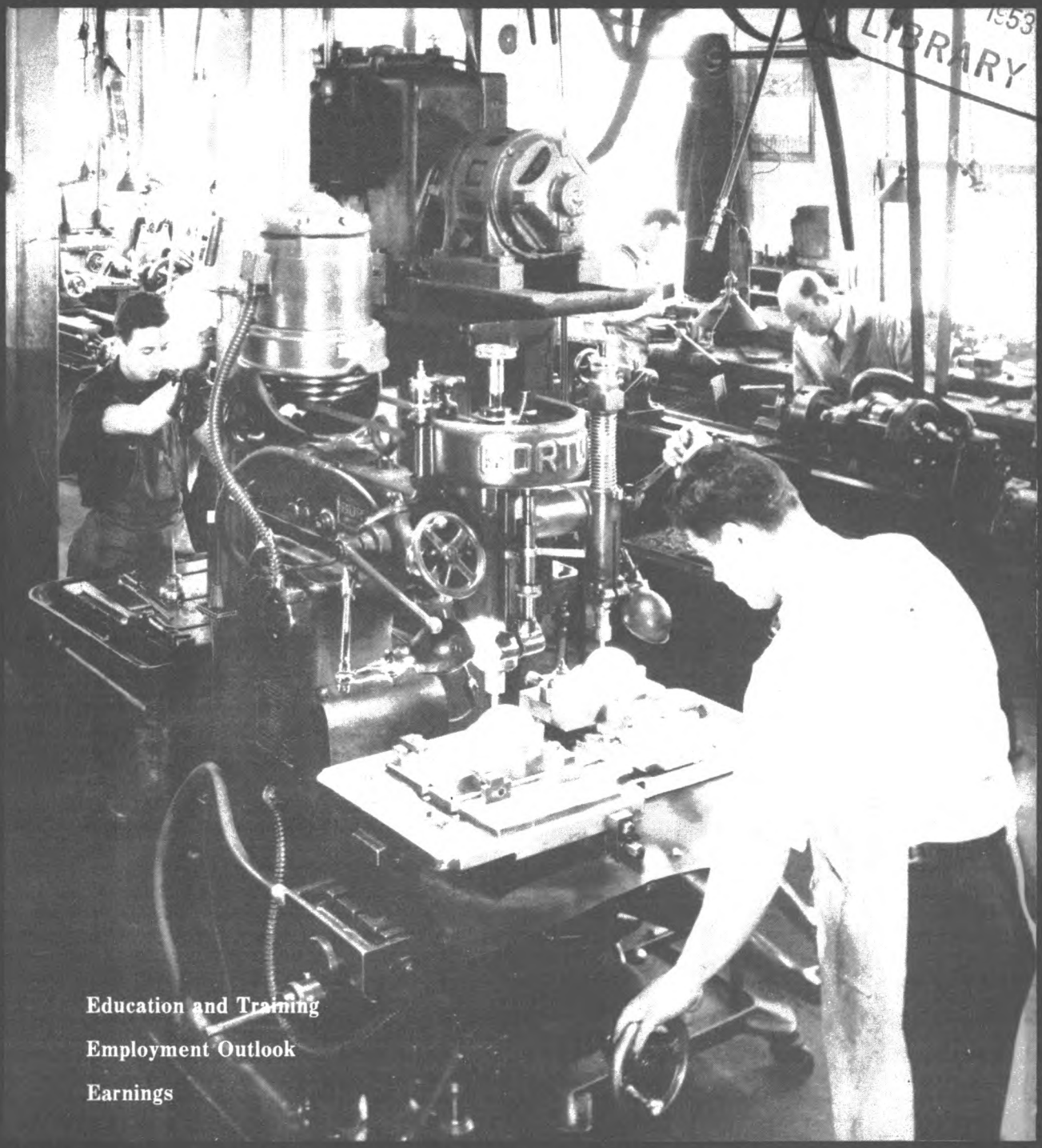
Employment Outlook in

METALWORKING OCCUPATIONS



Education and Training

Employment Outlook

Earnings

UNITED STATES DEPARTMENT OF LABOR
Martin P. Durkin, *Secretary*

BUREAU OF LABOR STATISTICS
Ewan Clague, *Commissioner*

In cooperation with VETERANS ADMINISTRATION

Reprint from 1951 Occupational Outlook Handbook

Bulletin No. 1130

Employment Outlook in Metalworking Occupations

A reprint from the
1951 Occupational Outlook Handbook

Bulletin No. 1130

UNITED STATES DEPARTMENT OF LABOR
Martin P. Durkin, *Secretary*
BUREAU OF LABOR STATISTICS
Ewan Clague, *Commissioner*
In cooperation with
VETERANS ADMINISTRATION

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. - - - - - - - - - - - - - Price 30 cents

Letter of Transmittal

UNITED STATES DEPARTMENT OF LABOR,
BUREAU OF LABOR STATISTICS,
Washington, D. C., January 21, 1953.

The SECRETARY OF LABOR:

I have the honor of transmitting herewith a report on the employment outlook in metalworking occupations taken from our 1951 edition of the Occupational Outlook Handbook. This reprint from the Handbook is being issued at this time to make available to the many counselors, teachers, students, and others who seek accurate occupational information, a separate report on metalworking which replaces our Bulletin 844 on welders, issued in 1945, Bulletin 880 on foundry occupations, issued in 1946, and Bulletin 895 on machine shop occupations, issued in 1947. In addition, this reprint covers forge shop work and a number of other metalworking occupations.

Librarians, counselors, and other users of the Occupational Outlook Handbook, as well as others with special interest in a single occupation or industry, have indicated the need for separate reports on the major occupational and industrial fields covered in the Handbook.

The research for the Occupational Outlook Handbook was carried on with the financial support of the Veterans Administration, which needed information for use in its vocational rehabilitation and education activities.

EWAN CLAGUE, *Commissioner.*

Hon. MARTIN P. DURKIN,
Secretary of Labor.

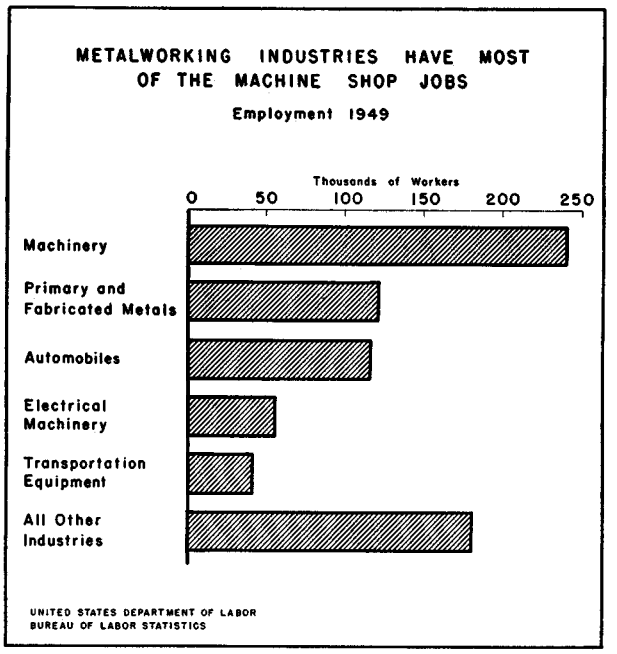
Contents

CHARTS

MACHINE-SHOP OCCUPATIONS

Machine-shop workers are the largest occupational group in metalworking and one of the most important groups in all industry. In early 1950, more than 750,000 workers were employed in the skilled and semiskilled machining occupations. In addition, there were many thousands of other workers, such as assemblers, inspectors, helpers, and laborers, employed in machine shops.[1]

CHART 49



The long-range upward trend of employment in this field, together with a large volume of replacement needs, should provide many opportunities for new workers. Job openings will be particularly numerous in the early fifties as the metalworking industries, which are the main sources of machine shop jobs, expand to meet defense requirements.

Nature of Machine-Shop Work

Machining is done by machine tools, and a machine shop is simply a workplace in which machine tools are used. A machine tool is a power-driven machine which firmly holds both the piece of metal to be shaped and a cutting instrument, or "tool," and brings them together so that the metal is cut, shaved, ground, or drilled. In some cases, the tool is moved and the metal held stationary; in others, the metal is moved against a stationary tool.

The most common kinds of machine tools include the engine lathe, turret lathe, grinding machine, boring mill, drill press, milling machine, screw machine, shaper, and planer. The operation of lathes is known as "turning." The piece of metal being cut is rotated against the cutting tool held in the machine. Boring mills and drilling machines are among the machines that make holes in metal. Grinding machines remove the metal with a power-driven, abrasive wheel. Milling machines shape metal with a saw-toothed cutting tool. Planers and shapers are used to machine flat surfaces. A screw machine is a type of lathe.

Some machine shops manufacture metal products and others do maintenance work—making or repairing metal parts for equipment use. The manufacturing shops are of two main types—job shops and production shops—depending upon the way their production is organized. In job shops, the earliest developed, a wide variety of products may be made with relatively few of each kind. Production shops, on the other hand, make large quantities of identical items.

Where Machine-Shop Workers Are Employed

Because of their importance in making metal products, machine-shop workers are employed principally in the metalworking industries. Nearly every industry, however, employs some machine-shop workers in maintenance work. More than three-fourths of all workers in the machine-shop occupations have jobs in metal industries like machinery, primary and fabricated metals, and automobiles. (See chart 49.)

Most of the remaining machine-shop workers are employed by the railroads, public utilities, and in the maintenance shops of nonmetal manufacturing plants which make such products as cotton textiles, paper, cigarettes, and chemicals. Even though the number of machine-shop workers in most nonmetal industries is small, these industries,

[1] Reports for some of these occupations, such as machinery assemblers and inspectors are elsewhere in this handbook. See index for page numbers.

taken together, are important as a source of employment for machine-shop workers since they provide almost a fourth of the jobs. Moreover, in many cases the machine-shop jobs rate among the better jobs in the plant and locality, as for example, in many textile mills in southern towns.

Because so many machine-shop workers are in metalworking industries, the bulk of them are found in the northeastern and midwestern sections of the country, where these industries are concentrated. Some machine-shop employment, however, is scattered throughout the country in railroad repair shops and the maintenance shops of other industries. There are machine-shop jobs in every State.

Outlook

Many thousands of new workers will get machine-shop jobs during the next decade. Job openings will be particularly numerous in the early fifties as the metalworking industries, which are the main source of machine-shop jobs, expand to meet increasing defense requirements. The long-range employment trend in metalworking industries is also upward, as chart 50 shows. However, as the chart also shows, the metalworking industries are more seriously affected by business depressions than industry generally. Thus, machine-shop workers suffer heavy lay-offs and a greatly reduced workweek when economic conditions are bad.

In the maintenance shops of nonmetal industries, long-run growth in machine-shop employment is also in prospect. These industries as a whole have a general upward trend associated with rising population and national income. Moreover, the gradual mechanization of industry tends to expand the need for maintenance machine-shop workers to keep mechanical equipment in good condition. Many of these nonmetal industries are much less affected by changes in general business conditions than are the metalworking industries, so that machine-shop workers in the nonmetal industries tend to have fairly steady employment over the years.

General view of a small machine shop.

COURTESY OF NATIONAL ARCHIVES

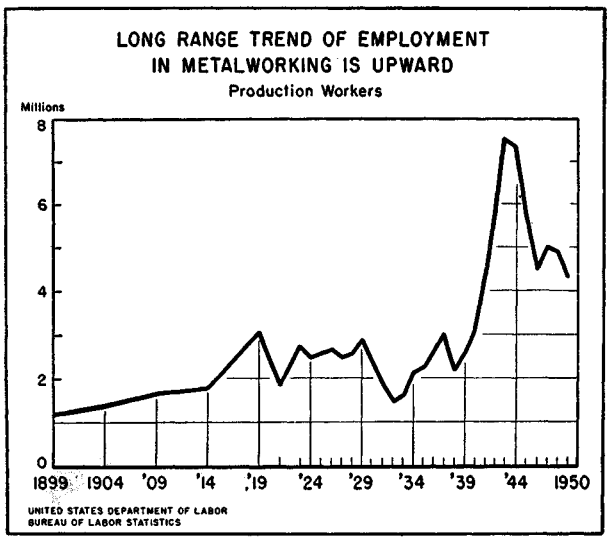
In addition to the expected rise in machine-shop employment, replacement needs (resulting from the loss of experienced workers) will create thousands of openings for beginners. Death and retirement of experienced men may provide something in the order of 15,000 openings annually during the 1950–60 decade. This will be a particularly important factor in the skilled occupations, which have a relatively high proportion of older workers. In the less skilled occupations, shifting into other lines of work is fairly common; many thousands of openings for newcomers will arise in this way.

In addition, replacements will be needed as workers are called up for service in the Armed Forces; although some of those who are in critical machine-shop occupations may be deferred.

Machine-Shop Workers and Their Jobs

Employment in major machine-shop occupations is shown in chart 51. The basic machine shop job is that of machinist, employed mainly where workers are needed who are qualified to do any of the operations in a machine shop. Tool and die makers are essentially highly trained machinists who specialize in making the cutting tools, jigs, fixtures, and dies used in the various metalworking operations. Machine-tool operators are the largest group of machine-shop workers; the occupation includes both skilled and semiskilled workers. Set-up men and lay-out men are skilled,

CHART 50



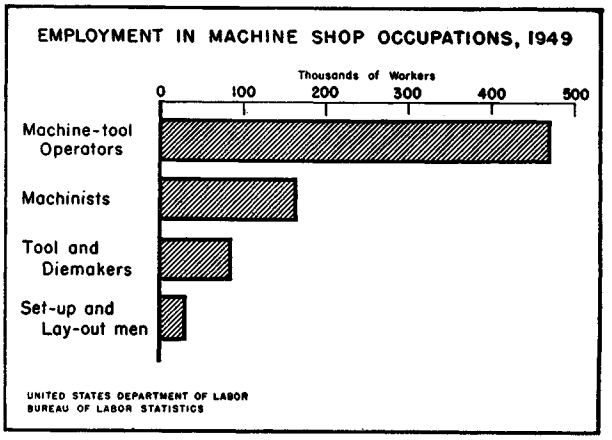


CHART 51

specialized workers employed in shops which carry on volume production; these are among the smaller machine-shop occupations.

Except for the semiskilled machine tool operating jobs, the main method of entering these occupations is through apprenticeship. The apprentice must be mechanically inclined and temperamentally suited to very careful and exact work. Apprentices are generally required to have high-school or trade-school education. There are no special educational requirements for the semiskilled jobs.

Great physical strength is not required for machine-shop work. The workers, however, usually must stand at their jobs most of the day and be able to move about freely. Since continuous attention is required when the machine is in operation, the work may often be rather tedious, especially on simple and repetitive machining jobs. Where the work is varied and complex, and the standards of accuracy high, the worker can consider himself a real craftsman and experience the satisfaction that this feeling gives to the conscientious and capable person.

Because the work is not physically strenuous, many women are employed as machine-tool operators. However, most of them are employed in the less skilled machining operations; practically none are found among the tool and die makers and all-round machinists and relatively few among the skilled machine-tool operators.

Most machine shops are relatively clean, well lighted, and free from dust. They are generally safer places in which to work than are most factories.

The great majority of machine-shop workers are members of unions. There are a number of labor organizations in this field, some of the more important of which are the International Association of Machinists (Independent), the International Union of Electrical, Radio and Machine Workers (CIO), the United Automobile, Aircraft and Agricultural Implement Workers of America (CIO), and the Mechanics Educational Society of America (Independent).

All-Round Machinists

(D. O. T. 4–75.010)

Outlook Summary

There will be many job opportunities in this occupation during the fifties, with many openings resulting from replacement needs.

Nature of Work

This is a skilled machine-shop occupation in which about 165,000 men are employed. In addition, there are many thousands with training as all-round machinists, but employed in other machine-shop occupations, such as that of machine-tool operator.

