected to make possible great increases in capacity and produc-



Operator checks control panel.

tion with little increase in the number of powerplant operators. For example, one operator can control a large modern turbogenerator as readily as he can control a much smaller one. Also, the growing use of more automatic equipment reduces the number of operators needed, and makes it possible to direct all operating processes from a central control room. However, because of the expected increased demand for electric power, it will be necessary to build and operate many new generating stations.

Generally, operating a nuclear-powered plant requires about the same number of employees as running a steam-generating plant using fossil fuels.

Earnings and Working Conditions

The earnings of powerplant workers depend on the type of job, the section of the country in which they work, and many other factors. The following tabulation shows estimated average hourly earnings for selected powerplant occupations in privately operated utilities in November 1967:

	Average hourly earnings
Auxiliary equipment operator ..	\$3.40
Boiler operator	3.84
Control room operator	4.19
Switchboard operator:	
Switchboard operator,	
Class A	4.08
Switchboard operator,	
Class B	3.74
Turbine operator	3.96
Watch engineer	4.99

A powerplant is typically well lighted and ventilated, clean, and orderly, but there is some noise from the whirring turbines.

Switchboard operators in the control room often sit at the panel boards, but boiler and turbine operators are almost constantly on their feet. The work of power-

plant operators generally is not physically strenuous, particularly in the newer powerplants. Since generating stations operate 24 hours a day, 7 days a week, powerplant employees sometimes must work nights and weekends.

TRANSMISSION AND DISTRIBUTION OCCUPATIONS

Nature of the Work

One-fifth of the workers employed by electric light and power systems are in transmission and distribution jobs maintaining the flow of electric power to the users. The principal workers in transmission and distribution jobs are those who control the flow of electricity—load dispatchers and substation operators—and the men who construct and maintain powerlines—linemen, cable splicers, troublemen, groundmen, and helpers. Linemen make up the largest single occupation in the industry.

Load dispatchers (D.O.T. 950.168) (sometimes called system operators or power dispatchers) are the key operating workers of the transmission and distribution departments. They control the flow of electricity throughout the area served by the utility. The load dispatcher's room is the nerve center of the entire utility system. From this location, he controls the plant equipment used to generate electricity and directs its flow throughout the system. He telephones his instructions to the switchboard operators at the generating plants and the substations. He tells the operators when additional boilers and generators are to be started or stopped in line with the total power needs of the system.

The load dispatcher must anticipate demands for electric power so that the system will be prepared to meet them. Power demands on utility systems may change from hour to hour. A sudden afternoon rainstorm can cause a million lights to be switched on in a matter of minutes.

He also directs the handling of any emergency situation, such as a transformer or transmission line failure, and routes current around the affected area. Load dispatchers also may be in charge of interconnections with other systems, and they direct the transfer of current between systems as the need arises.

The load dispatcher's source of information for the entire transmission system centers in the pilot board. This pilot board, which dominates the load dispatcher's room, is a complete map of the utility's transmission system. It enables the dispatcher to determine, at a glance, the conditions that exist at any point in the system. Lights may show the positions of switches which control generating equipment and transmission circuits, as well as high voltage connections with substations and large industrial customers. The board also may have several recording instruments which make a graphic record of operations for future analysis and study.

Substation operators (D.O.T. 952.782) generally are in charge of a substation and are responsible for its operation. Under orders from the load dispatcher, they direct the flow of current out of the station by means of a switchboard. Ammeters, voltmeters, and other types of instruments on the switchboard register the amount of electric power flowing through each line. The flow of electricity from the incoming to the outgoing lines is controlled by circuit breakers.

The substation operators connect or break the flow of current by manipulating levers on the switchboard which control the circuit breakers. In some substations, where alternating current is changed to direct current to meet the needs of special users, the operator controls converters which perform the change.

In addition to switching duties, the substation operators check the operating condition of all equipment to make sure that it is in good working condition. They supervise the activities of the other substation employees on the same shift, assign them tasks, and direct their work. In smaller substations, the substation operator may be the only employee.

Linemen (D.O.T. 821.381) construct and maintain the network of powerlines which carry electricity from generating plants to consumers. Their work consists of installations, equipment replacements, repairs, and routine maintenance work. Although in many companies the installation of new lines and equipment is important, in other companies this work is performed by outside contractors. When wires, cables, or poles break, it means an emergency call for a line crew. Linemen splice or replace broken wires and cables and replace broken insulators or other damaged equipment. Most linemen now work from "bucket" trucks with pneumatic lifts that take them to the top of the pole or adjacent to the overhead conductor at the touch of a lever.

In some power companies, linemen specialize in particular types of work. Those in one crew may work only on new construction, and others may do only repair work. In some instances, linemen specialize on high voltage lines using special "hot line" tools to avoid interruptions in the flow of current.

Troublemakers (D.O.T. 821.281)

are experienced linemen who are assigned to special crews that handle emergency calls for service. They move from one special job to another, as ordered by a central service office which receives reports of line trouble. Often troublemen receive their orders by direct radio communication with the central service office.

These workers must have a thorough knowledge of the company's transmission and distribution network. They first locate and report the source of trouble and then attempt to restore service by making the necessary repairs. Depending on the nature and extent of the trouble, a troublemaker may restore service in the case of minor failure, or he may simply disconnect and remove damaged equipment. He must be familiar with all the circuits and switching points so that he can safely disconnect live circuits in case of line breakdowns.

Groundmen (D.O.T. 821.887) dig poleholes and assist the linemen and apprentices to erect the wooden poles which carry the distribution lines. The linemen bolt crossarms to the poles or towers and bolt or clamp insulators in place on the crossarms. With the assistance of the groundmen, they raise the wires and cables and install them on the poles or towers by attaching them to the insulators. In addition, with assistance from groundmen, linemen attach a wide variety of equipment to the poles and towers, such as lightning arrestors, transformers, and switches.

Cable splicers (D.O.T. 829.381) install and repair single- and multiple-conductor insulated cables on utility poles and towers, as well as those buried underground or installed in underground conduits. When cables are installed, the cable splicers pull the cable through the conduit



Lineman works on transmission line.

and then join the cables at connecting points in the transmission and distribution systems. At each connection in the cable, they wrap insulation around the wiring. They splice the conductors leading away from each junction of the main cable, insulate the splices, and connect the cable sheathing. Many cables have a lead sheath which requires making a lead joint. Most of the physical work in placing new cables or replacing old cables is done by helpers.

Cable splicers spend most of their time repairing and maintaining the cables and changing the layout of the cable systems. They must know the arrangement of the wiring systems, where the circuits are connected, and where they lead to and come from. They make sure that the conductors do not become mixed up between the

substation and the customer's premises. The splicers connect the ends of the conductors to numbered terminals, making certain that they have the same identifying number at the remote panel box in an underground vault as they have in the control office. Cable splicers also make sure the insulation on the cables is in good condition.

Training, Other Qualifications, and Advancement

Load dispatchers are selected from among the experienced switchboard operators and from operators of the larger substations. Usually, 7 to 10 years of experience as a senior switchboard or substation operator are required for promotion to load dispatcher. To qualify for this job, an applicant must demonstrate his knowledge of the entire utility system.

Substation operators generally begin as assistant or junior operators. Advancement to the job of operator in a large substation requires from 3 to 7 years of on-the-job training.

Skilled linemen (journeymen) usually qualify for these jobs after about 4 years of on-the-job training. In some companies, this training consists of a formal apprenticeship program. Under formal apprenticeship, there is a written agreement, usually worked out with a labor union, which covers the content of the training and the length of time the apprentice works in each stage of the training. The apprenticeship program combines on-the-job training and classroom instruction in blueprint reading, elementary electrical theory, electrical codes, and methods of transmitting electrical currents.

The apprentice usually begins his training by helping the



groundman to set poles in place and by passing tools and equipment up to the lineman. After a training period of approximately 6 months, the apprentice begins to do simple linework on lines having low voltage. While performing this work, he is under the immediate supervision of a journeyman lineman or the line foreman. After about a year, he is assigned more difficult work but is still under close supervision. During the last 6 months of his apprenticeship, the trainee does about the same kind of work as the journeyman lineman but with more supervision. When he begins to work independently, he is first assigned simple, routine tasks. After he acquires several years of experience and demonstrates a thorough knowledge of the company's transmission and distribution systems, he may advance from lineman to troubleman.

The training of linemen who learn their skills on the job generally is similar to the apprenticeship program; it usually takes about the same length of time but does not involve classroom instruction. The worker begins as a groundman and progresses through increasingly difficult stages of linework before becoming a skilled lineman.

Candidates for linework should be strong, in good physical condition, and without fear of height. Climbing poles and lifting lines and equipment is strenuous work. They also must have steady nerves and good balance to work at the tops of the poles and to avoid the hazards of live wires and falls.

Most cable splicers get their training on the job, usually taking about 4 years to become fully qualified. Workers begin as helpers and then are promoted to assistant or junior splicers. In these jobs, they are assigned more difficult tasks as their knowledge of the work increases.

Employment Outlook

Several thousand job opportunities are expected to be available in transmission and distribution occupations during the 1970's. Most of these opportunities will occur because of the replacement of experienced workers who retire, die, or transfer to other fields of work.

Some increase in the employment of transmission and distribution workers is expected, although employment trends will differ among the various occupa-

tions in this category. In spite of the need to construct and maintain a rapidly growing number of transmission and distribution lines, the number of linemen and troublemen is expected to increase only slightly because of the use of more mechanized equipment. Some increase in the number of cable splicers is expected because of the growing use of underground lines in suburban areas. The need for substation operators will be reduced substantially, since the introduction of improved and more automatic equipment makes it possible to operate most substations by remote control.

Earnings and Working Conditions

The earnings of transmission and distribution workers depend on the type of job they have, and the section of the country in which they work. The following tabulation shows the average hourly earnings for major transmission and distribution occupations in privately operated utilities in November 1967:

	Average hourly earnings
Groundman	\$2.71
Lineman	4.09
Load dispatcher	4.90
Substation operator	4.01
Troubleman	4.20

Load dispatchers and substation operators generally work indoors in pleasant surroundings. Linemen, troublemen, and groundmen work outdoors and, in emergencies, in all kinds of weather. Cable splicers do most of their work in manholes beneath city streets—often in cramped quarters. Safety standards developed over the years by utility companies, with the cooperation of labor unions, have reduced greatly the accident hazards of these jobs.

CUSTOMER SERVICE OCCUPATIONS

Nature of the Work

Workers in customer service jobs include those who install, test, and repair meters, and those who read the meters. Also in this group are company agents in rural areas and appliance servicemen working in company-operated shops which repair electrical equipment owned by customers.

Metermen (D.O.T. 729.281) (or meter repairmen) are the most skilled workers in this group. They install, test, maintain, and repair meters on customers' premises, particularly those of large industrial and commercial establishments. Some metermen can handle all types of meters, including the more complicated ones used in industrial plants and other places where large quantities of electric power are used. Others specialize in repairing the simpler kinds, like those in homes. Often, some of the large systems have meter specialists, such as *meter installers* (D.O.T. 821.381) and *meter testers* (D.O.T. 729.281). Meter installers put in and take out meters. Meter testers specialize in testing the small meters on homeowners' property and some of the more complicated ones used by commercial and industrial customers.

Meter readers (D.O.T. 239.588) go to customers' premises—homes, stores, and factories—to read the figures on the meters which register the amount of electric current used. They record the amount of current used in a specific period so that each customer can be charged for the amount he used. Meter readers also watch for, and report, any tampering with meters.

District representatives usually

serve as company agents in outlying districts, in localities where the utility company does not have an office, and where the small number of customers does not justify the use of more specialized workers. Their work includes reading meters, collecting overdue bills, connecting and disconnecting meters, and making minor repairs. They receive complaints about service and reports of line trouble and send them to a central office for handling.

Training, Other Qualifications, and Advancement

Metermen begin their jobs as helpers in the meter testing and meter repair departments. Young men entering this field should have a basic knowledge of electricity. About 4 years of on-the-job training are required to become a fully qualified meterman. Some companies have formal apprenticeship programs for this occupation in which the trainee progresses according to a specific plan.

Utility companies usually employ inexperienced men to work as meter readers. They generally accompany the experienced meter reader on his rounds until they have learned the job well enough to go on the rounds alone. This job can be learned in a few weeks.

The duties of district representatives are learned on the job. An important qualification for men in these jobs is the ability to deal tactfully with the public in handling service complaints and collecting overdue bills.

Employment Outlook

Little change in employment in customer service occupations is expected through the 1970's. The need for meter readers will be

limited because of the trend toward less frequent reading of meters. Moreover, automatic meter reading may become more common, and new meters will require less maintenance. However, some job openings for metermen and meter readers will occur each year to replace those workers who retire, die, or transfer to other fields of work.

Earnings and Working Conditions

The earnings of customer service workers vary according to the

type of job they have, and the section of the country in which they work. The following tabulation shows the average hourly earnings for major customer service jobs in privately operated utilities in November 1967:

	<i>Average hourly earnings</i>
District representative	\$3.80
Meterman A	3.96
Meterman B	3.53
Appliance serviceman	3.67
Meter reader	2.98

The job of the meter reader is not physically strenuous but in-

volves considerable walking and some stair climbing. Metermen and appliance servicemen work indoors under typical repair shop conditions except when repairing or installing meters or appliances on customers' premises.

MERCHANT MARINE OCCUPATIONS

The American merchant marine is more than a vital link in the Nation's transportation system. It is our life-line in both peace and war and links us to every corner of the world. It transports America's exports and in return, brings imports from the rest of the world. In time of conflict, it carries troops, arms, and supplies to combat areas. Seafaring employment offers a wide variety of interesting and rewarding careers requiring diverse skills and levels of experience as well as an opportunity for travel and adventure.

Nature and Location of the Industry

The United States Flag Merchant Fleet consists of ocean-going vessels of 1,000 gross tons or over which carry U.S. foreign and domestic water-borne commerce. Approximately 1,100 vessels were in the active U.S. ocean-going merchant fleet in mid-1968, of which about 2 out of every 3 were privately-owned. Government-owned vessels are operated by the Navy's Military Sea Transportation Service (MSTS) which has civilian seafaring personnel. Three broad categories of vessels constitute the merchant fleet: combination passenger-cargo vessels, tankers, and freighters. Vessels in our "liner fleet" operate on regular schedules to specific ports. "Tramp" ships, on the other hand, sail for any port promising profit.

This country's 26 combination passenger vessels carry passengers, mail, and highly valued cargo on a regularly scheduled basis. Its approximately 270 tankers carry liquid bulk products, pri-

marily petroleum and petroleum products, almost exclusively in the domestic trade between Gulf Coast ports and Atlantic Coast ports. The more than 800 freighter vessels, on the other hand, are employed almost exclusively in the foreign trade of the United States. More than half of these vessels are employed in liner service to carry relatively high valued packaged cargoes on fixed schedules. Freighters are of various types, such as general cargo vessels, bulk carriers, refrigerator ships, roll-on-roll-off container, trailer, and other special-purpose type ships.

Places of Employment

The U.S. Flag Merchant Fleet employed about 60,000 seamen in mid-1968, two-thirds of whom were on freighters. Many additional men were employed during the year because many seamen leave their ships at the termination of a voyage; some take vacations which may average 100 days or more each year; others take temporary shoreside jobs or are unavailable for sea duty because of illness or injury.