Variety is the main feature of the all-round machinist's work. His training enables him to plan and carry through all operations needed in turning out a machined product and to switch readily from one kind of product to another. He knows how to work from blueprints and written specifications, can select the proper tools and materials required for each job, and can plan the proper sequence of cutting and finishing operations. When necessary, he lays out the work by marking the surface of the metal to show where machining is needed and to indicate the shape and depth of the cuts. After machining, he may finish his work by hand, using files and scrapers, and may assemble the parts by welding. His knowledge of shop practice, of the working properties of such metals as steel, cast iron, aluminum, and brass, and of what the various machine tools do, makes it possible for him to turn a block of metal into an intricate, precise part.

Training and Qualifications

According to most authorities, a 4-year apprenticeship is the best way to learn the machinist trade. Many have qualified without an apprenticeship, however, by picking up the trade over a number of years of varied shop experience.

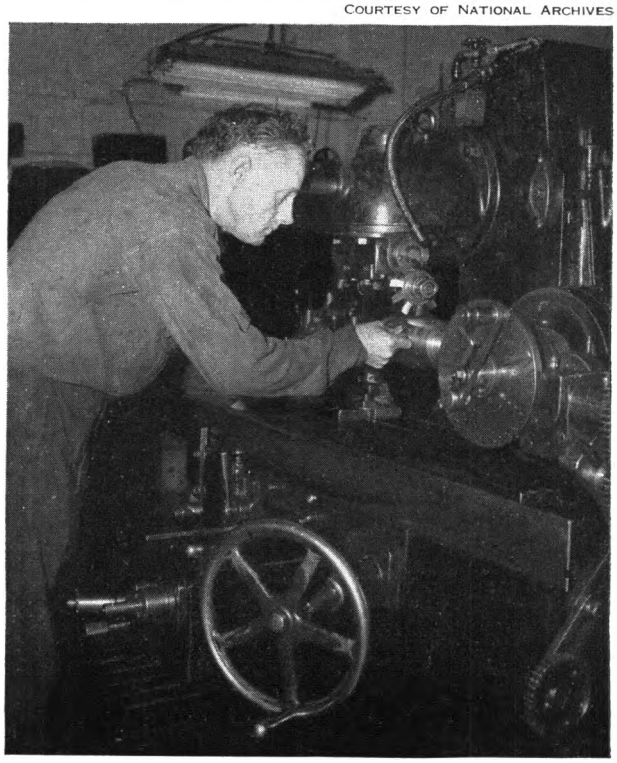
An apprentice machinist must be mechanically inclined and temperamentally suited to very careful and exact work. Great physical strength is not required for this work. A high school or grade school education is desirable preparation for machinist training and some employers require such preparation. In general, this is a man's occupation.

Where Employed

The majority of all-round machinist jobs are in maintenance shops in a variety of industries, such as railroads, textile mills, automobile factories, oil

The basic machine shop job is that of the all-round machinist, who can operate all standard types of machine tools.

COURTESY OF NATIONAL ARCHIVES



refineries, steel mills, and printing plants. Many all-round jobs are also found in manufacturing shops (including job and production shops). In production shops, there are large numbers of men trained as all-round machinists, but not usually employed as such; these men specialize in a single machine-shop function, such as set-up or operation of one type of machine tool.

Most of the machinists' jobs are in the Middle Western and Northeastern States where the metal-working industries are concentrated. Machinists are employed in every State, however, because of their use in maintenance work.

Outlook

Job openings for machinists will be plentiful during the early fifties, to fill the needs of expanding defense industries. However, there will be relatively few apprentice openings. In the long run, the number of jobs for all-round machinists in production work may show a slight decline. Continuing technical changes will reduce the skill needed in many machining operations, permitting the substitution of less trained men for machinists. Machinist training will continue, however, to offer considerable advantage to men going into these shops. Machinists are generally preferred for the specialized machine-tool operator jobs, which often pay as well or better than all-round jobs. They also will have many chances to get jobs setting up machines for groups of semiskilled operators. Moreover, all-round machine-shop workers must continue to be hired in order to supply the necessary supervisory staffs—the lead men and foremen—which are extremely important in the modern mass-production shops.

In maintenance shops, the number of all-round machinist jobs should show some growth over a period of many years. The increasing mechanization of industry will expand the need for men to keep production equipment in good working order, and this may mean more jobs for maintenance machinists. Replacement needs will provide many job opportunities. To provide for the replacement of all-round machinists who die or retire, 30 to 40 thousand new machinists must be trained between 1950 and 1960. In June 1949, there were nearly 10,000 registered machinists in training.

Earnings and Working Conditions

Although the pay of all-round machinists compares favorably with that of other machine-shop workers, it is often lower than the earnings of skilled machine-tool operators, many of whom work on an incentive basis. Earnings of production machinists in the machinery industries in selected cities in November 1949, are shown in the following tabulation:

City	Average hourly earnings[1]	City	Average hourly earnings[1]
Atlanta	$1.48	Los Angeles	$1.72
Baltimore	1.44	Milwaukee	1.65
Boston	1.57	Minneapolis–St. Paul.	1.60
Chattanooga	1.53	Newark–Jersey City.	1.62
Chicago	1.81	New York City	1.70
Cincinnati	1.42	Philadelphia	1.61
Cleveland	1.71	Pittsburgh	1.52
Dallas	1.50	Portland, Oreg	1.75
Denver	1.51	Providence	1.40
Detroit	1.79	St. Louis	1.74
Hartford	1.46	Seattle	1.79
Houston	1.80	Syracuse	1.54
Indianapolis	1.65	Tulsa	1.55

[1] Straight-time earnings (excluding premium pay for overtime and night work).

Average straight-time hourly earnings for production machinists in the airframe industry in May–June 1949 were $1.72. Recent earnings data for other industries are not available.

Promotional opportunities for all-round machinists are good. Many advance to foreman of a section in the shop, or to other supervisory jobs. With additional training, some develop into tool or die makers. Some are successful in opening and operating machine shops of their own.

Machine Tool Operators

(D. O. T. 4–78.000 to 78.039 and 6–78.000 to 78.039; 4–78.500 to 78.589 and 6–78.500 to 78.589; 4–78.060 to 78.069)

Outlook Summary

Good job prospects.

Nature of Work

The operators of machine tools make up the bulk of the workers in machine shops. Nearly 470,000 workers were employed as machine-tool operators in the fall of 1949.

Machine-tool operating jobs may be divided into two main classes, according to the skill required. The skilled machine-tool operator does widely varying kinds of machining. Working from blueprints or lay-outs, he sets up his machine for each machining operation, adjusts the feed and speed controls, and measures the finished work to see if it meets specifications. He knows how to sharpen cutting tools when they become dull and understands the machining qualities of various metals. In brief, his work is very much like that of the all-round machinist, except that it is limited to a single type of machine tool.

The majority of machine-tool operators are much less skilled than the machine-tool specialists described above and do work which is repetitive, rather than varied. A typical job consists mainly of placing rough metal stock into an automatic machine tool, watching the machining operation for signs of trouble, and measuring the finished work with specially prepared gages which simplify measurement. He may make minor adjustments to keep the machine tool in operation, but must depend on more skilled men for major adjustments.

Machine-tool operators, skilled and semiskilled alike, are designated according to the kind of tool which they operate—for example, engine-lathe operator, turret-lathe operator, drilling-machine operator, grinding-machine operator, milling-machine operator. There are many other kinds of machine-tool specialists, each of whom knows his particular machine tool.

To become a skilled machine-tool operator requires from 1½ to 3 years of on-the-job training. Many of these jobs, however, are filled by men who have completed all-round machinist apprenticeships. Semiskilled machine-tool operators are generally trained in not more than 6 months on the job.

Where Employed

Skilled machine-tool specialists are employed in all types of machine shops, but most of them work in production shops. The proportion of these specialists varies greatly among production shops, however, depending on the extent of job breakdown and the kind of machining done. They form a smaller percentage of the workers in job and maintenance shops, where an all-round knowledge of machine-shop practice is generally preferred. Nevertheless, a substantial number of skilled operators are employed in these shops, working under the guidance of all-round machinists.

The employment of semiskilled machine-tool operators is confined mainly to production shops and is concentrated particularly in such mass-production industries as automobiles and farm machinery. Because of their limited training, few can be used in either job or maintenance shops.

Outlook

There will be many thousands of opportunities for new workers to get jobs as machine tool operators during the next decade. Job openings will be particularly numerous during the early fifties as the metalworking industries expand to meet defense requirements.

Long-run job prospects for skilled machine-tool specialists are likely to be good. Some employers will continue to train specialists in preference to training all-round men, because it costs less. The growth of specialization in machine-shop work will continue and this trend may offset technical advances which otherwise would reduce the need for skilled operators.

Those who get jobs as semiskilled operators also have good prospects for continued employment in the future. The gradual simplification of machine-tool work through greater use of automatic machines may widen their field of employment. On the other hand, technical advances

which increase the efficiency of machine tools will tend to hold down the total number of jobs in this occupation.

The need to replace the many machine-tool operators who shift to other occupations or who die or retire will result in many job openings for new workers each year. Replacements will also be needed for those entering the Armed Forces.

Earnings and Working Conditions

Many machine-tool operators, especially the less skilled, are paid on an incentive basis and hence their earnings are often as high as machine-shop workers of greater skill. Average hourly straight-time earnings (excluding premium pay for overtime and night work) for drill-press operators and engine-lathe operators in machinery manufacturing industries in selected cities in November 1949 are shown in the accompanying table.

Average straight-time hourly earnings for machine tool operators, in plants producing passenger cars, in February 1950, were as follows:

Boring-mill operators	$2.00
Drill-press operators	1.61
Lathe operators	1.63
Milling-machine operators	1.61
Screw-machine operators	1.67

Recent earnings data for other industries are not available.

Skilled machine-tool specialists may be promoted to such jobs as set-up man or supervisor (on machines on which they have specialized). If they can get experience on several different kinds of machine tools, they, also, may develop into all-round machinists. Semiskilled operators generally have little chance for advancement since they are employed mainly in production shops where the work is very repetitive and where there are few opportunities to develop additional skills.

Average hourly straight-time earnings, 1949

City	Drill-press operators, single- and multiple-spindle			Engine-lathe operators		
	Class A	Class B	Class C	Class A	Class B	Class C
Atlanta	------	$1.16	------	------	------	------
Baltimore	------	1.19	$1.12	$1.50	------	------
Boston	$1.67	1.37	1.26	1.65	$1.41	------
Buffalo	------	1.28	------	1.65	1.43	------
Chattanooga	------	1.35	1.05	1.51	1.41	$1.00
Chicago	1.65	1.52	1.34	1.72	1.56	1.36
Cincinnati	1.52	1.34	1.05	1.51	1.31	1.08
Cleveland	1.70	1.70	1.28	1.74	1.65	1.33
Dallas	1.36	------	.95	1.47	------	------
Denver	------	1.33	------	1.62	1.31	------
Detroit	1.80	1.57	1.44	2.08	1.73	------
Hartford	1.84	1.35	1.33	1.62	1.40	1.23
Houston	1.60	------	------	1.76	1.65	------
Indianapolis	1.58	1.58	1.12	1.57	1.38	------
Los Angeles	1.53	------	1.11	1.69	1.48	1.35
Milwaukee	1.69	1.59	1.43	1.65	1.59	1.49
Minneapolis–St. Paul	1.61	1.47	1.16	1.65	------	------
Newark–Jersey City	1.53	1.43	1.39	1.67	1.50	1.30
New York City	1.76	1.48	1.18	1.75	1.51	1.21
Philadelphia	1.52	1.35	1.24	1.80	1.52	1.33
Pittsburgh	------	1.60	1.14	1.70	1.56	1.37
Portland, Oreg	1.61	------	------	1.72	------	------
Providence	1.30	1.19	1.19	1.40	1.23	------
St. Louis	1.62	1.41	1.11	1.64	1.49	1.20
Seattle	------	1.56	------	------	------	------
Syracuse	1.81	1.54	1.43	1.57	1.37	1.30
Tulsa	1.28	1.19	------	1.51	------	------
Worcester	1.62	1.45	.97	1.49	1.36	1.24

Tool and Die Makers

(D. O. T. 4–76.010, .040, and .210)

Outlook Summary

Tool and die making offers good long-range employment prospects.

Nature of Work

The function of tool makers is to make the cutting tools used on machine tools, and the jigs, fixtures, and other accessories which hold the work while it is being machined. They also make the gages and other measuring devices needed for precision work. Die makers construct the dies which are used in such metal-forming operations as forging, stamping, and pressing, and they also make the metal molds used in die-casting metal and molding plastics. Tool and die makers must

Average straight-time hourly earnings of tool and die makers

City	Jobbing shops	Other than jobbing shops
Atlanta		$1.80
Baltimore		1.68
Boston	$1.74	1.70
Buffalo	1.77	1.75
Chicago	2.05	1.94
Cincinnati	1.74	1.64
Cleveland	1.85	1.90
Dallas		1.67
Detroit	2.25	2.08
Hartford	1.65	1.70
Houston		1.89
Indianapolis	1.78	1.84
Los Angeles		1.81
Milwaukee	1.87	1.74
Minneapolis-St. Paul		1.77
Newark-Jersey City	1.82	1.86
New York City	1.93	1.91
Philadelphia	2.00	1.77
Pittsburgh		1.81
Portland, Oreg		1.78
Providence	1.73	1.60
St. Louis	2.08	1.96
Seattle		2.06
Syracuse	1.70	1.69
Tulsa		1.71
Worcester		1.62

have the broad knowledge of the all-round machinist, including blueprint reading, lay-out work, setting up and operating machine tools, using precision measuring instruments, understanding the working properties of common metals and alloys, and making shop computations. In addition, they must be able to work to closer tolerances than those usually required of machinists and must do a greater amount of precise hand work. These requirements, plus specialization on tools and dies, distinguish tool and die makers from all-round machinists.

Training and Qualifications

This work requires rounded and varied machine-shop experience, usually obtained through formal apprenticeship or the equivalent in other types of on-the-job training. In July 1949, there were about 6,000 tool and die maker apprentices in training. A tool and die apprenticeship ordinarily covers 4 or 5 years, including mainly shop training in various parts of the job. In addition, during the apprenticeship, courses such as shop arithmetic and blueprint reading are usually given in vocational schools. After apprenticeship, a number of years of experience as a journeyman is often considered necessary to qualify for the more difficult tool and die work. Since tool and die making is the most exacting type of machine-shop jobs, persons planning to enter the trade should have a great deal of mechanical ability and liking for painstaking work. This is essentially a man's job, although little physical strength is required.

Where Employed

The estimated 85,000 tool and die makers are employed in many different metalworking industries. The automobile industry is the largest employer of these workers. Also very important are tool and die jobbing shops. Many are employed in other machinery industries. Among the nonmetal industries using these workers is the plastics products industry, which employs die makers to make metal molds.

Most of the tool and die maker employment is in the midwestern and northeastern sections of the country. Michigan, especially the Detroit area, has more jobs than any other section. Many

An apprentice tool and die maker learns how to operate standard machine tools, such as this shaper.

PHOTOGRAPH BY U. S. DEPARTMENT OF LABOR

are also employed in Ohio, Illinois, New York, and Pennsylvania.

Outlook

Tool and die making offers good long-range employment prospects. These workers are needed not only to repair and replace the tools and dies normally used by industry but also to retool plants for new models and new products. Also the trends toward greater use of die casting, stamping, and plastics molding will tend to increase diemaker employment. In the early fifties, the demand for tool and die makers will be particularly strong as the metalworking industries expand to meet defense requirements.

Even in the event of a general business depression, with machine-shop employment temporarily falling to a low level, experienced tool and die makers, because of their all-round skills, would have fairly good chances to get lower rated machine-shop jobs. Thus, from the point of job security, they may have a considerable advantage over other machine-shop workers.

Earnings and Working Conditions

This is the highest paid machine-shop occupation. In November 1949, the average straight-time hourly earnings (excluding premium pay for overtime and night work) of tool and die makers employed in the machinery industries in selected cities are shown in the foregoing tabulation.