Although there are about 70 ports in the United States, more than half of the Nation's shipping is carried on in 17 deep-sea ports along the Atlantic, Gulf, and Pacific Coasts. The Nation's largest port is New York. Other major Atlantic ports are Philadelphia, Baltimore, Norfolk, Boston, Charleston, Savannah, Tampa, and Jacksonville. Gulf ports handling substantial volumes of cargo include New Orleans, Houston, Galveston, Port Arthur, and Lake Charles. Shipping on the West Coast is concentrated in the areas of San Francisco Bay,

Los Angeles, and Seattle and Portland.

The size and composition of crews employed aboard merchant vessels depend on the size and type of vessel. Cargo vessels and tankers have crews varying from 36 to 65 men, passenger vessels such as the United States may have a crew of a 1,000 or more.

The work performed aboard ship is divided among the deck, engine, and steward departments. The deck department is responsible for the navigation of the vessel, maintenance of the hull and deck equipment, and the loading, discharging, and storing of cargo. Personnel in the engine department operate and maintain the machinery that propels the vessel. The steward's department feeds the crew and maintains living and recreation areas.

About one-fourth of the jobs in the merchant marine are filled by licensed personnel that include highly skilled licensed supervisory and professional workers in the deck and engine departments. The remaining berths are filled by skilled and semiskilled personnel in the deck, engine, and steward's departments.

Training, Other Qualifications, and Advancement

No educational requirements are established for either licensed or unlicensed positions in the merchant marine industry. Like most jobs today, a good education is a definite advantage. Training for licensed ratings is conducted at the United States Merchant Marine Academy, at five State merchant marine academies, and through programs operated by trade unions in the merchant marine industry. Unions also conduct training programs to upgrade the ratings of unlicensed seamen and, to a limited degree, to train prospective seamen for entry ratings.

Ship officers are licensed. To obtain an officer's license, candidates must be United States citizens, physically fit, and pass a comprehensive written examination by the U.S. Coast Guard. Unlicensed crewmen going to sea for the first time must obtain a merchant mariner's document from the Coast Guard. To obtain the document, applicants must present proof that they have job offers as members of a crew of a U.S. merchant vessel and pass a physical examination.

Young persons considering the merchant marine as a career should give serious thought to the department (deck, engine, steward) in which they would like to work. Once a man starts up the ladder in one department he cannot switch without beginning near the bottom again. Advancement to a higher rating depends not only upon specified sea experience, leadership ability, and an opening, but also upon passing a Coast Guard examination. Examinations for officer positions require a much higher level of theoretical knowledge than certification in the unlicensed ranks.

Deck officers start as third mates, and after accumulating prescribed amounts of sea service, may advance to second mate, to first mate, and finally to master. An officer in the engine department starts as a third assistant engineer and, in turn, may advance to second assistant engineer, first assistant engineer, and finally to chief engineer.

Unlicensed personnel also advance along well defined promotional lines. In the deck department, persons may advance from ordinary seamen to able seamen (A.B.). Some able seamen are upgraded to boatswains (foremen). In the engine department an unlicensed seaman usually advances from wiper to fireman/

watertender or to oiler. The next step is a highly skilled rating such as deck engine mechanic, refrigerator engineer, or electrician. In the steward's department, a messman or utilityman advances to third cook, to cook/baker to chief cook, and finally to chief steward.

More detailed information on training, other qualifications, and advancement appears in the statements on Licensed Merchant Marine Officers and Unlicensed Merchant Seamen.

Employment Outlook

Except during periods of war and national emergency, there has been a long-term decline in the number of men and vessels engaged in our merchant marine. Unless considerable reorientation takes place in our Nation's merchant marine policy, more of the same is expected during the decade ahead.

Because of substantially higher shipbuilding and manning costs, our merchant fleet finds that competing in the intensive worldwide shipping market is difficult. To insure that our country has a merchant fleet operating in regular or essential trade routes, the Government subsidizes about 300 cargo and passenger vessels (about a third of the active fleet). Much of the fleet is composed of slow, inefficient ships of World War II vintage that are sinking one by one into the sea of obsolescence.

Whether it is prudent to let this trend continue is the subject of much discussion. The Government presently is formulating a new merchant marine policy that is expected to define the role that Federal assistance will play in the size of tomorrow's fleet. The future of our merchant marine rests with this policy.

Radical new concepts that could dramatically cut shipping costs on some items and improve our competitive position are presently in the testing stage. For example, surface-effect ships that glide on or just above the water are capable of speeds 5 times those of most modern cargo ships. Greater application of nuclear power to merchant shipping is also on the horizon. But few of such radical innovations are likely to have a substantial impression on seaborne trade in the next decade. Instead present trends toward greater mechanization and automation will continue.

Future ships will be larger and faster and will operate with fewer men. For example, a central console in the engine room of the newest ships controls engines, boilers, and most auxiliary equipment. Data loggers automatically print the performance of various parts of the systems such as temperatures and pressures and automated boiler systems.

The size of the deck crew is being reduced primarily in the area of maintenance by improvements such as hydraulically operated hatch covers, inorganic zinc coatings that protect metals for years, and automatic tension mooring winches that assist in docking and undocking. Eventually a "lookout" device is foreseen that not only will warn of a collision but also will automatically adjust the course to avoid a crash. Improved efficiency on our newest ship already has cut 11 to 14 men from conventional manning requirements of about 55; still further reductions are likely.

Widespread unemployment is not necessarily a corollary to these reductions in manpower needs. For one thing, the dozen or so seagoing unions are likely



to resist substantial cuts in the size of crews. Further, many seamen began their careers when our fleet was built during World War II. This older work force, in conjunction with liberalized pension provisions and normally high departure rates for shore jobs, is expected to result in a large outflow of seamen from the industry during the years ahead.

For less skilled unlicensed positions, much of the attrition will be compensated for by declining manpower needs and upgrading among the abundance of men in the lower ratings. As more emphasis is placed on fewer but more highly trained men, there will be very little demand for unskilled men in the entry jobs.

The employment outlook for officers is somewhat brighter. They are among the older work-

ers in the merchant marine, and replacements are restricted by the limited training facilities presently available. Even assuming a smaller officer corps a decade from today, more than 1,000 employment opportunities are expected each year for academy graduates (who presently number about 600 a year) and those who work their way up through the ratings.

Whether an officer's best prospects lie in the deck or the engineering department is a question generating considerable heat among the unions representing these respective workers. It seems clear, however, that the present sharp craft line drawn between deck and engineering jobs will become blurred. The emphasis will be on job function; the newest automated equipment will cut

across departmental lines, union jurisdictions, and present work specialties. Some jobs will be entirely new, and both officers and unlicensed workers will require a new inventory of skills to hold them. For example, experience gained by standing watch in an engineroom of a conventional vessel may be secondary compared with basic courses in electronics.

In anticipation of this trend, the U.S. Merchant Marine Academy now selects 10 percent of the approximately 300 men who enter the academy each year to be trained as "omnicompetent" officers. They are taught both navigational and technical skills so they can work in either department.

Earnings and Working Conditions

Earnings aboard American flag deep-sea ships are the highest of any Nation in the world. In few other industries can an ambitious man who has a high school education or less do so well financially. An unlicensed seaman who has advanced a rung or two in rating can receive base and overtime earnings of nearly \$700 a month, in addition to free food and lodging. Most officers earn over \$1,000 a month.

Wages vary not only according to the job but also by the size and type of vessel. They are highest on multiple-screw passenger vessels. An outstanding characteristic of the maritime industry is that base wages represent only part of the seamen's take-home pay. Additional payments for assuming extra work or responsibility add as much as 50 percent to the base wages paid to licensed and unlicensed seamen. These additional payments include overtime pay, supplemental pay and so-called "penalty" pay.

Liberal employer-financed pension and welfare plans are provided. Today seamen whose vacation benefits range from 60 to over 100 days' vacation pay may retire at any age after 20 years of service, and receive pensions of \$250 per month for unlicensed seamen and \$325 per month for licensed seamen. All seamen and dependents are covered by comprehensive medical and welfare benefits. (See statements in Licensed Merchant Marine Officers and Unlicensed Merchant Seamen for more information on earnings).

The workweek for persons employed aboard ship is considerably different from the workweek for persons employed on the shore. At sea, the daily hours of licensed officers, able and ordinary seamen, firemen/watertenders, oilers, or deck/engine mechanics usually employed as watchstanders consist of 3 watches during each 12 hours. Each watch is 4 hours long and each man stands 2 watches, 7 days a week. Overtime is paid for any work over 40 hours a week. When the ship is in port, the crew works a 40-hour week, Monday through Friday.

Working and living conditions aboard ship have improved over the years. Mechanization has reduced work demands and newer vessels contain private rooms, air-conditioning, television, and expanded recreational facilities. However, life aboard ship is confining. Although a seaman may visit many parts of the world, his shore time may be limited by the increasingly rapid "turn-around" time of modern vessels.

While at sea, crew members must be able to derive satisfaction from simple pleasures, such as reading or a chair-side hobby. Since voyages last several weeks or months, seamen are away from home and families for substantial

periods of time. Some men tire of the lengthy separations and choose shoreside employment. Others become frustrated by periods of unemployment. Although union hiring rules recognize seniority in hiring, a man who has long years of sea experience does not have the same degree of job security often associated with seniority in shore jobs. Although available jobs are usually first offered to workers in the highest seniority "level," employment within these levels is typically on a first-come, first-served basis; and when berths are scarce, the list of candidates may be long.

The merchant marine has been called a feast or famine industry. During shipping emergencies such as the Vietnam conflict, hundreds of additional ships are put into service. When shipping demands recede, the industry frequently has excess shipping capacity and men. This accounts in part for the large number of seamen whose connection with the industry is only casual. It also explains in part why the potential supply of qualified seamen almost always exceeds the number of jobs, and why a person considering a career at sea can never be sure of the number of men with whom he might be competing in the future.

The duties aboard ship are hazardous relative to other industries. At sea, there is always a possibility of injuries from falls or the danger of fire, collision, or sinking. In the past, sudden illness at sea could be extremely hazardous, but emergency air service available today reduces the danger. Despite these drawbacks, for many men, the spirit and adventure of the sea; good wages and living conditions; and liberal vacation, pension, and welfare protection, more than compensate for the disadvantages of the work.

Sources of Additional Information

General information about jobs in the merchant marine may be obtained from:

Office of Maritime Manpower,
Maritime Administration, U.S.
Department of Commerce,
Washington, D.C. 20235.

Information about job openings, qualifications for employment, wage scales and other particulars can be obtained from local maritime unions. If no seafaring union is listed in a local telephone directory, information may be obtained from the following:

International Organization of
Masters, Mates and Pilots, 39
Broadway, New York, New
York 10006.

National Marine Engineers' Bene-
ficial Association, 17 Battery
Place, New York, New York
10004.

National Maritime Union of
America, 36 Seventh Avenue,
New York, New York 10011.

LICENSED MERCHANT MARINE OFFICERS

Nature of the Work

The Coast Guard licenses ship's professional and supervisory personnel consisting of deck, engine, and radio officers. In command of every ocean-going vessel is the *captain* (D.O.T. 197-168) or *master* who is the shipowner's sole representative. He is responsible and has complete authority for the operation of the ship including discipline and order, and the safety of the crew, passengers, cargo, and vessel.

While in port, the captain may function as the agent for the ship owners by conferring with custom officials. In some cases, he may

act as paymaster for the ship. Although not technically a member of a specific department, he generally is associated with the deck department, from whose ranks he was promoted.

Deck Department. Acting under supervision of the master, licensed deck officers or "mates" as they are traditionally called, direct the navigation and piloting of the ship and the maintenance of the deck and hull. While at sea, deck officers stand watch, take navigational observations, and supervise emergency drills. From his position on the bridge, the watchstanding deck officer is responsible for the ship's navigation. American vessels contain the most modern navigational devices, such as gyrocompass, radar, sonar, Fathometer, Loran, and radio directional finders. Deck officers must be familiar with these and other instruments as part of their duties in the safe and efficient operation and navigation of the ship.

While on duty, the deck officer maintains the authorized speed and course; plots the vessel's position at frequent intervals; posts lookouts when required; records his watch in the ship's "log" of the voyage; and immediately notifies the master of any unusual occurrences.

Besides acting as watch officer, each deck officer performs other duties. The *chief mate* (D.O.T. 197.133), or first mate or chief officer, as he is also known, acts as the captain's key assistant in assigning duties to the unlicensed deck crew, maintaining order and discipline, and by seeing that the deck crew, maintaining order and orderly. He also plans and carries out the loading, unloading, and stowing of cargo, and assists the captain in taking the ship in and out of port. On some ships he also may be in charge of first aid treatment.



Chief mate directs speed and course of cargo ship from bridge.

By tradition, the *second mate* (D.O.T. 197.133) is the navigating officer. He sees that the ship is provided with the necessary navigation charts and that navigating equipment is maintained properly.

The *third mate* (D.O.T. 197.133), the most junior-rated deck officer, is responsible for the care and the maintenance of the navigating bridge and the chartroom. He functions as the signal officer and is in charge of all signaling equipment and assists in the supervision of cargo loading and unloading operations. Third mates frequently inspect life boats and other lifesaving equip-

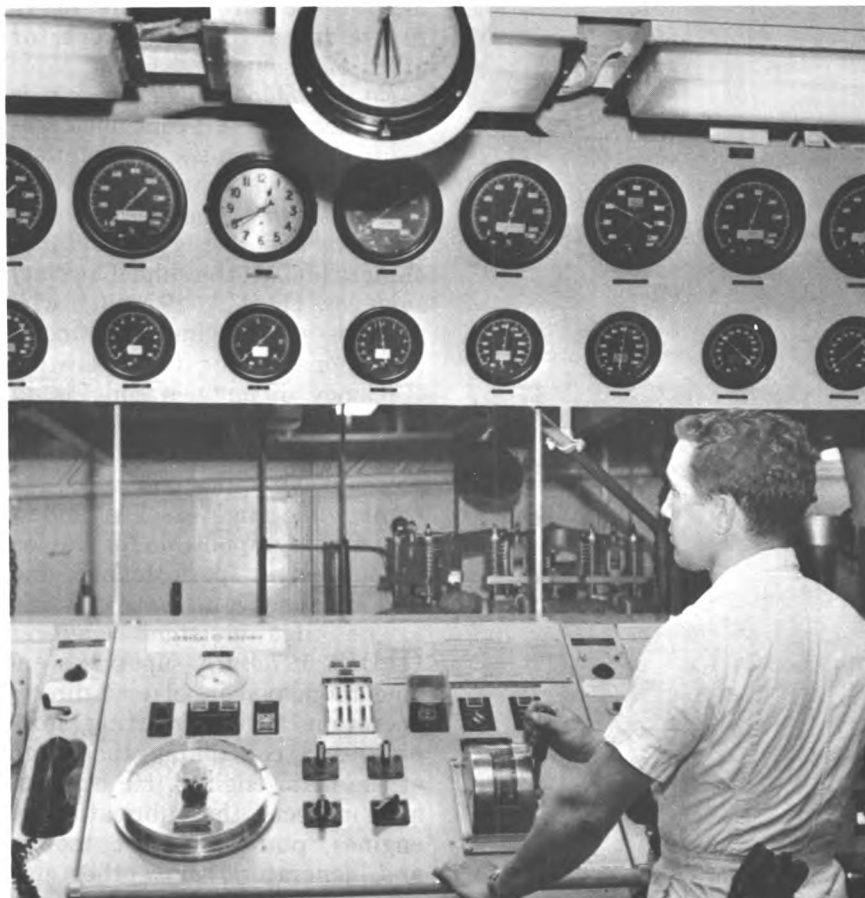
ment to be sure they are ready to use for a fire, shipwreck, or other emergency.