Higher rates are generally paid in jobbing shops than in production shops. Average earnings in the airframe industry for tool and die makers in mid-1949 were $1.79 an hour. In passenger-car manufacturing plants, average straight-time hourly earnings, in February 1950, were $1.98 for die makers (excluding leaders) and $1.97 for tool makers (excluding leaders). Recent earnings information for other industries is not available.

Tool and die makers often rise to better jobs. Many have advanced to shop superintendent or other responsible supervisory work, or to such positions as tool designer. (See statement on this occupation, p. 192.) Another avenue of opportunity is the opening of their own small tool and die jobbing shops.

Set-up Men (Machine Shop)

(D. O. T. 4–75.160)

Outlook Summary

Some openings for qualified men in this small, growing occupation.

Nature of Work

The set-up man is a skilled specialist employed in machine shops which carry on large-volume production. His job is to install cutting tools and adjust the controls of machine tools so that they can be run by semiskilled operators.

The usual practice is to assign a set-up man to a number of machine tools, which are often of one type, such as the turret lathe. The set-up man works from blueprints, written specifications, or job lay-outs in order to set the cutting tools in place and to adjust for each machining operation the guides, speed and feed controls, working tables, and other parts of machine tools. After setting up and adjusting a machine, he makes a trial run to see if it is working properly, and then turns it over to the regular operator. During the machining operation he makes all important adjustments needed for accurate production.

In order to become a set-up man, it is usually necessary to qualify first as an all-round machinist or as a skilled machine-tool specialist, since the job requires a good background in machine-shop practice as well as a thorough knowledge of the operation of at least one type of machine tool.

Outlook

Set-up men comprise one of the smaller occupations among machine-shop workers. However, the long-run trend toward using these skills in conjunction with semiskilled machine-tool operators in many shops is expected to continue. Thus, there should be openings for men with the necessary qualifications. The number of set-up men should increase substantially during the early fifties because of the expected expansion of production in metalworking industries.

Lay-out Men (Machine Shop)

(D. O. T. 4–75.140)

Outlook Summary

There will will be openings for experienced all-round machinists to get into this field.

Nature of Work

The lay-out man is a highly skilled specialist whose job is to make guide marks on metal before it is machined to indicate to the machine-tool operators the kind of machining needed.

Working from blueprints or written specifications, the lay-out man marks guide lines, reference points, and other instructions to operators on rough castings, forgings, or metal stock. He uses a wide assortment of instruments, including the scriber, with which he marks lines on the surface of the metal; the center punch, used to indicate the centers on the ends of metal pieces to be machined or drilled; the keyseat or box rule, used for drawing lines and laying off distances on curved surfaces; dividers, for transferring and comparing distances; L- or T-squares for determining right angles; and calipers and micrometers for accurate measurement. Not only must the lay-out man work with extreme accuracy, but also he has to be familiar with the operation and uses of each of the standard machine tools.

Generally it takes from 6 to 10 years to develop this skill, including the machinist apprenticeship or equivalent training needed to learn the fundamentals of machine-shop practice. Earnings in this occupation are among the highest in machine shops.

Outlook

This is one of the smaller machine-shop occupations. However, employment opportunities for qualified men are likely to be good, since there is a trend toward employing skilled lay-out men in conjunction with semiskilled machine-tool operators in production shops. A considerable rise in the number of lay-out men is in prospect during the early fifties as production in metalworking plants expands to meet defense requirements.

Where To Get Additional Information

Employment Outlook in Machine-Shop Occupations. Bulletin No. 895. U. S. Department of Labor, Bureau of Labor Statistics, 1947. 28 pp., 3 charts, 7 illus. Superintendent of Documents, Washington 25, D. C. Price, 20 cents.

Persons interested in opening their own metalworking business would do well to consult Establishing and Operating a Metalworking Shop. U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce, 1945. Superintendent of Documents, Washington 25, D. C. Price, 35 cents.

The lay-out man must have a broad knowledge of machine-shop work and be able to use marking and measuring instruments.

PHOTOGRAPH BY U. S. DEPARTMENT OF LABOR

FOUNDRY OCCUPATIONS

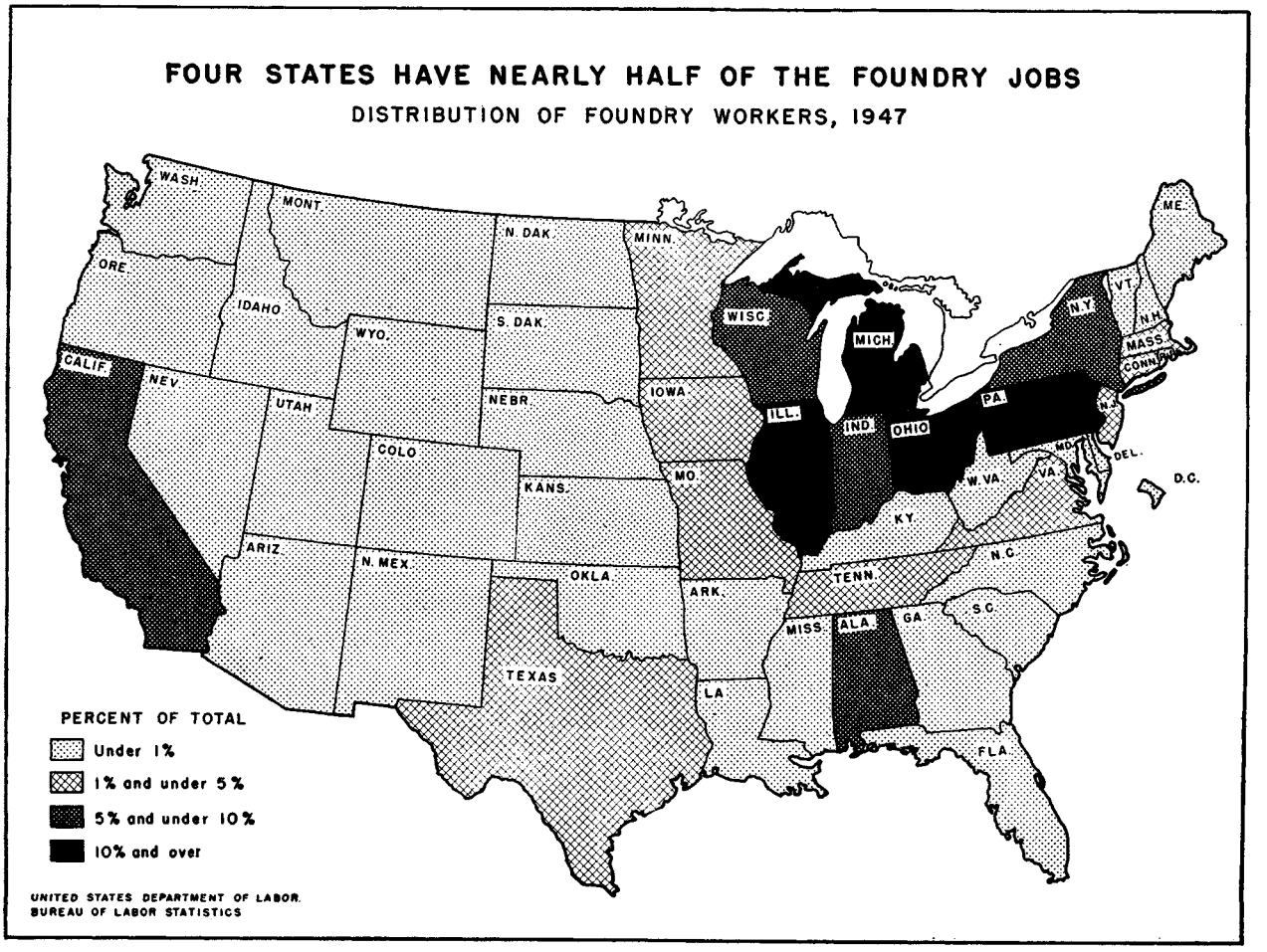
Foundries constitute one of the principal metalworking fields and one of the larger sources of employment for trained workers in manufacturing. The more than 5,000 foundries in the United States employed about 435,000 production workers in July 1950, many of them in skilled occupations. Prospects are that a large number of new workers will get foundry jobs during the 1950–60 decade. Earnings are above the average for factory work generally.

Characteristics of Foundries

Foundries are places where castings are made. A casting is formed by pouring molten metal into a mold and allowing the metal to harden, taking the shape of the mold. This is one of industry's basic metalworking methods since it can produce metal parts in a wide range of shapes and sizes. Castings in general use include automobile cylinder blocks, water mains, bathtubs, machinery bearings, ship propellers, railway car wheels, machine-tool bases, radiators, valve bodies, locomotive frames, and hundreds of other industrial applications.

Casting is applied to a number of different metals and their alloys. Gray iron accounts for most of the tonnage produced and the largest segment of employment in the entire foundry field. Steel and malleable iron are the other important types of ferrous metals which are cast. Among the nonferrous metals, the main casting materials are brass, bronze, aluminum, and magnesium. Foundries usually specialize in casting one or two

CHART 52



metals—since somewhat different kinds of equipment and methods are used for the various metals. Most foundry workers can transfer, however, from casting one type of metal to another without much extra training.

Foundries differ greatly in the way their production is organized. *Production foundries* make large quantities of identical castings, using mainly machine methods and requiring relatively few skilled workers. Many of the production foundries are "captive" or "integrated" foundries, that is, they are departments of firms which use castings in manufacturing finished products such as automobiles, various types of machinery, agricultural implements, plumbing and heating equipment, or electrical machinery. *Jobbing foundries*, on the other hand, make a variety of shapes and sizes of castings, usually in limited quantities.

Although the amount of mechanization has been increasing, hand methods are still used to a great extent in jobbing shops, and a relatively high proportion of skilled workers is required. Jobbing foundries are usually separate establishments ("independent" or "commercial" foundries), selling their castings to other companies. The distinction between production and jobbing foundries is not always sharply defined, as production foundries often do some jobbing work and jobbing foundries may carry on some semiproduction operations.

Foundries vary greatly in size. In 1947, of the more than 1,600 independent gray-iron foundries, only 13 had more than 1,000 workers each. On the other hand, over one-half of the gray-iron foundries employed fewer than 50 workers. Both steel foundries and malleable-iron foundries are generally larger than the typical gray-iron foundry; more than half of the workers in these foundries were employed in plants with more than 500 employees. Nonferrous foundries are typically small; four-fifths of them had fewer than 50 employees each in 1947.

As the map (chart 52) shows, most of the foundry jobs are in the Midwestern and Northeastern States. Foundries tend to be near the great concentrations of metalworking industries for which they produce castings, and near the supply of such basic materials as pig iron, coke, and nonferrous metals. The leading foundry States are Ohio, Pennsylvania, Illinois, and Michigan. However, foundry jobs appear in substantial numbers in other parts of the country. Alabama, for example, has many foundry workers; in California, foundry employment has recently become more important. Every State has some foundry jobs.

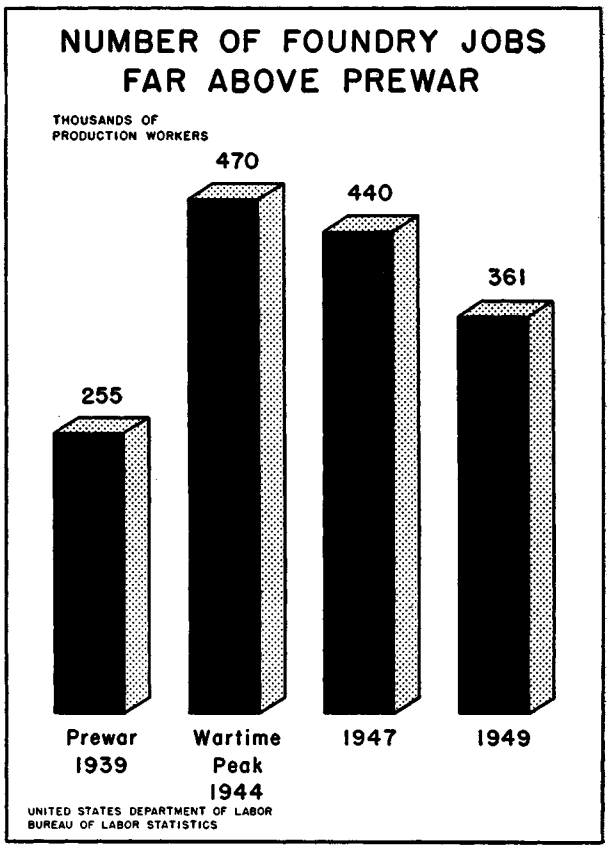


CHART 53

Employment Outlook

Foundries are expected to hire many new workers during the 1950–60 decade. Openings will be particularly numerous during the early fifties, as metalworking industries—the principal users of castings—expand to meet defense requirements. Many job opportunities will be created by the need to replace those workers who leave the foundries because of death, retirement, or shifting to other fields of work.

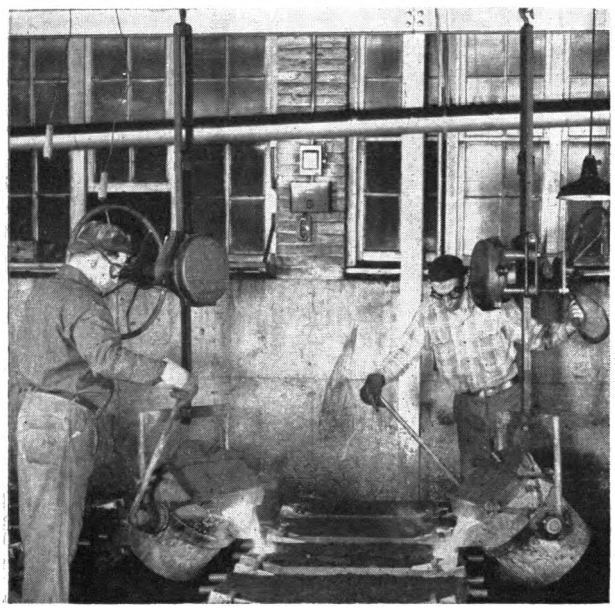
There has been a long-run upward trend in foundry production and employment. This trend reflects the growth of the whole economy and particularly the great expansion of the metalworking industries including the automobile, machinery, railroad, electrical equipment, and plumbing and

heating equipment industries. However, foundry activity has also shown wide fluctuations from year to year. To a high degree, these fluctuations are associated with changes in general business conditions; foundries are especially hard hit during depressions, but in boom times, their situation is particularly favorable. For example, there was a drop of 67 percent in iron and steel castings output between 1929 and 1933, and a rise of 82 percent between 1939 and 1947. Wartime also causes sharp fluctuations in foundry activity. Tremendous requirements for castings for aircraft, tanks, and ordnance lead to a rapid rise in foundry output, followed by some postwar decline.

Chart 53 shows the trend of foundry employment in recent years. It can be seen that the number of workers employed in foundries is far above prewar, although somewhat lower than the wartime peak. In July 1950, about 435,000 production workers had jobs in foundries (including both independent and integrated foundries). In the early fifties, foundry employment is expected to rise above this level, because of the need for castings by defense industries during the next decade.

Long-run prospects are good in many of the industries which use large amounts of castings, including automobile, electrical equipment, farm machinery, many kinds of industrial equipment, and plumbing and heating supplies. This should mean gradually increasing levels of castings production. However, foundry employment is not expected to rise quite as much as production. Continued technical advances in foundry methods will mean that fewer workers will be needed to produce a given amount of castings. Some of the more important technological changes may include more extensive installation of materials-handling equipment and greater use of permanent-mold castings.

Foundry workers pouring molten metal into sand molds to form castings.



Although no great rise in employment is anticipated, over the long run, foundries will hire many workers each year because of the need to replace employees who leave the foundries. Openings resulting from death and retirement may run about 6,000 to 10,000 annually. Replacement demand of this kind will be especially important in the more skilled occupations, in which there are many workers of relatively advanced age. An even greater number of openings should result from the shifting of experienced foundry workers into other kinds of employment. In the semiskilled and unskilled occupations, most of the job openings will arise in this way. Replacements will also be needed for those entering the Armed Forces.

Foundry Workers and Their Jobs

Most skilled jobs in foundries, as well as many of the less skilled, are not found elsewhere in industry. Estimated employment in some of the principal foundry occupations is shown in chart 54. There are many occupations which are not typical of foundry work as such, but which are, nevertheless, represented in foundries. These workers are found throughout industry and include maintenance workers (such as carpenters and electricians), engineers, clerical employees, and laborers.

The customary employment practice is to hire only men for most foundry occupations. During the war, a large number of women worked in foundries, but relatively few have remained. In May 1950, about 5 percent of all employees in independent iron and steel foundries were women. The proportion of Negroes in foundries is fairly high. They are employed not only in many unskilled and semiskilled foundry occupations but also to a substantial extent as skilled molders and coremakers.

Wages in foundries are somewhat above the aver-

age for manufacturing as a whole. In July 1950, production workers in independent iron and steel foundries earned an average of about $1.54 an hour (including pay for overtime and night work). Those in nonferrous foundries averaged about $1.60 an hour. This compares with average hourly earnings of about $1.46 for all manufacturing industries in the same month.

The working environment varies greatly among individual foundries. In some, the conditions compare favorably with metalworking industries generally; in others, safety and comfort are below the average for metalworking.

Foundries are sometimes hot places to work, particularly near the melting units in the summer months. Smoke and fumes are sometimes a nuisance. Noise may be a problem in certain operations, particularly in cleaning and finishing.

The injury rate in foundries tends to be relatively high, but there has been considerable improvement of working conditions and safety practices in recent years. The frequency of accidents varies among the different foundry occupations. In general, patternmaking and coremaking are the least hazardous, molding is somewhat more unsafe, and jobs in melting and chipping tend to have among the highest injury rates.

The large majority of foundry workers are union members. The principal labor organizations covering these workers include the International Molders and Foundry Workers Union of North America (AFL), the United Steelworkers of America (CIO), and the United Automobile, Aircraft, and Agricultural Implement Workers of America (CIO). Most patternmakers are members of the Pattern Makers' League of North America (AFL).

The first step in casting is for the *patternmaker* to make a wood or metal pattern in the shape of the final casting desired. *Sandmixers* prepare sand for use in molding and coremaking. *Hand molders* make the sand molds into which metal is poured. The molds are made by packing and ramming sand around the patterns. *Molders' helpers* may assist in these operations. *Machine molders* operate one of several types of machines which simplify and speed up the making of large quantities of identical sand molds. *Coremakers* shape the bodies of sand, or "cores," which are placed inside molds in order to form any hollow spaces needed in castings. *Core assemblers* may be used

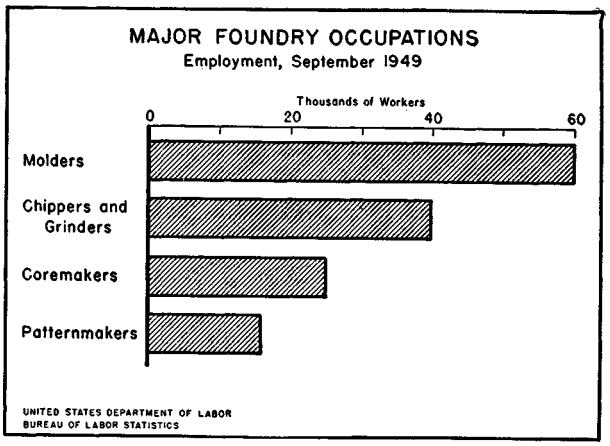


CHART 54

to put together core sections. *Core-oven tenders* operate furnaces in which cores are often baked.

With the mold made and the cores, if any, put inside, the next step is to pour the molten metal into the mold. A *melter* operates a furnace used to melt metal for castings. The actual pouring is customarily done by a *pourer*, although in some small foundries it is part of the molder's job. When the casting has cooled off, it is taken out of the mold by *shake-out men* and sent to the cleaning and finishing department. *Sandblasters* and *tumbler operators* run the various kinds of cleaning equipment. *Chippers* and *grinders* remove excess metal and finish castings. The casting may be placed in an annealing furnace to improve its physical properties; *annealers* run these furnaces. *Casting inspectors* then check finished castings for structural soundness and proper dimensions. Another group of workers are the *foundry technicians*—skilled workers having to do with quality control in the making of castings.

Among the many types of jobs associated with foundry work, three occupations—molder, coremaker, and patternmaker—stand out as especially significant. Molding and coremaking are relatively large occupations and include a high proportion of skilled jobs requiring apprenticeship or equivalent training. Although fewer workers are engaged in patternmaking, the skill needed is very high and apprenticeship is the normal method of entry. For the less skilled foundry jobs, persons without previous foundry experience may be hired directly or foundry laborers may be upgraded. The leading foundry occupations are discussed below.

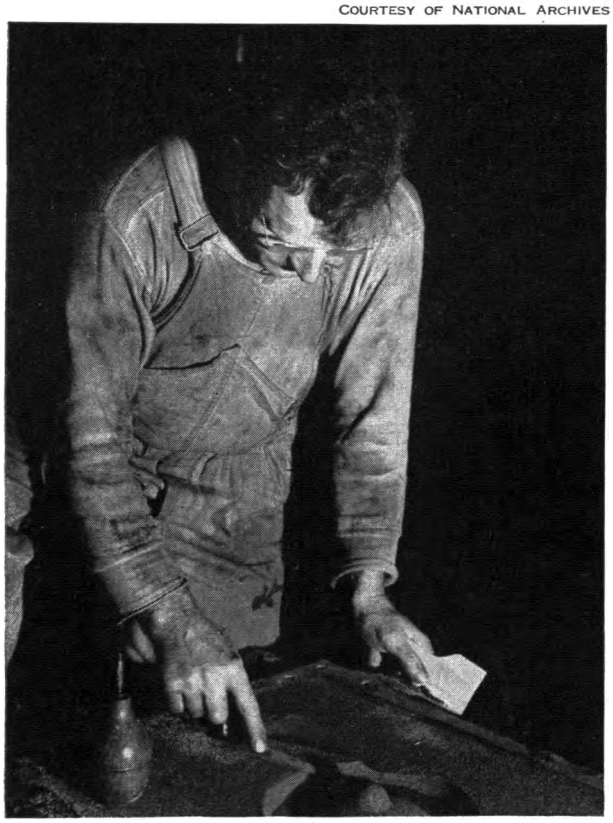
Hand Molders

(D. O. T. 4–81.010 and .030)

These foundry workers use mainly hand methods to prepare the sand molds into which metal is poured to make castings. A mold is made by packing and ramming prepared sand around a model or pattern of the desired casting and then removing the pattern, leaving in the sand a hollow space in the shape of the casting to be made. Molds for smaller castings are usually made on a workbench by *bench molders;* those for large and bulky castings are made on the foundry floor by *floor molders.* Skill requirements in this occupation vary considerably. An all-round hand molder (journeyman) makes widely varying kinds of molds. A less skilled molder does more repetitive work, specializing on a single kind of mold. Hand molders work mainly in jobbing foundries. In production foundries, where most of the molding is done by machine, some journeyman molders are employed in skilled, specialized molding jobs and in supervisory positions.

A floor molder smoothing sand mold.

COURTESY OF NATIONAL ARCHIVES



Completion of a 4-year apprenticeship, or the equivalent in experience, is needed to become a journeyman molder and thus to qualify for all-round hand molding and for the skilled specialized or supervisory jobs. Men with this training are also preferred for many kinds of machine molding. For the less skilled jobs, not more than 6 months of on-the-job training is usually required.

For a molding apprenticeship, an eighth grade education is usually the minimum, and many employers specify additional school work up to and including high school graduation. Eighth grade schooling, however, suffices for most jobs as learners of less skilled hand molding.

Physical standards for molding jobs take into account the need for continual standing and moving about, frequent lifting, good vision, and manual dexterity.

Hand molders are among the highest paid foundry workers. Average straight-time hourly earnings of male floor and bench molders in independent ferrous foundries in the summer of 1950, are shown in the following tabulation:

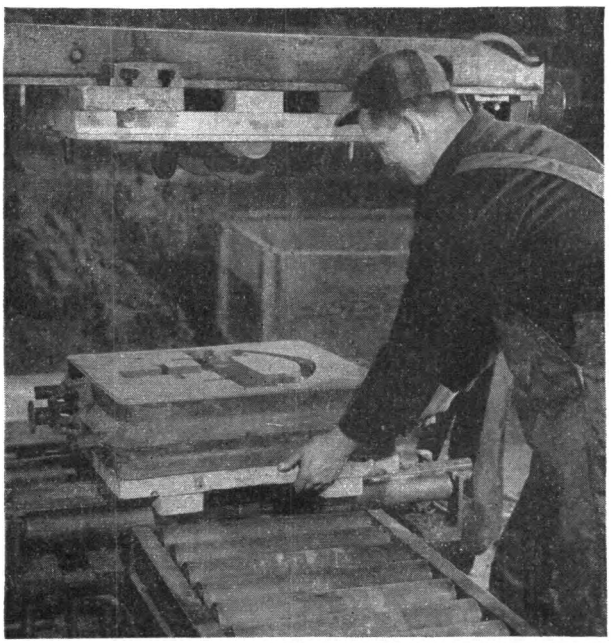
	Floor	*Bench*
Birmingham	$1.15	$1.15
Boston	1.67	1.68
Buffalo	1.65	1.64
Chicago	1.76	1.74
Cincinnati	1.70	1.60
Cleveland	1.83	1.76
Denver	1.53	----------
Detroit	1.92	1.90
Hartford	1.83	1.70
Houston	1.62	----------
Indianapolis	1.72	1.62
Los Angeles	1.76	1.64
Milwaukee	1.83	1.66
Minneapolis-St. Paul	1.61	1.61
Newark-Jersey City	1.71	1.72
New York	1.73	1.72
Philadelphia	1.70	1.68
Pittsburgh	1.69	1.61
Portland, Oreg	1.77	1.76
St. Louis	1.69	1.73
San Francisco	1.85	1.85
Toledo	1.76	1.61

Hand molders with all-round training have good chances for promotion to supervisory jobs. Opportunities for advancement are much more limited for the less skilled hand molders.

Machine Molders

(D. O. T. 4–81.050; 6–81.010 and .020)

Machine molders are foundry workers who operate one of several types of machines which simplify and speed up the making of large quantities of identical sand molds for castings. The basic duties of a machine molder consist mainly of assembling the flask (molding box) and pattern on the machine table, filling the flask with prepared sand, and operating the machine by the properly timed use of its control levers and pedals. Machine molders sometimes are qualified journeyman molders who require little supervision and who set up and adjust their own machines. More commonly, however, the machine molder is a semiskilled worker, whose duties are limited to operating the machine which is set up for him. Machine molders are employed mainly in production foundries which make large quantities of identical castings.



COURTESY OF U. S. OFFICE OF EDUCATION

Machine molders operate machines which simplify and speed up the making of a large quantity of identical molds.

For molding machine jobs of the more difficult and responsible types, a 4-year molder apprenticeship or equivalent training is required. However, machine molding of the less skilled variety is ordinarily learned in from 30 to 90 days of on-the-job training. Average physical strength is needed.

Machine molders are generally among the highest paid foundry workers. Average straight-time hourly earnings of men operating molding machines in independent ferrous foundries in the summer of 1950, are shown in the following tabulation:

Birmingham	$1.21	Los Angeles	$1.91
Boston	1.65	Milwaukee	1.91
Buffalo	1.93	Minneapolis-St. Paul	1.70
Chicago	1.73	Newark-Jersey City	1.74
Cincinnati	1.81	Philadelphia	1.78
Cleveland	1.81	Pittsburgh	1.66
Denver	1.53	Portland, Oreg.	1.78
Detroit	1.95	St. Louis	1.78
Hartford	1.86	San Francisco	1.84
Indianapolis	1.97	Toledo	2.03

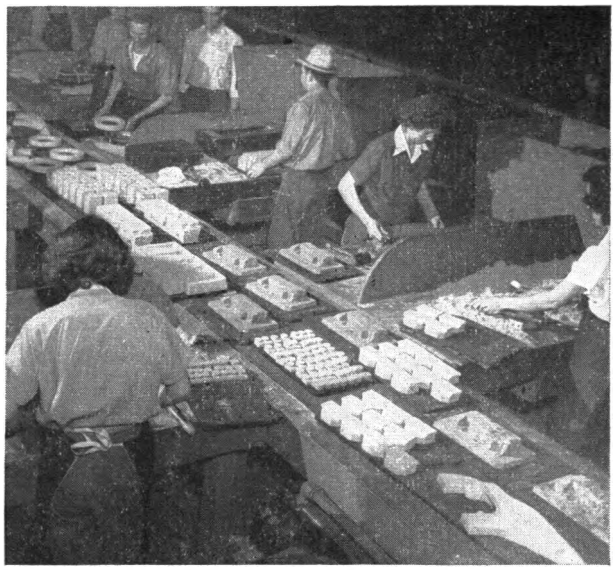
A machine molder who has completed an apprenticeship or acquired other all-round molding experience is often in line for promotion to a supervisory job. A semiskilled machine molder, however, generally has much less chance for advancement.

Hand Coremakers

(D. O. T. 4–82.010)

These workers use hand methods to prepare the bodies of sand, or cores, which are placed in molds to form hollows or holes required in metal castings. A core is made by packing prepared sand into a hollow form (core box) so that the sand is compressed into the desired shape. Small cores are made on a workbench by *bench coremakers;* large and bulky cores are made on the foundry floor by *floor coremakers.* Skill requirements in this occupation differ considerably. All-round hand coremakers (journeymen) prepare a variety of larger or more intricate cores. The less skilled coremakers make the small and simple cores, frequently produced in large numbers, so the work is highly repetitive.

Journeyman hand coremakers usually work in



Hand coremakers prepare the bodies of sand, or "cores," which are placed in molds to form the hollows or holes required in metal castings.

jobbing foundries. Some journeyman coremakers work in production foundries as supervisors or in skilled, specialized jobs. Semiskilled hand coremakers are generally employed in production foundries.

Completion of a 4-year apprenticeship, or the equivalent in experience is needed to become a journeyman coremaker. Molding and coremaking training is often combined in a single apprenticeship. For the less skilled jobs, only a few months of on-the-job training is usually required. For coremaking apprentices, an eighth grade education is usually the minimum, and many employers specify additional school work up to and including high-school graduation. Eighth grade schooling, however, suffices for most jobs as learners of less skilled hand coremaking.

Physical requirements for light coremaking are fairly modest, since the work is not strenuous; women are frequently employed in the less skilled coremaking jobs. Coremaking is generally somewhat safer than other foundry work.

Hand coremakers are among the better paid foundry workers. Average straight-time hourly earnings of male hand coremakers in independent ferrous foundries in the summer of 1950, are shown below:

Birmingham	$1.15	Los Angeles	$1.71
Boston	1.67	Milwaukee	1.82
Buffalo	1.70	Minneapolis-St. Paul	1.61
Chicago	1.76	Newark-Jersey City	1.62
Cincinnati	1.74	New York	1.70
Cleveland	1.86	Philadelphia	1.92
Denver	1.54	Pittsburgh	1.73
Detroit	1.95	Portland, Oreg	1.78
Hartford	1.50	St. Louis	1.75
Houston	1.57	San Francisco	1.84
Indianapolis	1.60	Toledo	1.85

A hand coremaker who has completed his apprenticeship or acquired equivalent, all-round experience may be promoted to a supervisory job.

Machine Coremakers

(D. O. T. 6-82.010, .020, and .030)

Machine coremakers operate several different types of machines which force prepared sand into specially shaped hollow forms to make sand cores. These cores are placed in molds to form hollow spaces required in the castings. The duties and skill of machine coremakers vary. Some workers are required to set up and adjust their own machines and do any necessary finishing operations on the cores; less skilled coremakers are more closely supervised, and the necessary adjusting of the machines is done for them. Machine coremakers are employed mainly in production foundries, where large quantities of identical castings are made.