Engine Department. A ship is equivalent to a self-contained seagoing city, because it manufactures its own lights, water, and power. Marine engineers operate and maintain all engines and machinery aboard the ship. The *chief engineer* (D.O.T. 197.130) who supervises the engine department, is responsible for the operating efficiency of engines and for all other mechanical equipment. He oversees the operation of the main power plant and auxiliary equipment while the vessel is underway and is responsible for the log of equipment performance and fuel consumption.

The *first assistant engineer* (D.O.T. 197.130), supervises engine room personnel and directs operations such as starting, stopping, and controlling the speed of the main engines. He oversees and inspects the lubrication of engines, pumps, electric motors and generators, and other machinery; directs the installation of steam and water pipes and electric wiring; and with the aid of the chief engineer directs all types of repairs.

As with the deck department, the engineroom is operated on a 24-hour basis and officers are assigned watch periods. The chief engineer and/or first assistant engineer appoints the second assistant engineer and two of the third assistant engineers to a watch period during which they are responsible for the operation of the ship's propulsion plant and auxiliary machinery and the supervision of unlicensed engine department personnel. Marine engineers on watch must notify the chief engineer of any unusual occurrence and keep a record of equipment performance.

Each member of the licensed engineering staff performs spe-



Marine engineer controls running speed of main engine.

cific duties. The *second assistant engineer* (D.O.T. 197.130) has direct charge of the boiler and associated equipment, such as the water-feed system, pumps, and fuel oil heater system. He is responsible for the maintenance of proper steam pressure and oil and water temperatures. He supervises the cleaning of the boilers and is usually responsible for their operation and the operation of the steam generator.

The *third assistant engineer* (D.O.T. 197.130) supervises the operation and maintenance of the lubrication system and engine-room auxiliaries. At least one third assistant engineer is employed as a day man (nonwatchstander) and is responsible for the electrical and/or refrigeration

systems aboard ship.

Other officers. A ship maintains contact with shore and other vessels through its *radio officer* (D.O.T. 193.282), who is also responsible for maintaining this equipment. A passenger ship carries three to six operators; the average cargo vessel employs one. He sends and receives messages by voice or Morse code. He periodically receives and records time signals, weather reports, position reports, and other navigation and technical data. The radio operator may also maintain depth recording equipment and electronic navigation machinery.

Some cargo and tanker vessels and all passenger vessels carry *pursers* (D.O.T. 197.168). The purser or staff officer performs

the extensive paperwork required to enter and clear a vessel in each port, prepare payrolls, and assist passengers as required. In recent years, the Staff Officers Association has established a program designed to train pursers to act also as Pharmacist Mates. This instruction would improve the medical care aboard all dry cargo and tankers and facilitate the obtaining of Public Health clearance when a vessel arrives in port. All passenger vessels must carry licensed doctors and nurses.

Places of Employment

About 15,000 officers were employed aboard U.S. Flag ocean-going vessels during mid-1968. Licensed deck officers and engineering officers each account for about two-fifths of total employment. The remaining one-fifth is made up of radio and staff officers.

Training, Other Qualifications, and Advancement

Persons applying for the first time for an officer's license in the deck and engineering departments of oceangoing vessels must meet certain major legal requirements. Masters, chief and second mates, chief and first assistant engineers are required to be at least 21 years of age. The minimum age for third mates, third assistant engineers, and radio operators is 19. In addition, applicants must present documentary proof of United States citizenship and obtain a U.S. Public Health Service certificate attesting to their vision, color perception, and general physical condition.

In addition to legal and medical requirements, candidates for deck officer rating must pass Coast Guard examinations that

require extensive knowledge of seamanship, navigation, cargo handling, and the operations of the deck department in all its phases. Marine engineering officer candidates must demonstrate in-depth knowledge of propulsion systems, electricity, plumbing and steam fitting, metal shaping and assembly, and ship structure. To progress to a higher rating, officers are required to complete successfully their examinations.

For a Coast Guard license as a radio officer, applicants must have a first or second-class radiotelegraph operator's license issued by the Federal Communications Commission. For a license to serve as the sole radio operator aboard a cargo vessel, the Coast Guard also requires 6 months of radio experience at sea.

Unlike most professions, no educational requirements have been established to become a merchant marine officer. Anyone who has served for 3 years in the deck or engine department may apply for either a third mate's license or for a third assistant engineer's license. However, the complex machinery, navigational, and electronic equipment on modern vessels require that officers have extensive technical knowledge.

To pass the Coast Guard's examination for an officers' license generally requires formal training. The fastest and surest way to become a well-trained officer is through an established officer training program. Such training programs are available at the U.S. Merchant Marine Academy at Kings Point, New York and at five State merchant marine academies: California Maritime Academy, Vallejo, Calif.; Maine Maritime Academy, Castine, Maine; Massachusetts Maritime Academy, Hyannis, Mass.; Texas Maritime Academy, Galveston,

Tex.; and New York Maritime College, Fort Schuyler, New York, N.Y. Approximately 600 students graduate each year from the six schools; about one-half are trained as deck officers and one-half as marine engineers. Entrance requirements for each of the academies are very high. Admission to the Federal academy is through nomination by a member of Congress, whereas entrance to the other academies is made through written application directly to the school.

Each of the academies offers 3- or 4-year courses in nautical science or marine engineering, as well as practical experience at sea. Subjects include navigation, mathematics, electronics, seamanship, propulsion systems, electrical engineering, languages, history, and shipping management. Each student receives a subsistence allowance and a bachelor of science degree upon graduation. After Coast Guard examinations are passed, licenses are issued for either third mate or third assistant engineer. In addition, graduates may receive commissions as ensigns in the U.S. Naval Reserve.

Because of their thorough grounding in theory and its practical application, academy graduates are in the best position to move up to master and chief engineer ratings. Their well-rounded education also qualifies them for shoreside jobs such as marine superintendent, operating manager, or shipping executive.

A number of trade unions in the maritime industry provide officer training. These unions include the International Organization of Masters, Mates and Pilots; the Seafarers' International Union; the Brotherhood of Marine Officers, and the National Marine Engineers' Beneficial Association. Most union programs are designed to upgrade unli-

censed seamen to the licensed ratings although some programs accept inexperienced young men. For example, the National Marine Engineers' Beneficial Association (MEBA) District 1-Pacific Coast District operates the Calhoun MEBA Engineering School in Baltimore, Maryland, which offers high school graduates a 2-year apprenticeship training program in preparation for a third assistant engineer's license. The program consists of both classroom instruction and sea experience and provides free room, board, medical care, and text books in addition to a monthly grant. Trainees must agree to serve at least three years in the U.S. Merchant Marine after the 2-year training period.

Advancement for deck and engine officers is along well-defined lines and depends primarily upon specified sea experience, passing a Coast Guard examination, and leadership ability. Deck officers start as third mates. After 1 year's service they are eligible to take a second mate examination. To rise to chief mate, a candidate must have served as second mate at least 1 year or 2 years as a watch officer while holding a license as a second mate. The chief mate may apply for master's license after 1 year of service, or after 2 years of service as second mate while holding a chief mate's license. An officer in the engine department starts as third assistant engineer. After 1 year of service, he may apply for a second assistant's license. After further experience, he may apply for first assistant's license and finally a chief engineer's license.