Generally, for the less skilled machine-coremaker jobs only a brief period of on-the-job training is needed, and no special form of preparation is required. Persons without previous foundry experience may be hired directly, or foundry laborers or helpers may be upgraded to this work. However, a 3- or 4-year coremaker apprenticeship, or equivalent training, is sometimes needed for the more difficult and responsible machine-coremaking jobs. For many types of machine coremaking, little physical strength is needed, and some women are employed.

Patternmakers

(D. O. T. 5–17.010 and .020)

Patternmakers are the highly skilled craftsmen who construct patterns and core boxes for castings. They are classified, primarily, according to the kind of material they use in making patterns. Those who construct wooden patterns constitute about two-thirds of the total. Of the remainder, most are metal patternmakers, although there are a few who work with other materials, such as plaster.

To do his job properly, a patternmaker must understand general foundry practice. He works from blueprints and plans the pattern, taking into consideration the manner in which the object will be cast and the type of metal to be used. The wood patternmaker selects the appropriate wood stock and lays out the pattern, marking the design for each section on the proper piece of wood. Using power saws, he cuts each piece of wood roughly to width and length. He then shapes the rough pieces into their final form, using various woodworking machines—such as borers, lathes, planers, band saws, and sanders—as well as many small hand tools. Finally, he assembles the pattern segments by hand.

The duties of a metal patternmaker differ from those of a wood patternmaker principally in that metal and metalworking equipment are substituted for wood and woodworking equipment. Metal patternmakers prepare patterns from metal stock, or, more commonly, from rough castings made from an original wood pattern. To shape and finish their work, they use a variety of metalworking machines, including the engine lathe, drill press, milling machine, power hacksaw, grinder, and shaper. Apart from these differences, metal patternmaking is similar to work on wood patterns, requiring blueprint reading and lay-out.

Throughout his work the patternmaker carefully checks each dimension of the pattern. A high degree of accuracy is required, since any imperfection in the pattern will be reproduced in the castings made from it. Other duties of patternmakers include making core boxes (in much the same manner as patterns are constructed) and repairing patterns and core boxes.

Patternmaking is done in specially equipped pattern shops, which are of two types—independent and integrated. Independent pattern shops are separate establishments which make patterns for sale. An integrated shop may be operated in conjunction with a foundry which uses the patterns; on the other hand, it may be the pattern department of a plant that buys castings from a commercial foundry, to which it supplies appropriate patterns with each new order for castings.

Apprenticeship, or a similar program of on-the-job training, is the principal means of qualifying as a journeyman patternmaker. Because of the high degree of skill and the wide range of knowledge needed for patternmaking, it is very difficult to obtain the necessary training through informally picking up the trade. Good trade school courses in patternmaking provide useful preparation for the prospective apprentice, and may in some cases be credited toward completion of the apprentice period. However, these courses do not substitute for apprenticeship or other on-the-job training.

The usual apprenticeship period for patternmaking is 5 years, or about 10,000 working hours. At least 720 hours of classroom instruction in related technical subjects is normally provided during apprenticeship. Since wood and metal patternmaking differ in certain essential respects, there are separate apprenticeships for each type.

Patternmaking, although not strenuous, requires considerable standing and moving about. A high degree of manual dexterity is especially important because of the precise nature of many hand operations. For all practical purposes, this is entirely a man's occupation.

Patternmaking is among the highest paid occupations in manufacturing. In independent pattern shops, union patternmakers in such large foundry centers as Chicago, Cleveland, and Detroit generally earn upward of $2 an hour straight-time, and some make as much as $3.50 an hour.

Average straight-time hourly earnings of patternmakers in independent ferrous foundries in the summer of 1950, are shown below:

Buffalo	$1.79	Milwaukee	$1.75
Chicago	2.10	Philadelphia	1.92
Cleveland	2.28	Pittsburgh	1.78
Hartford	1.89	St. Louis	1.95
Indianapolis	2.08	San Francisco	2.27
Los Angeles	2.32		

An experienced patternmaker may be advanced to pattern lay-out man or pattern-room foreman. Occasionally a journeyman may have the opportunity to start a small pattern shop of his own. When patternmaking employment is not available, journeymen patternmakers can find jobs in related fields. Wood patternmakers can qualify for nearly every kind of skilled woodworking jobs—cabinetmaking, for example. Metal patternmakers are suited for many types of machine shop work, including the jobs of machinist, machine tool operator, and lay-out man. (See: Machine Shop Occupations, p. 186.)

Chippers and Grinders (Foundry)

(D. O. T. 6-82.910)

Chippers and grinders constitute a large group of workers—most of them semiskilled—in the cleaning and finishing departments of foundries. Chipping consists of removing the excess metal from castings by means of pneumatic hammers or hand hammers and chisels. In grinding, a mechanically powered abrasive wheel is used to smooth and finish castings. Although chipping and grinding may be separate occupations they are often combined in one job, especially in the smaller foundries. There are variations in skill requirements, depending on the intricacy of the castings on which work is done, the degree of precision required, and the amount of supervision given the worker. Chippers and grinders are employed in both jobbing and production foundries.

Grinders use mechanically powered abrasive wheels to smooth and finish castings.

PHOTOGRAPH BY U. S. DEPARTMENT OF LABOR

The basic duties of the chipper or grinder are generally learned in a brief period of on-the-job training, and no special form of preparation is needed. Persons without previous foundry experience may be hired directly, or foundry laborers may be upgraded to this work. Considerable experience in chipping and grinding is required, however, to qualify for the more intricate, precise, and responsible duties.

In many respects chipping and grinding involves strenuous work, and at least average strength is needed. Consequently, relatively few women are employed in this occupation, and they work only on small castings.

Average straight-time hourly earnings of male chippers and grinders in independent ferrous foundries in the summer of 1950, are shown in the following tabulation:

Boston	$1.26	Milwaukee	$1.66
Buffalo	1.46	Minneapolis-St.Paul	1.40
Chicago	1.51	Newark-Jersey City	1.22
Cincinnati	1.39	New York	1.29
Cleveland	1.57	Philadelphia	1.47
Denver	1.23	Pittsburgh	1.52
Detroit	1.74	Portland, Oreg	1.50
Hartford	1.33	St. Louis	1.62
Houston	1.13	San Francisco	1.53
Indianapolis	1.73	Toledo	1.72
Los Angeles	1.30		

Castings Inspectors

(D. O. T. 6–82.920)

Casting inspectors are foundry workers who check finished castings for structural soundness and proper dimensions. The more skilled inspectors are able to read blueprints, to work on widely different types of castings, and to mark partially defective castings to show what should be done to salvage them. The less skilled do routine measuring and checking of large numbers of identical castings under close supervision. Castings inspectors are employed in both jobbing and production foundries.

Skilled inspector jobs are usually filled by promotion from lower-grade inspection jobs or from other cleaning and finishing occupations, such as that of chipper and grinder. For the less skilled work, previous foundry experience may not be needed. Physical requirements depend on the size of castings inspected and the availability of mechanical handling equipment. In the lighter types of inspection work some women are employed, mainly for the less skilled jobs. Skilled inspectors may be promoted to the jobs of chief inspector or cleaning room foreman.

Melters (Foundry)

(D. O. T. 4–91.351; .411, .441, .447, .571, and .572)

A foundry melter operates or directs the operation of a furnace used to melt metal for castings. He usually specializes on a particular type of furnace—cupola, open-hearth, electric, crucible, or reverberatory—and on one or two metals. Skill requirements in this occupation depend on the way the foundry is organized and the type of melting equipment used. Skilled melters need little supervision and are responsible for charging the furnace, controlling the furnace temperature and melting time, and determining from the appearance of the molten metal when it is ready for pouring. Less skilled melters work under close supervision of a foundry manager or an engineer and need use little independent judgment. Melters are employed in both production and jobbing foundries.

As a rule, there are no apprenticeships or other organized training programs provided for melters. The less skilled melting jobs are learned in a brief period of informal training. The usual way to get one of the more skilled jobs is to begin as a furnace helper or less skilled melter and gradually learn the trade. The more skilled melters must have some familiarity with general foundry practice, shop arithmetic, and certain practical aspects of chemistry and metallurgy. Since the duties of melters are in many respects strenuous, physical requirements are fairly high and normally only men are employed. Accidents to workers in the melting units tend to occur more frequently than to those in other departments of the foundry.

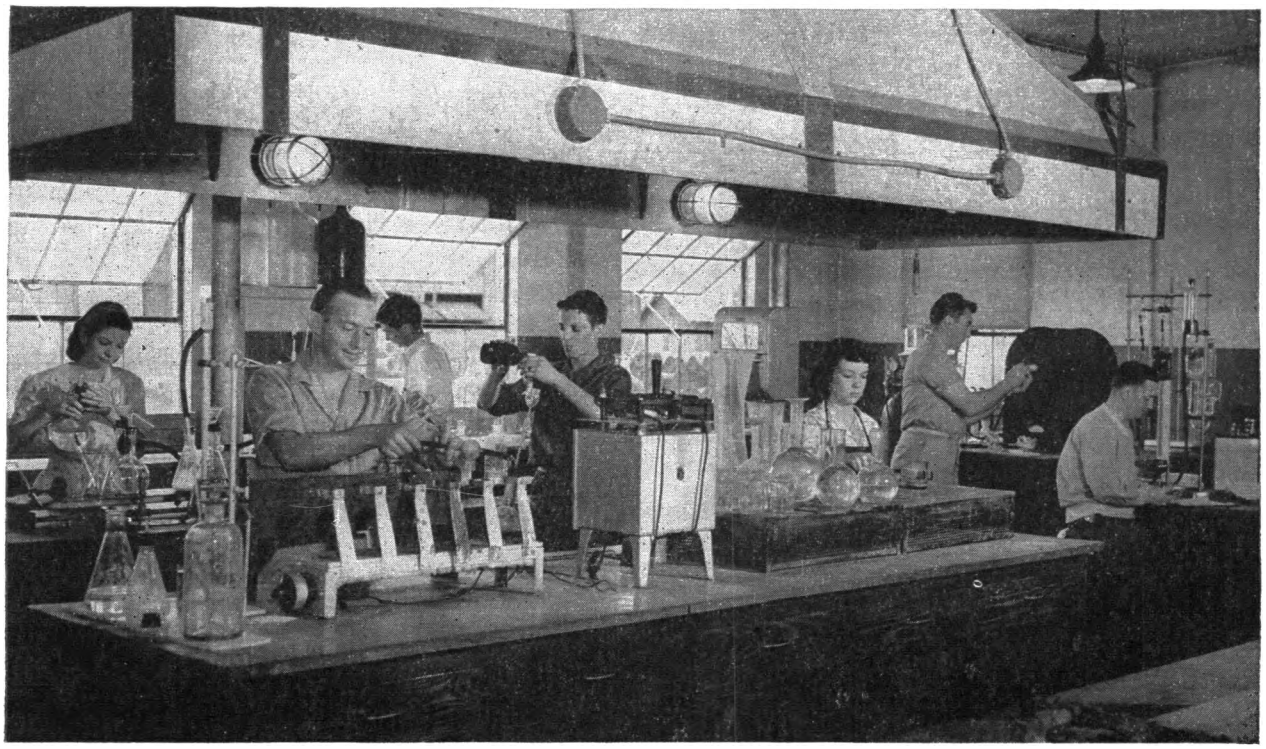
Foundry Technicians

(D. O. T. 4–86.170)

This is a group of skilled foundry occupations having to do with quality control in the making of castings. Included are workers with such specialized duties as the testing of molding and core-making sand, chemical analysis of metal, operation of machines which test the strength and hardness of castings, and the use of X-ray or magnetic apparatus to inspect the internal structure of castings.

In general, a high school education is a prerequisite, and employers may require additional technical schooling. However, most of the foundry technician's duties are learned on the job. Physical strength is not ordinarily needed, and women are often employed. Foundry technicians may advance to supervisory positions in their various specialized fields.

Technicians working in a foundry laboratory. These workers have to do with quality control in the making of castings.



FORGE SHOP OCCUPATIONS

Forge shop work is among the smaller fields of employment in metalworking. In late 1949, about 45,000 workers were employed in forge shop occupations.[1] However, these are among the best-paid factory occupations and include a high proportion of skilled jobs. During the fifties, there will be many job opportunities for new workers in forge shops. Most openings will be for laborers or helpers; the more-skilled forge shop jobs are generally filled by upgrading experienced men.

Nature of Forge Shop Work

Forging is used to shape metal objects which are required to withstand great stress, such as automobile crankshafts and axles, locomotive wheels, and marine engine drive shafts. Steel is the main material used, but brass and other nonferrous metals are also forged.

In general, forgings are produced in machines which pound or squeeze heated metal into the desired shape. This is similar to the work done by the old-time blacksmiths, except that machine power is substituted for the blacksmith's arm, and dies replace his hammer and anvil.

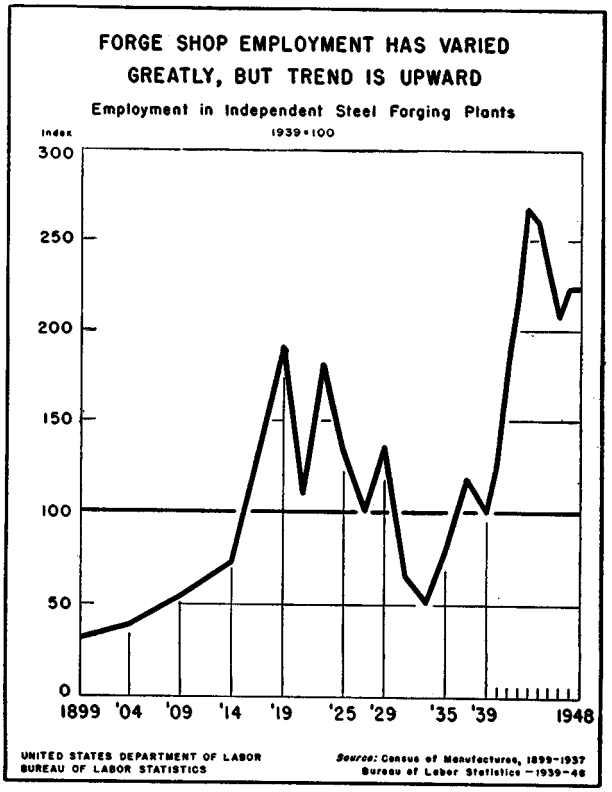
Forge shop jobs are found in a variety of industries. The largest group is in independent steel forgings plants, producing forgings for sale to other industries. Many workers, however, are employed in the forge departments of plants which use forged parts in their final products, such as automobiles, railroad equipment, hand tools, or machinery. A number of these workers are in forge shops operated as part of steel mills.

Employment of forge shop workers is concentrated mainly in the metalworking centers of the Midwest and Northeast. Forge shops are located near the steel producing centers, which provide steel for forgings, as well as near the metalworking plants which are the major users of forged products, such as automobiles, machinery, and railroad equipment. Accordingly, the bulk of forge shop jobs are found in the industrial centers of Michigan, Illinois, Ohio, Wisconsin, Pennsylvania, and New York.

Employment Outlook

The long-range trend of forge-shop employment is upward. This is indicated by chart 55 which shows production worker employment in the independent iron and steel forgings industry during the last half century. The upward trend reflects the growth of the whole economy as well as the great expansion of metalworking industries which are the users of forgings. It has also resulted from the development of improved forging methods, leading to wider use of forged parts. During wartime especially, the industry experienced great gains because of the critical importance of forged parts in many military products. In part, these gains have been retained in postwar

CHART 55



[1] Forge shop occupations, as used here, are those characteristic of the forging process, including operation of the forging hammers and presses, and preparing metal for forging, heat treating to remove the stresses resulting from the forging process, the removal of excess metal and scale, and inspection. Not considered as employed in forge shop occupations are those workers who have machining, maintenance, custodial, or other nonforging jobs in forge shops.

periods. The chart also reveals that forging activity is extremely sensitive to the business cycle; relative to the economy as a whole, forging is especially hard hit during depressions. For example, by 1933, employment in independent iron and steel forge shops had dropped to about 40 percent of the 1929 level, while employment in manufacturing as a whole had dropped to about 70 percent of that level.

During the early fifties, the number of forge shop jobs is expected to rise substantially. Expanding defense requirements will greatly increase activity in the Nation's forge shops. In the long run, moderate growth is in prospect in this field. Most of the industries which use forged parts in their final products, such as automobiles, tractors, farm machinery and aircraft have generally favorable long-run prospects.

Most job openings will be for helpers and laborers, since the more skilled jobs are generally filled by upgrading experienced men. In addition to opportunities that may be created by any rise in employment, shifting of less skilled workers into other fields of work will create jobs for beginners. The need to replace older workers dropping out of the shops because of death or retirement or transferring to physically less-demanding forge shop work will provide promotional opportunities for experienced workers and will create additional vacancies in starting jobs.

Forge Shop Workers and Their Jobs

There are many different kinds of jobs in the metal forging process. The principal jobs are those having to do with the operation of the forging hammers and presses. These hammers and presses usually are run by crews of 2 or more, sometimes as many as 10 or 15. Operators and their crews generally specialize on a particular kind of forging hammer or press. Considerable strength and endurance are required for these jobs, in order to do the necessary heavy lifting and to withstand the noise, heat, and vibration typical of forge shops. Virtually all the workers are men.

In addition to the hammer and press crews, forge shops have many workers engaged in cleaning, finishing, or inspecting forgings, as well as laborers employed mainly in moving materials.

The more-skilled forge shop jobs, such as drop-hammer operator, are filled by promoting men from lower-rated jobs. For example, a man starts as a helper on a drop-hammer crew, advances to the job of heater, and then to hammer operator. Ordinarily this takes several years to achieve.

Earnings in forge shops are among the highest in industry. In July 1950, production workers in independent iron and steel forging plants earned an average of $1.76 an hour (including pay for overtime and night work). In the same month, the average for all manufacturing industries was about $1.46 an hour. In part, the level of forge shop earnings is accounted for by the prevalence of incentive pay; the generally difficult working conditions are also a factor in the wage scale. Earnings in certain occupations, such as that of hammer operator, range considerably higher. Recent earnings data for individual forging occupations are not avaliable for most industries. However, in the automobile industry, in February 1950, average straight-time hourly earnings were $2.57 for hammermen (steam, medium); $2.08 for upsetters (3 inch and over); and $1.94 for heaters. Because some of these jobs require speed and stamina, older men are often unable to continue in the occupation and transfer to lower-rated, physically less-demanding forge shop jobs.

Forge shops are typically hot and noisy, and much of the work is strenuous. Accident frequency rates for forge shops are somewhat higher than the average for metalworking industries.

Most forge shop workers are union members. The leading unions in this field include the International Brotherhood of Blacksmiths, Drop Forgers and Helpers (AFL), the United Steelworkers of America (CIO), and the United Automobile, Aircraft and Agricultural Implement Workers of America (CIO).

Some of the more important forge shop occupations are briefly described below.

Helpers (Hammer and Press Crews)

(D. O. T. 6–88.713 and 8–93.71)

The basic entry job on hammer and press crew is that of helper. This worker assists the hammer or press operator in bringing the materials up to the machine and helping in manipulating the metal. On the smaller equipment, the job of helper is often combined with that of heater. It is important to note the generally modest educational requirement for forge shop jobs. Employers usually require no more than an eighth-grade education for helpers and other workers in entry occupations. With experience, these workers can rise to more skilled and better paid jobs.

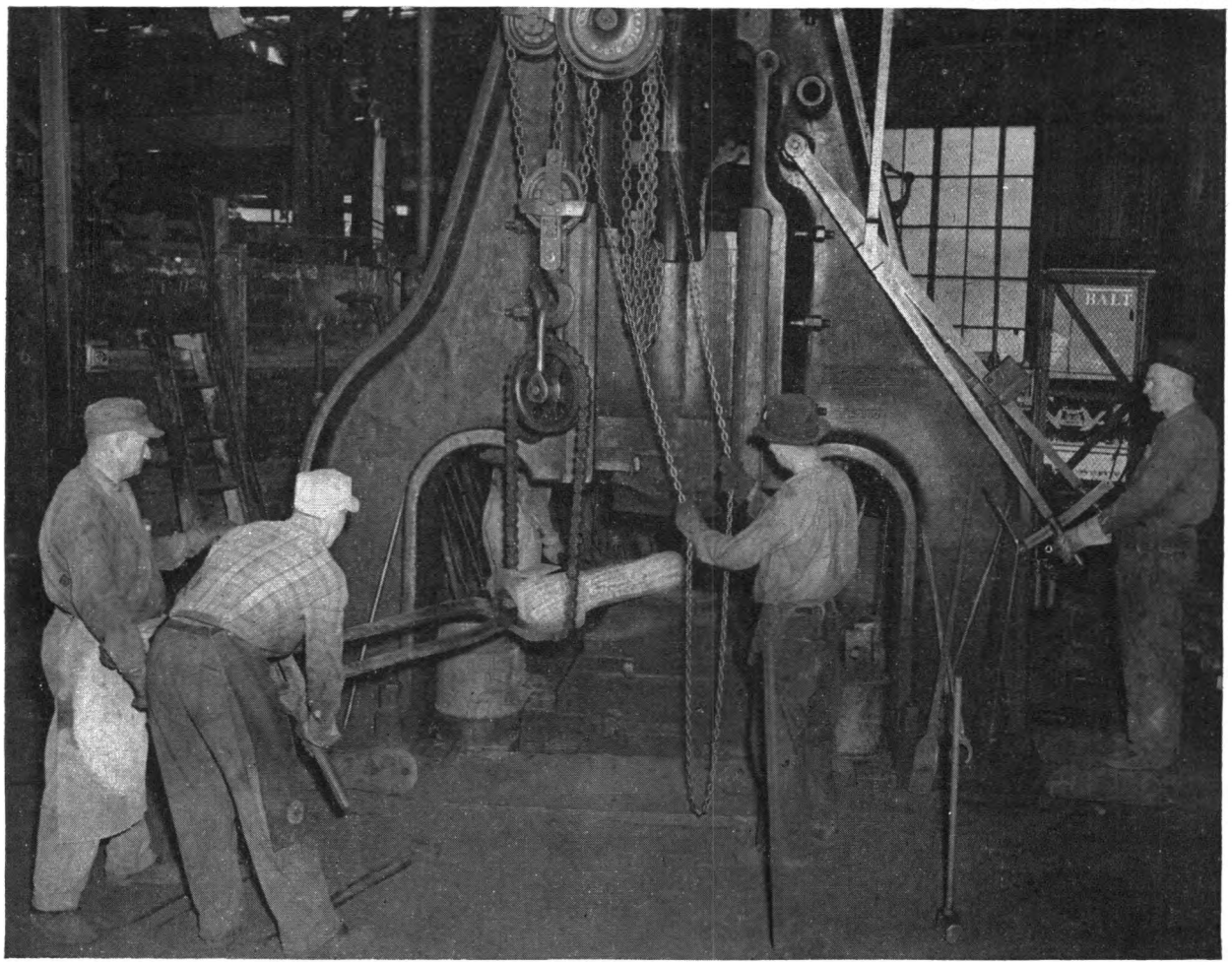
Heaters

(D. O. T. 6–88.732)

When a vacancy occurs, experienced and qualified helpers are upgraded to the job of heater. The heater prepares metal shapes for forging by heating the metal pieces in a furnace. His duties include operating the furnace and feeding fuel to it, controlling the temperature, placing the metal shapes in the furnace, taking them out when properly heated, and transferring them to the forging machine. A growing number of shops require heaters to have some technical knowledge of metallurgy. Experienced heaters are in line for promotion to higher-rated jobs on the hammer crews.

The hammersmith supervises a crew of men.

COURTESY OF NATIONAL ARCHIVES



Hammersmiths

(D. O. T. 4–86.120)

The hammersmith operates a hammer equipped with unshaped (open) dies, used to pound heated metal into required shapes. (This is what the blacksmith does by hand.) This method is employed in forging objects which are too large for closed dies (shaped to form a particular object) or which are needed in quantities too small to justify the expense of making closed dies. The hammersmith supervises several men—for example, an assistant operator (or "hammer driver"), a heater, and one or more helpers assigned to his hammer. The work is generally considered more skilled than closed die forging. In addition to control of the hammer stroke and careful manipulation of the heated metal under the die, the job requires a knowledge of forging practice, blueprint reading, properties of metals, and shop arithmetic.

At least several years of forge shop experience in lower-grade jobs is required to become a hammersmith. It is usual to begin as a helper. An experienced helper, who shows the needed aptitudes, may be promoted to the job of heater, and thence to assistant operator. Hammersmiths are selected from among the more experienced assistants.

Drop-Hammer Operators

(D. O. T. 4–86.120)

A drop hammer is a kind of forging machine which pounds metal into various shapes between closed (shaped) dies. The operator directs the work of the heater and supervises any helpers assigned to his hammer. He may also direct his crew in setting up the hammer. The two principal types of hammers are steam and board. The operators of steam hammers are generally considered more skilled than those on board hammers. On both types of hammers, the skill required usually tends to increase with the size of the hammer and the complexity of the object to be forged. Men can transfer from one type of hammer to another only with an additional period of training. Because of their greater skill, steam-hammer operators can more readily transfer to board hammers than board-hammer operators to steam.

Drop-hammer operator jobs are filled by upgrading experienced heaters. Usually a minimum of 2 to 4 years' experience in the forge shop is required.

Upsettermen

(D. O. T. 4–86.125)

The upsettermen in forge shops operate upsetter forging machines used to form metal between closed dies (shaped to make a particular object) which move horizontally, pressing the metal along its greatest length. This action causes the metal to spread along its other dimensions, until it takes on the required form. The upsetterman directs a small crew, consisting of a heater and helpers assigned to his machine. He must know how to control the heating operation, to adjust the machine's pressure on the metal, and to position the metal stock between the dies. In general, the larger the object forged, the greater the skill required. Several years' work experience is generally needed to learn upset forging; heaters generally are upgraded to fill vacancies.

Forging-Press Operators

(D. O. T. 4-86.125)

These workers operate forging presses, which shape metal by squeezing it between either closed (shaped) or open (unshaped) dies. Open die press forging, which generally requires considerably more skill than closed die work, is used where a relatively small number of large pieces are required. In open die press forging, the operator shapes the heated metal by manipulating it under an unshaped die (making his job comparable in skill to that of the hammersmith). He usually supervises a crew of at least several workers. Closed die presses are mainly used where large quantities of relatively small forgings—either steel or nonferrous—are needed. The closed die-press operator may supervise a small crew or may work alone. Both kinds of press operators must know how to control the heating of the metal, to regulate the pressure of the machine, and to position the work in the dies. Duties may also include setting up the press.

To become an open die-press operator, the worker begins as a helper on a press crew and progresses to higher-rated jobs as vacancies occur; it usually takes at least several years to rise to the job of operator. Closed die work can be learned more quickly. Where crews are used, the worker starts as a helper. Where one man operates the press, inexperienced men, or workers in lower-rated jobs elsewhere in the shop, are assigned as trainees.

Other Forge Shop Workers

One of the larger groups of forge shop workers are *inspectors*. Some inspectors examine forged pieces for flaws and faulty workmanship while the forgings are still hot. Others inspect forgings after trimming, checking dimensions and appearance to determine whether required standards and specifications are met.

Another group of forge shop occupations is in the cleaning and finishing departments. *Trimmers* remove excess metal with a saw or trimming press. *Chippers* and *grinders* remove surplus metal and imperfections by means of pneumatic or hand hammers and chisels or by using a mechanically powered abrasive wheel. *Blasters* operate sandblasting or shotblasting equipment to clean and smooth forgings. *Picklers* dip forgings in an acid solution to remove scale. *Heat treaters*, by controlled heating and cooling of the forged pieces, alter the physical properties of forgings to produce a specified degree of hardness and strength.

OTHER METALWORKING OCCUPATIONS

Arc and Gas Welders

(D. O. T. 4–85.020, .030: 6–85.080)

Outlook Summary

Employment is expected to rise over the long run. During the early fifties, job openings should be particularly numerous.

Nature of Work

In electric arc and gas welding, metal parts are joined through the application of heat intense enough to melt the edges to be joined. The welder controls the melting by properly directing the heat, either from an electric arc or from a gas welding torch, and adds filler metal where necessary to complete the joint.

In hand arc welding, the most commonly used method, the welder "strikes" an arc by touching the metal part to be welded with an electrode and then withdrawing the electrode a short distance. The arc results when the electric circuit is broken by withdrawing the electrode making the current jump the gap between the metal to be welded and the electrode. The welder then guides the electrode along the joint to be welded, holding it at the proper arc length.

In gas welding, the welder directs the flame from a gas welding torch along the joint to be welded. The flame is usually produced by combustion of oxygen and acetylene or other fuel gases. The welder must know how to light and adjust the torch for various metals and kinds of welds.

Experienced arc and gas welders should be able to make various kinds of welds in different metals, work from different positions, and read welding symbols.

To a considerable extent, particularly in maintenance and repair work, welding is done by members of other crafts. The boilermaker, the structural steel worker, the machinist, and the automobile mechanic, all may be required to know and perform welding in their work. Typically, however, in production work, welding is done by workers who specialize in its application. No matter where he works, the skilled welder should have some practical knowledge of the fabricating and assembling operations in the field of work in which he is engaged. For example, a welder working in a shipyard should know in general how ships are put together, or one employed in a boiler shop should understand how boilers are assembled. If the welder moves into a type of work in which he is not experienced, some of the basic practices in the new field must be learned.

Training and Qualification

A course in welding methods, usually in public or private vocational schools, followed by extensive job experience, has been the common way for skilled welders to receive their training. During World War II, there were a number of "training-within industry" programs which have been continued in areas where there is a fairly large demand for welders and training facilities in schools are not readily available. Formal apprenticeships in welding alone are not often found. Frequently, welders doing the simpler repetitive types of work are trained on the job, without any special instruction, in about 6 months. To become an all-round skilled welder, regular course instruction in welding is desirable, either in public or private vocational schools or in courses conducted by industrial firms to train their workers. Before enrolling in a private school, the prospective student should check with the local educational authorities about the quality of the instructions offered. The American Welding Society has issued codes of recommended standards for welding courses which provide for a minimum of 150 hours of actual welding practice under qualified instructors and not less than 20 hours of class instruction in welding theory. Experience has shown that a longer learning time is usually required.

Since a poor weld may have serious consequences in the failure of the completed product when in use, welders are usually required to have passed qualification tests established by the American

Welding Society. Requirements are administered by insurance companies, employers, and inspection agencies as specified by the applicable code. In addition, welders must be licensed to do certain types of construction work in some localities.

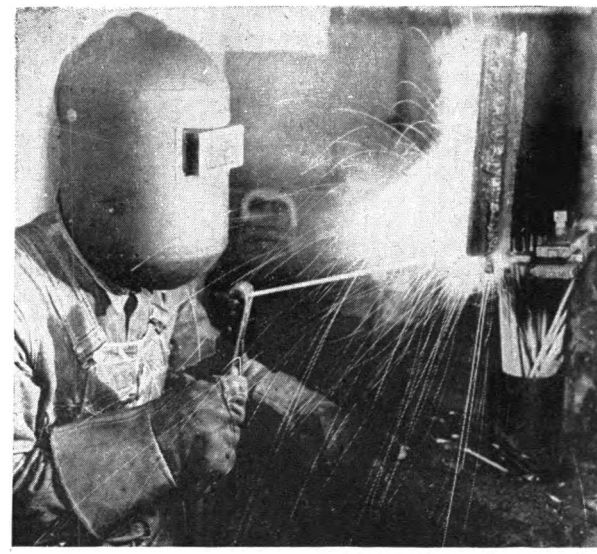
Where Employed

Welding jobs are found in a wide range of industries. Most welding jobs, however, are in production work in the metal products industries; the leading employers are those making machinery, automobiles, electrical equipment, ships, aircraft, boilers and tanks, and fabricated structural steel. Examples of places where welders are used mainly in maintenance work are railroad shops, electric power plants, street railway systems, paper mills, foundries, and chemical plants. A large number of welders work in local repair shops that either specialize in welding or do general metal repair work. Usually these are small shops, and very often they are owned and operated by individual welders, with perhaps several employees to assist. These shops serve mainly their local communities, repairing such things as farm equipment, automobile parts, and industrial machinery, and making welded products on a subcontract basis for local manufacturing plants.