Employment Outlook

Employment of ship officers is expected to decline moderately during the 1970's. However, be-

cause pensions are improved and the average age of officers is high, a few thousand replacements will be needed each year. Other officers are expected to quit the sea for shore-side employment. The primary factors responsible for the expected decline are the continued decline in the absolute size of the fleet and the smaller crew sizes required because of mechanization. The level of employment of licensed officers in the industry in the final analysis will depend upon government policy with respect to a vessel replacement program and its determination of the level of U.S. flag participation in the U.S. water-borne foreign commerce.

Earnings and Working Conditions

The level of wages paid to officers depends upon rank and the size and type of vessel. Wages are highest on multiple-screw passenger vessels. The accompanying tabulation shows monthly base wages for officers aboard an average freighter. Additional payments for overtime, supplemental pay and "penalty pay" generally average about 50 percent of base pay. A monthly sum in lieu of overtime is paid to master, chief mate, chief engineer and first and third assistant engineers who do not stand watch. In 1968, this was equal to \$218.40 per month.

	Base pay ¹
Master	\$1,821
First mate	1,102
Second mate	780
Third mate	720
Radio officer	884
Purser	656
Chief engineer	1,696
First assistant engineer	1,102
Second assistant engineer	780
Third assistant engineer	720

¹East Coast wages in August 1968 aboard a 12,000-17,000 power ton single screw ship.

²Purser/pharmacist mate, \$806.

Licensed officers and their dependents enjoy substantial benefits from noncontributory pension and welfare plans. For example, licensed deck officers are eligible for a monthly pension of \$325 after 20 years of service, and up to one-half their monthly rate after 25 years of service. Partial pensions are provided for those men forced to retire prematurely due to a permanent disability. Comprehensive medical care and hospitalization are provided licensed officers and their families through union programs.

While at sea, officers stand two watches each day. In port, the normal workday is from 8 a.m. to 5 p.m., Monday through Friday. Aboard the ship, each officer has a private room with hot and cold running water. He dines with fellow officers in a dining salon separate from the messhall in which unlicensed crewmen eat. A bedroom steward cleans his room each morning.

A number of labor organizations represent merchant marine officers. The two largest are the International Organization of Masters, Mates and Pilots representing deck officers and the National Marine Engineers' Beneficial Association representing engineering officers. Licensed unions for Officers may require initiation fees as high as \$1,000.

The Brotherhood of Marine Officers represents licensed deck and engine personnel on about 70 vessels. The Staff Officers Association represents pursers on all Atlantic and Gulf Coast passenger vessels and certain freight ships. Radio officers are represented by the American Radio Association and the Radio Officers Union. In addition, a number of independent unions represent licensed and/or unlicensed personnel on tanker vessels.

(See introductory statement

on Merchant Marine Occupations for additional information on earnings and working conditions and for sources of additional information.)

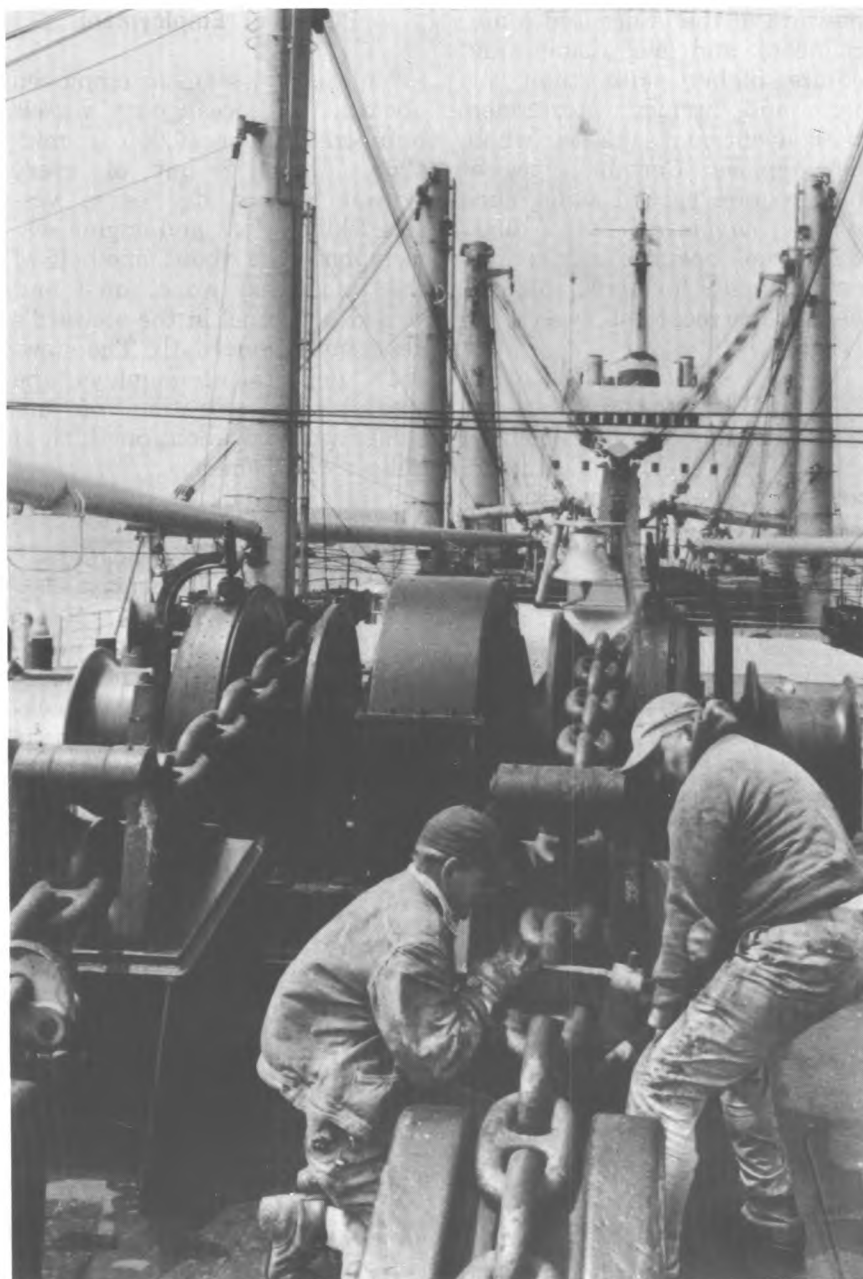
UNLICENSED MERCHANT SEAMEN

Nature of the Work

Unlicensed seamen make up most of a ship's crew and perform most of the manual labor aboard ship. Employment is along craft lines with varying degrees of skill levels and includes the following departments: Deck, engine, and steward's department.

DECK DEPARTMENT. *Ordinary Seamen* (D.O.T. 911.887), the entry rating in the deck department, perform general deck maintenance work such as scrubbing decks, coiling and splicing ropes, chipping rust, and painting. Aboard ship, they may perform other types of general maintenance work including the cleaning of the quarters of the unlicensed personnel of the deck department. Ordinary seamen also may "spell" (relieve) the helmsman and lookout. All dry cargo and tanker vessels employ three ordinary seamen; each man is assigned a watch at sea.

Able Seamen (D.O.T. 911.884) or A.B.'s constitute about one-fifth of the unlicensed crew. All dry cargo and tanker vessels have aboard six A.B.'s, two of whom are assigned to each watch. These skilled workers must have a thorough knowledge of all parts of the vessel and be able to handle all gear and deck equipment. They act as helmsmen or quartermasters to steer the ship. Usually, A.B.'s each take 2 hours turns at the wheel, and as lookouts report sightings to the watch



Seamen secure anchor chain for sea voyage.

officer. Able seamen on passenger ships perform many of the same functions as able seamen on cargo vessels.

Able seamen are also responsible for rigging, overhauling, and stowing cargo-handling and other gear. They must be able to tie common knots and handle moor-

ing lines when the ship is docking or departing. In addition to their more skilled tasks, A.B.'s perform general deck maintenance work similar to that performed by ordinary seamen.

Because of the ever-present danger of fire at sea, able seamen must be familiar with approved

methods of fire prevention and control. They participate in periodic boat drills and are trained in all operations connected with launching lifeboats and life rafts, and handling of the boats and commanding boat crews.

The boatswain (D.O.T. 911-131), or bosun, is a day worker (nonwatchstander) and the highest ranking able seaman. As foreman in charge of the deck crew he relays the deck officers' orders and sees that such orders are executed. The boatswain assists the chief mate in assigning work for crew members not on watch duty and directs general maintenance operations such as cleaning decks, polishing metalwork, and maintaining lifeboats. When the ship docks or anchors, he supervises the deck crew in handling the lines used for mooring.

Most cargo vessels carry one to three *deck utilitymen* (D.O.T. 911.884), day workers who maintain the deck department under the direct supervision of the boatswain. Deck utilitymen must be able seamen in qualifications and Coast Guard endorsement so that in emergencies they may stand A.B.'s watch. Their work includes determining the condition of bilges (compartments in the bottom of the hull), overhaul of blocks, and general maintenance work.

Some vessels carry a *ship's carpenter* (D.O.T. 860.281) whose duties include securing cargo hatches and ports, bracing (shoring) cargo, and maintaining water-tight integrity of the ship. He may operate winches that hoist and drop the anchor and seal the hawsepipes (steel pipes through which anchor chains pass) when anchor and chains are not in use. Because of mechanization, newer vessels are sailing with fewer carpenters and deck utilitymen.

ENGINE DEPARTMENT.

The unlicensed engineering staff consists of a variety of occupational specialties requiring varying degrees of skill from the entry rating of wiper to specialized skilled jobs such as reefer engineer. *Wipers* (D.O.T. 699.887), are day workers and are responsible for keeping the engine room and machinery clean. Most cargo vessels carry two or three wipers. *Oilers* (D.O.T. 911.884) lubricate moving parts or wearing surfaces of mechanical equipment. They make regular rounds of ship machinery to check oil pressures and flow. They inspect the machinery for overheating, fuel supply, and apply proper grades of grease or oil to all ship machinery. Oilers may help the engineer in charge to overhaul and repair main and auxiliary engines. *Firemen/watertenders* (D.O.T. 951.-885) check and regulate the amount of water in the boilers; inspect gauges; regulate fuel oil gauges to keep steam pressure constant; and change and clean burner nozzles. They also check the operation of evaporators and condensers and test water for salt control, check fuel boilers; clean oil burning equipment; remove, clean, and replace burners; and clean strainers used to filter dirt from oil before use in the burners.

The *ship's electrician* (D.O.T. 825.281) takes orders from the chief engineer. He keeps the electrical equipment in good repair. He tests electrical equipment; repairs defective electrical systems; oils and greases winches; and changes oil in casings. Many vessels carry a *second electrician* to maintain and repair electrical equipment and machinery.

All automated vessels carry *deck-engine mechanics* of whom one usually is classified as a day worker and three, as watchstanders. These jobs combine

the work of the unlicensed junior engineers and electricians and require higher skills than the oilers and firemen-watertenders on conventional vessels whom they replace. Certain types of ships require special skills, such as *reefer engineers* (D.O.T. 950.-782) who operate refrigerator compartments for perishable cargoes such as meat and vegetables.

STEWARD'S DEPARTMENT.

The steward's department does not include licensed officers. However, its members vary from stewards to unskilled utility men. The *chief steward* (D.O.T. 350.138) supervises the operation and maintenance of the living quarters of officers, crew, and passengers. He directs and supervises all the department's personnel, orders and purchases food supplies, inspects and stores supplies, and supervises the preparation and serving of meals and the care and upkeep of living quarters. The *chief cook* (D.O.T. 315.131) and assistant cooks prepare the meals aboard ship. The chief cook helps the steward plan and prepare the meals and draw pantry supplies from the storeroom. He also supervises the other galley (ship's kitchen) workers and is responsible for keeping the galley clean and orderly. The *cook/baker* (D.O.T. 315.381) assists the chief cook and also acts as the ship's baker. *Utilitymen* (D.O.T. 318.887) and *messmen* (D.O.T. 350.878) complete the crew in the steward's department. These beginning jobs require little skill. Generally, utility men carry food supplies from the storeroom and iceboxes; prepare vegetables; wash cooking utensils and scour galley equipment; whereas messmen set tables, serve meals, clean off tables, wash dishes, and care for living quarters.

Places of Employment

Unlicensed seamen employed aboard U.S. oceangoing vessels numbered about 45,000 in mid-1968. About 2 out of every 3 were aboard dry cargo vessels. Skilled deck and engine seamen made up about one-half of the unlicensed work force and skilled personnel in the steward's department, one-sixth. The steward's department employs the greatest concentration of unskilled workers, about one-fifth of unlicensed seamen.

Training, Other Qualifications, and Advancement

Although not required, previous sea experience in the Coast Guard or Navy is a good background to enter the merchant marine. Applicants for work must possess health certificates. In addition, every person going to sea for the first time in a job or "rating" that does not require a license must obtain seaman's papers from the United States Coast Guard. Seaman's papers do not guarantee a job. They merely qualify a person to be considered for a job when the supply of regular workers and newcomers registering earlier has been exhausted. To get a job, a man must be present at the hiring hall when the opening becomes available. In good shipping times an opening may come within a few days, or a month or more; in less prosperous times, a berth may never appear.

An inexperienced man usually gets a job on a ship by applying for work at a central hiring hall in one of the chief ports of the country. These hiring halls are operated by unions for commercial vessels and by the Navy's Military Sea Transportation Service MSTS for government oper-

ated ships. In most ports along the Atlantic and Gulf Coasts and Great Lakes, the National Maritime Union or Seafarers' International Union operate hiring halls. The Sailors Union of the Pacific operates hiring halls in many ports of the West Coast. MSTs employment offices are located at Brooklyn, N.Y.; New Orleans, La.; and Oakland, Calif.

The job seeker is given a shipping card when he registers at the hiring hall. The shipping companies send job orders to the hiring hall and the applicant unemployed the longest is entitled to the first preference on a job for which he is qualified. The applicant must be present at the hall when the job is announced and he may lose his place if he is not present or has turned down three job offers. Upon accepting a job, the applicant presents an assignment slip to the shipping company.

A seaman advances in the deck and engine departments by serving a designated period in a rating and by successfully completing a Coast Guard examination which tests the seaman's ability to use and maintain the equipment in his department. For example, after serving a minimum of one year, the ordinary seaman may apply to the Coast Guard for a limited endorsement to his merchant mariner's document as able seamen. For full endorsement for a Coast Guard A.B. ticket, the seaman. For full endorsement for To obtain the endorsement, the applicant must be 19 years of age and pass an examination designed to test his knowledge of seamanship and ability to carry out all the duties required of an able seaman. Upon obtaining an A.B. ticket, a seaman may serve in any unlicensed rating in the deck department. Unlicensed seamen who have the ability to supervise may advance to boat-

swain after years of sea service. Advancement to higher positions in the steward's department is by recommendation of the chief steward to the master.

Most training programs in the industry assist workers already in the industry to upgrade their ratings. However, the Seafarers' International Union of North America operates the Harry Lundberg School for seamanship at Piney Point, Md. that accepts and trains in general seamanship skills a limited number of young men who have no previous sea experience. Upgrading courses for seamen are offered by the Seafarers' Union; the National Maritime Union of America, and a number of other organizations.

Employment Outlook

Workers seeking employment as unlicensed seamen will face keen competition during the 1970's as the total number of ships decline and manning crews are reduced. The total number of seamen is expected to decline moderately. Demand for men in entry ratings will be especially limited. However, some berths will be available each year as seamen die, retire, or quit the sea for other reasons.