Because of their wide employment among different industries, jobs for welders are found in all sections of the country. Many of the jobs are concentrated in the industrial centers in the Midwestern and Northeastern States, where the machinery, automobile, and electrical equipment plants are mainly located. Some companies often have openings in foreign countries for employment on pipeline work and similar construction.

Outlook

During the early fifties, there will be many openings for welders. Expanding defense requirements in such industries as aircraft, ordnance, machinery, iron and steel, and electrical equipment will substantially increase the need for welders. A very important consideration in the outlook for welders is the extent of shipbuilding and repair activity. At the World War II peak, 180,000 [1] welders had jobs in the shipyards; this was twenty times the prewar (1940) total. Total employment in United States shipyards in August 1950 was less than 150,000—about a twelfth of the World War II peak of 1,700,000. Although no such expansion as occurred in World War II is expected, any large increase in shipyard activity would result in many jobs for welders.



COURTESY OF NATIONAL ARCHIVES

Welders are subject to certain hazards in their work, but these can be almost entirely avoided by proper precautions.

In the long run, prospects are for a gradual growth in the number of jobs for arc and gas welders. The metalworking industries, which employ most of these workers, have a generally favorable long-run outlook. Moreover, new uses for welding are being found, and as a result of new developments in welding, more and more types of material can be welded. This should also mean an increase in the number of arc and gas welding jobs. The gains in employment, however, may not keep pace with the increase in amount of welding done, as techniques become more efficient, fewer man-hours are required to do a job. Especially in production work, new applications of welding methods will call for automatic welding machines which do not have to be operated by skilled hand welders.

Among the less skilled welders, there is considerable shifting of experienced workers into other occupations; this will create opportunities for newcomers. Death and retirement of experienced welders will also provide openings for newcomers; however, this will be a relatively less im-

[1] Estimate includes other types of welders and burners in addition to arc and gas welders as of December 1943.

portant source of jobs than in many other occupations, since the welders are a comparatively young group of workers.

A few experienced, all-round welders will be able to establish their own welding repair and service shops. Prospects for such shops depend upon the situation in the particular community in which the shop is located. Before a new shop is opened the needs of the community and the competition to be faced should be carefully considered.

Earnings and Working Conditions

Recent information is not available on earnings of welders in most of the industries which employ them. Average straight-time hourly earnings of men in arc and gas welding jobs in machinery plants in November 1949, are shown in the accompanying tabulation.

	Class A	Class B
Atlanta	$1.44	$1.16
Baltimore	1.57	1.32
Boston	1.53	1.48
Buffalo	1.63	1.40
Chattanooga	1.61	1.36
Chicago	1.68	1.51
Cincinnati	1.48	1.27
Cleveland	1.80	1.55
Dallas	1.36	1.25
Denver	1.72	----
Detroit	1.81	----
Hartford	1.46	1.46
Houston	1.76	1.76
Indianapolis	1.59	1.58
Los Angeles	1.74	1.43
Milwaukee	1.68	1.58
Minneapolis-St. Paul	1.58	1.53
Newark-Jersey City	1.81	1.57
New York	1.83	----
Philadelphia	1.83	1.68
Pittsburgh	1.63	1.51
Portland, Oreg	1.72	----
Providence	1.48	----
St. Louis	1.89	1.50
Seattle	1.76	----
Syracuse	----	1.66
Tulsa	1.57	1.45
Worcester	1.47	----

Arc and gas welders in passenger car assembly plants received $1.70 an hour, straight-time, in February 1950. In petroluem refineries, average straight-time earnings were $2.02 an hour in September 1948. In the airframe industry in May–June 1949, average straight-time earnings of Class A hand welders (production) were $1.67 an hour, and $1.53 an hour for Class B hand welders (production).

Welders are subject to certain hazards in their work, but these can be almost entirely avoided by proper precautions. Without such precautions arc welders may be exposed to minor skin burns and eye injuries and to electric shock. Similarly, gas welders are subject to the possibility of explosion and fire and, when welding is done in confined spaces, poisonous fumes or gas may be present. These hazards can be largely eliminated, however, by training in safety methods and by the use of proper equipment such as goggles and ventilating devices.

Where To Get Additional Information

Employment Opportunities for Welders. Bulletin No. 844. United States Department of Labor, Bureau of Labor Statistics, 1945. 19 pages. Superintendent of Documents, Washington 25, D. C. Price 10 cents.

Acetylene Burners

(D. O. T. 6–86.215)

Outlook Summary

Increasing employment in this relatively small field is anticipated during the early fifties.

Nature of Work

Acetylene burners (also referred to as "oxygen cutters"), use an oxyacetylene torch to cut or trim metal objects to the desired size or shape. The oxygen cutting equipment generally consists of a torch into which oxygen and acetylene gas are fed from hoses connected with the gas supply. The ignited acetylene, which serves as the fuel gas, heats the metal, and jets of oxygen do the actual cutting.

Torch tips, through which the flames are directed, come in various sizes, depending upon the nature of the cutting jobs. The operator prepares

for the cutting job by attaching the proper torch tip for the particular job, connecting the torch to the gas hoses, and regulating the flow of gases into the torch for the desired cutting flame. He then guides the torch manually along previously marked lines or, following a template or pattern, cuts through the metal. In some cases, he marks the lines on the metal himself, following blueprints or other instructions. In other cases, the cutting torch or torches are mounted on a machine which by electronic or mechanical means automatically follows the proper line of cut.

Training and Qualifications

Acetylene burners are semiskilled workers. Newcomers usually learn the work in a relatively short period of on-the-job training. Experienced acetylene gas welders can easily qualify for jobs as burners, if they desire, since theirs is a more skilled job and covers all the things that the burner has to know.

Where Employed

Acetylene burners are generally employed in plants where operations include cutting steel plates to size, removing metal from castings, trimming rough steel shapes, and cutting up scrap metal. Among the principal employers of acetylene burners are the shipbuilding, steel, machinery, fabricated structural steel, and boiler shop industries. Many are also employed by firms that prepare and sell scrap metal to be re-used in steel mills and foundries.

Outlook

The number of jobs for acetylene burners is expected to rise during the early fifties as a result of expanding military requirements in the industries employing these workers. A substantial revival of shipbuilding, for example, would result in many openings in this occupation. Over the longer run, increased use of oxygen cutting machines will hold down increases in employment of burners, even when metalworking activity is expanding. In addition to any increase in employment, replacement needs will provide some openings for new workers in this relatively small field.

See also Arc and Gas Welders, page 212.

Resistance Welders

(D. O. T. 6–85.010, .020, .030, .060, and .100)

Outlook Summary

There will be many openings for resistance welders during the early fifties.

Nature of Work

Resistance welders, unlike hand arc and gas welders, who use manual methods, are operators of resistance welding machines. These machines fuse metal part by bringing them together under heat and pressure. The pieces of metal to be joined are pressed between two electrodes through which electric current is passing. The parts being welded offer sufficient resistance to the flow of current to create intense heat, which, together with the pressure, fuses them together. The principal types of resistance welding machines are the spot, seam, projection, flash, and upset welding machines and portable spot welding guns. The supervisor, or in some cases the operator, sets the controls of the machine for the desired electric current and pressure. The operator mainly feeds and aligns the work, starts the machine, and then removes the work when it is finished. The machines that weld automobile bodies are large and highly automatic, while smaller and less-automatic machines are used to assemble such products as metal furniture.

Most resistance welding operators learn their work on the job in a relatively short time. The length of the learning period depends upon the scope of the duties. Some welding operators, following general directions, insert the proper electrodes and regulate and adjust the welding machine each time a different welding operation is begun. To do this, a welder should learn the meaning of welding symbols, the characteristics of different metals, and how to select and install the electrodes. In most welding jobs, however, the machine is set up and adjusted for the welding operator, and the welding is simple and repetitive. Beginners can learn these jobs in a month or two.

Where Employed

Resistance welding operators are employed almost entirely in metal-working industries, particularly in plants assembling large quantities of products made of sheet metal and intended for the final consumer rather than as equipment to be used in factories. Thus, most of the jobs are in the industries making automobiles, aircraft, machinery, ordnance, electrical household appliances, refrigerators, metal furniture, and similar products. Some are also employed in machinery, industrial electrical equipment, and aircraft plants. Because metalworking employment is concentrated in the Midwest and Northeast, most of the jobs are located in these regions.

Outlook

There will be many openings for resistance welders during the early fifties. Expanding defense requirements in many industries which employ large numbers of resistance welders will result in rising employment in this occupation.

Over the longer run, a gradual upward trend in employment is in prospect. Opportunities for these workers depend upon prospects in the metalworking industries and the extent to which resistance welding becomes widely used. The metalworking industries, which employ most of the workers in the occupation, are expected to increase their activity over the long run. In recent years, rapid progress has been made in improving resistance welding methods and in spreading its use to more products. For example, only during the thirties did welding become extensively used in assembling automobiles, although now it is a very important part of the process. About 15,000 welders were employed in passenger car plants in 1950, of which over two-thirds were resistance welders. Further gains in the use of resistance welding are expected. The resulting rise in the employment of machine welders will be limited, however, by a trend toward the use of more rapid and highly automatic machines. There is likely to be a sizable number of job openings, however, because, as is the case in many semi-skilled occupations, transfer of experienced workers to other fields is relatively common.

Earnings and Working Conditions

Earnings usually range somewhat below those of arc welders and skilled machine-tool operators. In February 1950, average straight-time hourly earnings in passenger automobile plants were: gun welders, $1.64; spot welders, $1.62; and machine welders, $1.57.

The hazards connected with resistance welding are not great, and generally the working conditions compare favorably with those in other metalworking operations.

Where To Get Additional Information

Employment Opportunities for Welders. Bulletin No. 844. United States Department of Labor, Bureau of Labor Statistics, 1945. 19 pages. Superintendent of Documents, Washington 25, D. C. Price, 10 cents.

Assemblers (Machinery Manufacturing)

(D. O. T. 4–75.120; 6–78.632)

Outlook Summary

This occupation will provide many job opportunities for new workers during the fifties.

Nature of Work

These workers assemble machinery parts to form complete units, such as a machine tool or Diesel engine, or subassemblies such as a gear box or fuel pump. *Floor assemblers* put together heavy machinery or equipment on shop floors, fitting and finishing parts with hand and power tools and fastening them together with bolts, screws, or rivets. *Bench assemblers* assemble machinery parts into subassemblies or small complete units while working at a bench. Skilled assemblers work on the more complex machines and subassemblies with little or no supervision. They must know how to read blueprints and how to use precision measuring instruments and various hand and power tools, such as scrapers, chisels, files, and drill presses. The less-skilled assemblers do repetitive operations under close supervision and are generally not responsible for the final assembling of complex jobs.

Where Employed

Assemblers are employed in a wide variety of nonelectrical machinery plants, including those which make machine tools, pumping equipment, tractors, refrigerators, business machines, and internal combustion engines.

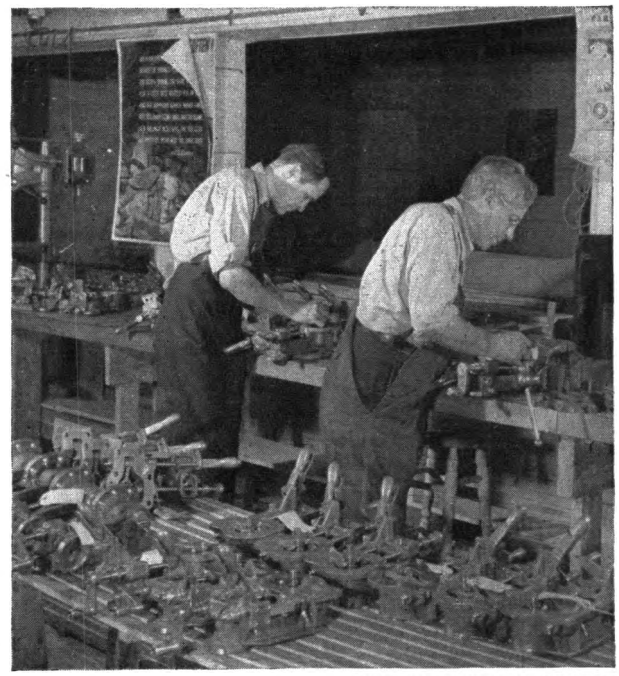
Assemblers work in machinery plants throughout the country. Most of the jobs for these workers are concentrated in the Midwest and Northeast, particularly in Ohio, Illinois, Pennsylvania, Michigan, New York, and Wisconsin.

Training and Qualifications

For the more-skilled assembling jobs, machinists and others with experience are usually employed. Inexperienced workers may be hired as trainees or helpers and trained on the job to do the less-skilled assembling.

Assemblers usually specialize on one type of machinery or equipment. Often they cannot readily transfer to assembly of other products, or even of similar products in other plants, without additional training.

	Class A	Class B	Class C
Atlanta	$1.54	$1.10	--------
Baltimore	1.60	1.46	$1.17
Boston	1.62	1.44	1.32
Buffalo	1.47	1.38	--------
Chattanooga	1.50	1.47	1.07
Chicago	1.69	1.52	1.33
Cincinnati	1.47	1.34	1.06
Cleveland	1.76	1.61	1.33
Dallas	1.39	--------	--------
Denver	1.63	1.31	--------
Detroit	1.81	1.57	1.48
Hartford	1.58	1.40	1.23
Houston	1.63	1.41	--------
Indianapolis	1.50	1.47	--------
Los Angeles	1.62	1.47	1.15
Milwaukee	1.72	1.60	1.58
Minneapolis-St. Paul	1.57	1.52	1.22
Newark-Jersey City	1.80	1.52	1.32
New York	1.81	1.55	1.29
Philadelphia	1.63	1.49	1.44
Pittsburgh	--------	1.66	1.36
Portland, Oreg	1.71	1.58	1.23
Providence	1.41	1.28	1.09
St. Louis	1.63	1.35	1.16
Seattle	1.79	--------	--------
Syracuse	1.67	1.53	1.52
Tulsa	1.37	1.20	1.12
Worcester	1.57	1.67	1.11



COURTESY OF NATIONAL ARCHIVES

Bench assemblers fit together and assemble small machinery parts into complete units or subassemblies.

Much of the work in bench assembling is relatively light, and women are often employed in the less-skilled jobs.

Outlook

The number of jobs for assemblers is expected to rise substantially during the early fifties as the machinery industries expand to meet defense requirements. The outlook, in the longer run, is for continued growth in employment. The machinery industries which employ these workers have had a long-range upward trend in employment; in July 1950, production workers in nonelectrical machinery manufacture totaled about 1,000,000, which was over 50 percent above the 1929 level.

In addition to the new openings that may be created by the expected increase in employment, replacement needs will provide a considerable number of job opportunities for new workers. This is a relatively large occupation—about 100,000 jobs in the fall of 1949. Death and retirement of experienced workers should provide approximately 1,500 to 2,500 job openings annually. Moreover, shifting into other occupations is common among the less-skilled assemblers and many job opportunities will be created in this way. Re-

placements will also be needed for assemblers called up for military service.

Although the long-range outlook is generally favorable, it should be noted that machinery manufacturing industries are extremely sensitive to the business cycle and to changing military needs; the past trend of employment, while upward, has been marked by extreme ups and downs. Compared to manufacturing as a whole, the machinery industries are particularly hard hit during depressions. Between 1929 and 1932, for example, the number of wage earners in the nonelectrical machinery industries dropped by about 55 percent while manufacturing employment as a whole declined by only 38 percent.