Many of the merchant vessels now operating in the U.S. fleet are of World War II vintage and are approaching obsolescence. Replacements for these vessels and ships being refitted are equipped with mechanized features which limit the manpower requirements for unlicensed personnel, particularly in the unskilled ranks. (See employment outlook section of introductory section Merchant

Marine Occupations for additional information on technological changes.)

Earnings and Working Conditions

Crew members of American merchant ships enjoy excellent pay, subsistence, and working conditions. Most jobs provide 60 days paid vacation each year, some even longer. Earnings of unlicensed seamen depend on their job assignments and the type of vessel on which they are employed. Basic monthly pay for a cross section of unlicensed ratings on a typical freighter is illustrated in the accompanying tabulation:

	Base Pay ¹
Able seaman	\$444
Ordinary seaman	346
Deck utilityman	496
Carpenter	536
Electrician	686
Oiler	444
Fireman/watertender	444
Wiper	412
Chief steward	583
Cook/baker	505
Messman/utilityman	344

¹East Coast wages in August 1968 aboard a 12,000-17,000 power ton single screw ship.

Monthly earnings are supplemented by premium pay for overtime and other factors. On the average, premium earnings are equal to about 50 percent of base wages. For example, an oiler with a monthly base pay of \$444 may regularly earn about \$665 each month.

Working conditions for seamen aboard U.S. merchant vessels are generally good, but not luxurious. Meals are served in a mess hall, which often doubles as a recreation room where the crew can read, write letters, play cards, and socialize. Crewmen generally share quarters with other men and have little privacy.

Unlicensed seamen are repre-

sented by a number of labor organizations; the two largest are the National Maritime Union of America and the Seafarers' In-

ternational Union of North America.

(See introduction statement on Merchant Marine Occupations

for additional information on earnings and working conditions and for sources of additional information).

RADIO AND TELEVISION BROADCASTING OCCUPATIONS

The glamor and excitement associated with radio and television make careers in broadcasting attractive to many young people. The electronic technology involved in transmitting programs and the business aspects of operating a broadcasting station or network also are attractions. In 1968, about 105,000 full-time and 25,000 part-time staff were employed in commercial broadcasting; altogether, over 55 percent were employed in radio. Staff employees work for a broadcasting station or network on a regularly scheduled and continuous basis. In addition to staff employees, several thousand freelance performers, such as actors, musicians, dancers, comedians, and top-level announcers work on specific assignments from stations, networks, and other program producers. (Several thousand other employees work for independent program producers in activities closely related to broadcasting, such as the preparation of filmed and taped programs and commercials for broadcasting.)

Women make up almost a fourth of broadcasting staff employment. They frequently work as production assistants, producers, newswriters, continuity writers, casting directors, costume or set designers, and supervisors of religious and children's programs. They also work in the many office occupations often filled by women. A job as secretary is frequently a good entry job for women interested in the programming and administrative areas of broadcasting.

Broadcasting stations offer a variety of interesting jobs in all parts of the country. Opportunities for entry jobs are best at sta-

tions in small communities. Generally, the most specialized and best paying jobs are in large cities, especially those with national network stations. Nevertheless, the talented individual will have many opportunities to advance to good paying jobs in stations located in smaller communities.

Nature and Location of the Industry

In early 1969, about 6,200 commercial radio stations were in operation in the United States. Of these, approximately 4,200 were AM stations; and approximately 2,000 were FM stations.

During this same period, about 678 commercial television stations were in operation. Of these, about 3 out of every 4 were VHF stations. UHF stations generally employ fewer workers than VHF stations.

Most commercial radio broadcasting stations are small, independent businesses. In early 1968, the average AM and AM-FM radio station had about 11 full-time employees and 4 part-time workers. Television stations were generally larger, and on the average, they employed about 50 full-time and 8 part-time employees.

Commercial radio stations are served by four nationwide networks and a large number of regional networks. Stations can affiliate with networks by agreeing to broadcast their programs on a regular basis. National radio networks have affiliated stations in almost every large metropolitan area, although only a minority of all radio stations are affiliated with national networks. Regional radio networks have fewer affili-

ated stations, and their activities usually consist of arranging for the sale of advertising time, and interconnecting member stations for special events such as baseball and football games. Regional networks have few full-time employees because their programming is conducted by staff employees of the affiliated stations. The four national radio networks, together employed over 2,500 workers in early 1968.

Most television stations depend on one or more of the three national television networks for programs that would be too expensive for individual stations to originate—for example, sports events such as world series baseball games or international Olympic contests; broadcasts of operas, plays, and musicals; and newscasts of national and international significance. These networks, in turn, can offer national coverage to advertisers. Since some small cities have only one or two television stations, these stations often carry the programs of two or three networks to offer their viewers a wider variety of programs. A typical network television show may be carried by up to 200 stations across the country. In early 1968, the three national television networks employed over 15,000 workers, or 3 of every 10 staff employees in television.

One-third of all radio stations are located in communities which have a population of less than 10,000, and most of these are in one-station communities. Generally, television stations are located in communities of more than 25,000 population. About three-fourths of all television stations are in communities of 100,000 or more. In contrast, over 60 percent of all radio stations are in communities of less than 100,000 population. Practically all large broadcasting stations are located in metropolitan areas, but small stations are found in big cit-

ies as well as small communities. About one out of four broadcasting jobs are in New York and California because New York City and Los Angeles are the two major centers for origination of network programs. In addition, one out of three broadcasting jobs are in Texas, Pennsylvania, Ohio, Illinois, Florida, North Carolina, Michigan, Tennessee, Georgia, and Virginia. The balance of broadcasting jobs are distributed throughout the other states.

In addition to commercial broadcasting stations, there were over 350 noncommercial radio stations (mainly FM), and approximately 180 noncommercial television stations, both VHF and UHF, in early 1969. These stations are operated by non-profit organizations, principally educational agencies such as State commissions; local boards of education; colleges and universities; and special community educational television organizations. Relatively few full-time staff members were employed in educational radio and television stations; instructors and students often help to operate many of these stations, especially those located on college campuses.

Broadcasting Occupations

Employees of broadcasting stations generally specialize in 1 of 4 major areas of work. Those concerned with programing prepare and produce programs; engineering workers operate and maintain the equipment that converts sounds and pictures into electronic impulses that can be picked up on home receivers; sales workers sell time to advertisers and develop publicity and promotional material for the station. The remaining employees handle general business matters, such as accounting, payroll, pub-



lic relations, personnel administration, and the clerical work related to all the station's activities.

Nearly half of all staff employees in broadcasting hold professional and technical jobs such as staff announcer, newsmen, continuity writer, or broadcast technician. About one-fourth hold managerial or proprietary jobs such as producer, manager, or director. Clerical workers accounted for about 1 of every 7 workers, and sales workers for only slightly more than 1 of every 20 jobs in broadcasting. Of the remaining workers in broadcasting, skilled mechanics, such as radio and television repairmen, and skilled maintenance personnel, such as carpenters and electricians, were the largest groups of workers employed.

Job duties vary greatly between small and large stations. In small radio stations, a large proportion of broadcast time consists of recorded music and weather and news announcements. As a result, small stations employ only a few workers, each

of whom performs a variety of tasks. The station manager, who frequently is also the owner, may act as business and sales manager, or perhaps as program director, announcer, and copywriter. Announcers in small stations may do their own writing, often operate the studio control board, and may even act as salesmen. The engineering staff may consist of only one full-time broadcast technician assisted by workers from the other departments. Small low-powered stations, which do not use a directional antenna, may employ a chief engineer part-time and share his services with similar stations in the community. In large radio and television stations, jobs are more specialized and usually are confined to 1 of the 4 departments. The kinds of jobs found in each of these departments are described below.

Programing Department. The programing department plans, prepares, and produces radio and television programs. Staff employees plan the station's programing, produce the daily and