Earnings and Working Conditions

Earnings of assemblers vary widely, depending on their skill grade, the type of product assembled, the size and location of the plant in which they are employed, and whether they are paid on an incentive basis. Average straight-time hourly earnings of male assemblers in machinery plants in November 1949, for selected large cities are shown in the accompanying tabulation. These earnings exclude premium pay for overtime and night work.

Most assemblers are members of unions. There are several labor organizations in the field, including the International Association of Machinists (Ind.), the International Union of Electrical, Radio and Machine Workers of America (CIO), and the United Automobile Aircraft and Agricultural Implement Workers of America (CIO).

Working conditions for assemblers are usually good compared with factory work in general. Their places of work, generally, are relatively clean, well-lighted, and free from dust.

See also Machine Shop occupations, p. 186.

Inspectors (Machinery Manufacturing)

(D. O. T. 4–78.671; 6–78.671)

Outlook Summary

Rising employment is expected in this occupation during the first part of the fifties.

Duties and Training

These workers examine complete units of machinery (such as turret lathes), subassemblies (such as starter mechanisms), or individual metal parts. They look for various defects, checking dimensions and appearance against required standards and specifications. The more skilled inspectors work with little or no supervision and examine either a variety of parts or relatively complex units. They must be able to read blueprints and interpret specifications. Often they are required to use such measuring devices as calipers, gages, and micrometers. Skilled inspectors usually must have a general knowledge of machining and other metalworking processes. The less skilled inspectors inspect large numbers of identical parts or relatively simple products under close supervision. Often they use specially prepared gages and other measuring instruments which greatly simplify inspection.

Where Employed

Inspectors are employed in a wide variety of nonelectrical machinery plants, including those which make machine tools, tractors, refrigerators, internal combustion engines, and business machines.

They work in machinery plants throughout the country. Most of the jobs for these workers are concentrated in industrial centers of the Midwest and Northeast, particularly Ohio, Illinois, Pennsylvania, Michigan, New York, and Wisconsin.

Training and Qualifications

Skilled inspectors are obtained from the ranks of metal-processing workers, such as machine tool operators, or by upgrading less-skilled inspectors. Inexperienced workers are often hired for the less-skilled jobs and taught to do repetitive inspection in a brief period of on-the-job training. The work is not strenuous and many women are employed as inspectors. Because of the nature of the work, good eyesight is generally required.

Inspectors usually specialize on one type of product; often they cannot readily transfer to in-

spection of other products, or even similar products in other plants, without additional training.

Outlook

The number of jobs for inspectors is expected to rise substantially during the early fifties as the machinery industries expand to meet defense requirements. In late 1949, machinery plants employed about 30,000 inspectors. The outlook, in the longer run, is for continued growth in employment. The machinery industries which employ these workers have had a long-range upward trend in employment; in July 1950, production workers in nonelectrical machinery manufacture totaled about 1,000,000 which was over 50 percent above the 1929 level.

In addition to the new jobs that will be created by increases in employment, replacement needs will provide job opportunities for new workers. Death and retirement of experienced inspectors should provide about 500 to 700 job openings annually. Moreover, shifting into other occupations is common among the less skilled inspectors and job opportunities will be created in this way. Replacements will also be needed for workers called up for military service.

Although long-range employment prospects are generally favorable, it should be noted that machinery manufacturing is extremely sensitive to the business cycle; the past trend of employment, while upward, has been marked by extreme fluctuations. Compared to manufacturing as a whole, the machinery industries are particularly hard hit during depressions.

Earnings and Working Conditions

Earnings of inspectors vary considerably, depending on their skill, grade, the type of product inspected, and the size and location of the plant in which they are employed. Average straight-time hourly earnings of male inspectors in machinery plants in selected large cities in November 1949 are shown in the following tabulation. These earnings exclude premium pay for overtime and night work.

City	Class A	Class B	Class C
Baltimore	$1.51	$1.38	$1.21
Boston	1.67	1.46	1.29
Buffalo	1.64	1.38	----
Chattanooga	1.50	----	----
Chicago	1.72	1.48	1.32
Cincinnati	1.48	1.32	----
Cleveland	1.73	1.61	1.47
Dallas	1.59	----	----
Detroit	1.98	1.64	1.45
Hartford	1.57	1.32	1.24
Houston	1.75	----	1.41
Indianapolis	1.63	1.49	----
Los Angeles	1.73	1.41	1.38
Milwaukee	1.66	1.55	1.37
Minneapolis–St. Paul	1.65	1.37	----
Newark–Jersey City	1.65	1.46	1.20
New York	1.82	1.45	1.23
Philadelphia	1.77	1.51	1.32
Pittsburgh	----	1.77	----
Providence	1.48	1.32	1.11
St. Louis	1.54	1.37	----
Syracuse	1.54	1.35	1.21
Tulsa	1.40	1.19	----
Worcester	1.53	1.41	----

Most inspectors are members of unions. There are several labor organizations in the field. Among such organizations are the International Association of Machinists (AFL), the International Union of Electrical, Radio and Machine Workers (CIO), and the United Automobile, Aircraft and Agricultural Implement Workers of America (CIO).

Working conditions for inspectors are usually good compared with factory work in general. Their places of work, generally, are relatively clean, well-lighted, and free from dust.

See also Machine Shop Occupations, page 186.

Blacksmiths

(D.O.T. 4–86.010)

Outlook Summary

Long-run prospects are for little change in the employment of blacksmiths. Replacement needs will provide some opportunities for new workers.

Nature of Work

Blacksmiths use mainly hand methods to shape and repair metal articles and parts. They heat metal in a forge and hand-hammer the metal on an anvil into the desired shape. They also forge-weld metal by heating the pieces and hammering them together; sharpen tools such as chisels, drills, and picks by heating them and hammering the cutting edges to proper shape; and heat-treat metal articles to improve their physical properties.

Where Employed

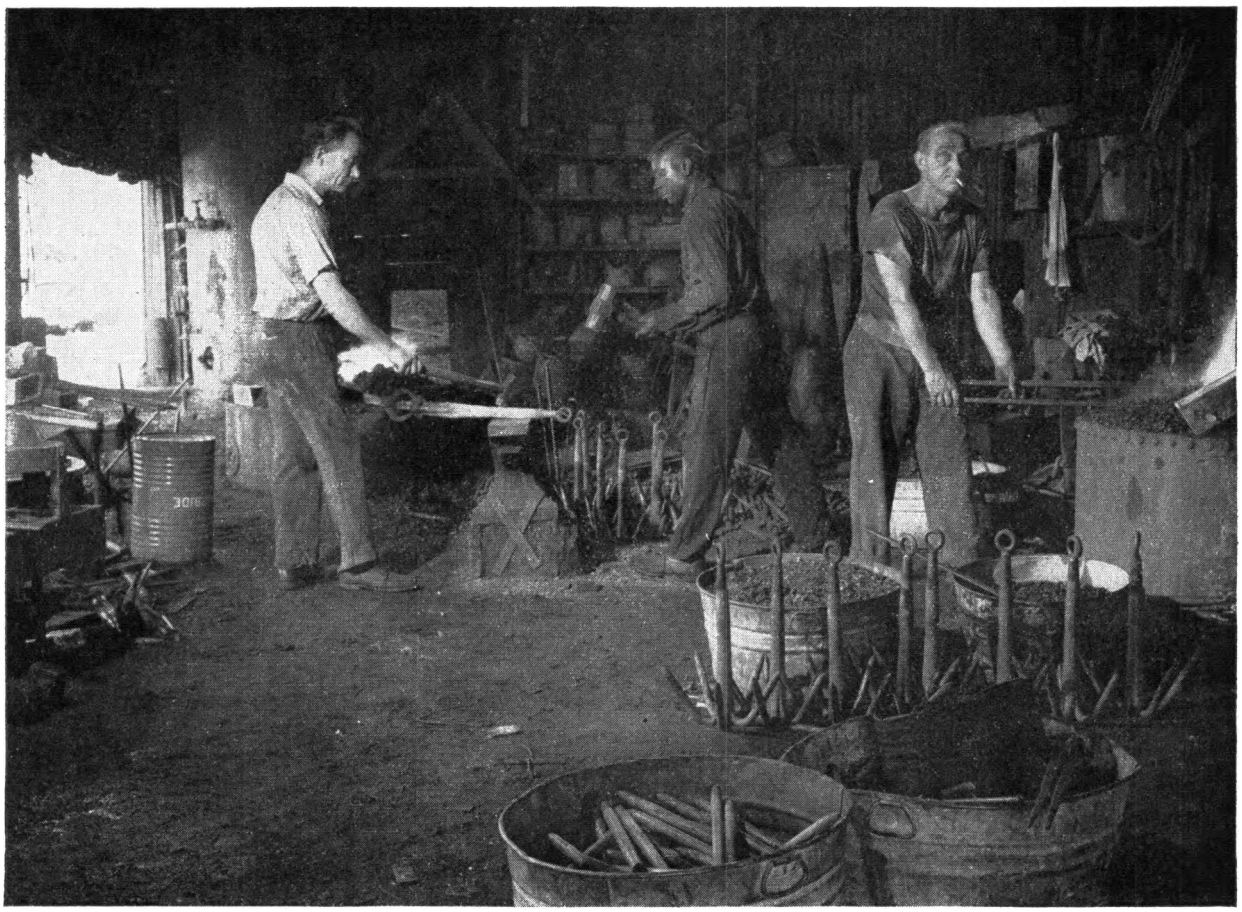
Most blacksmiths work in small shops which repair farm and garden equipment, tools, automobile parts, and household articles. Often these shops perform other services, such as welding and tool dressing; a few shoe horses. Many blacksmiths are self-employed, operating their own shops.

Other blacksmiths are employed in maintenance and repair departments in metalworking plants, in railroad repair shops, and in coal and metal mining.

Blacksmiths are found in all parts of the country, many in small rural communities as well as in large industrial centers.

Blacksmiths use mainly hand methods to shape and repair metal articles and parts.

COURTESY OF NATIONAL ARCHIVES



Training and Qualifications

Some workers enter this occupation through apprenticeship, others by picking up the trade while working as laborers or helpers in blacksmith shops. The apprenticeship period is generally 3 or 4 years and customarily includes blueprint reading, training in the use of tools and equipment, heat-treating metal, forging methods, and welding.

Considerable physical strength is required in order to pound metal into shape and to handle heavy metal parts.

Outlook

There will be a small number of openings for new workers in this occupation. Few young men have entered the occupation in the last several decades.

A large proportion of the men now engaged in the trade are of relatively advanced age, nearing the time when they will have to be replaced. Openings for new workers will occur because of this replacement demand rather than because of expanding employment.

Prospects for those entering the occupation are for continued employment over a long period. About 40,000 blacksmiths were employed in 1940, substantially fewer than 20 or 30 years before. However, there has been little change in employment in recent years and no further decline is anticipated. The number of blacksmiths working in small repair shops is expected to remain stable because of the diversified demands for their services and the importance of blacksmithing in local communities. Since blacksmiths employed in manufacturing plants, railroads, and mines generally do maintenance work, which tends to be fairly steady, there should not be much fluctuation in the number of jobs for these workers.

Boilermakers

(D. O. T. 4–83.100)

Outlook Summary

The number of boilermakers is expected to rise during the early fifties as a result of expanding defense requirements. Over the longer run, a moderate downward trend in employment is likely. Replacement needs, however, will provide openings for new workers.

Nature of Work

Boilermakers fabricate, assemble, and repair boilers, tanks, vats, smoke stacks, and similar products made of heavy steel plate. Their work involves such duties as planning and laying out work from blueprints or specifications; cutting plate to size and shape with power shears or acetylene burners; shaping plates on power presses; assembling parts by bolting, riveting, or welding; and calking seams and rivet heads. Many men qualified as all-round boilermakers, however, specialize in a single boiler-shop function, such as welding. Some of the most skilled boilermakers do only lay-out work—marking the steel plates to show other workers where the metal is to be sheared, welded, bent, or otherwise fabricated.

Where Employed

Boilermakers are employed in railroad repair shops, construction projects, boiler repair shops, and electric power plants throughout the country; in boiler shop products plants concentrated in the Great Lakes, Middle Atlantic, and Pacific Coast areas; in coastal shipyards; and in the oil refining areas of Texas, Pennsylvania, California, New York, and other States. Other industries employing boilermakers include steel, chemicals, and machinery.

Training and Qualifications

To become an all-round boilermaker, a 4-year apprenticeship or equivalent on-the-job training is usually required. Welders, helpers, and other boiler-shop workers sometimes have the opportunity to learn the trade without serving an apprenticeship. Much of the boilermaker's work is fairly strenuous and at least average physical strength is needed.

Outlook

The number of jobs for boilermakers is expected to rise during the early fifties as a result of expand-

ing defense requirements. A substantial revival of shipbuilding, for example, would result in many openings in this occupation. Over the longer run, however, prospects are not as favorable. There has been a downward trend in boilermaker employment over the last three decades. In 1940, the Census counted about 33,000 boilermakers in the labor force (employed or seeking work); this was only about half the number reported in 1920. In early 1950, the number of boilermakers employed was somewhat higher than prewar, but below the wartime peak, when many boilermakers were working in shipyards. Many of these wartime workers had been quickly trained in some part of boilermaking and were not all-round boilermakers. After being released from the shipyards at the end of the war, many of these less-skilled men went into other lines of work.

In railroad repair shops—the leading source of jobs for boilermakers in peacetime—employment of these workers has decreased steadily since World War II. Class I railroads employed an average of about 13,500 boilermakers in 1946; in 1948, they employed about 12,000. In June 1950, the number was about 9,800—about the prewar level.

There have been two main factors responsible for the decline in employment in this occupation. One has been the general tendency in boilermaking operations to utilize specialized workers (such as welders) to do the various parts of the boilermaker job, thereby reducing the need for all-round boilermakers. The other has been the specific trend toward less boilermaking work in the construction and repair of railroad equipment; this is a direct result of the increasing use of Diesel and electric locomotives in place of steam locomotives. In contrast to work on steam locomotives, relatively few boilermakers are used in making and repairing the Diesel and electric types. Both factors are expected to continue to operate in the future, so that further declines in the number of boilermaking jobs is likely over the long run.

In spite of the expected drop in the number of jobs, over the long run there should be opportunities for a number of new workers to enter this occupation. A high proportion of the experienced boilermakers are older men who will be leaving the labor force; deaths and retirements during the 1950–60 decade may total something in the order of 10,000, or nearly a third of the number of experienced boilermakers in 1940. Other replacements will be necessary for men shifting to jobs in other fields or entering military service. This indicates that replacement needs may be considerably greater than any probable reduction in employment. Moreover, men trained in all-round boilermaking will have some opportunities to get specialized boilermaking jobs, since they are preferred by most employers to the men qualified in only one part of the work.

Earnings and Working Conditions

Earnings of boilermakers vary among the industries in which they are employed. In September 1949, the wage rate for boilermakers working for steam railroads was generally about $1.74 an hour. In construction work, in July 1949, the average hourly wage rate of union journeyman boilermakers in 77 cities was $2.39. Recent wage data are not available for boilermakers employed in other industries.

Boilermaking tends to be more hazardous than most other metalworking occupations. The injury frequency rate in the boiler-shop-products industry is considerably higher than the average for manufacturing industries as a whole.

Boilermakers are generally unionized. A large number are members of the International Brotherhood of Boilermakers, Iron Shipbuilders and Helpers of America (AFL); others have been organized by industrial unions, such as the United Steelworkers of America (CIO) and the Industrial Union of Marine and Shipbuilding Workers of America (CIO).

See also Arc and Gas Welders, page 212. Railroad shop trades, page 426.

Millwrights

(D. O. T. 5–78.100)

Outlook Summary

Long-run prospects are for a fairly stable level of employment in this occupation. Some increase is probable during the early fifties as new plants and equipment are added to meet expanding defense needs.

Nature of Work

The job of a millwright is to install, dismantle, move, and set up heavy machinery and industrial equipment. Millwrights also prepare the platforms on which machines are mounted and help plan the location of new equipment in the plant. They sometimes perform some of the duties of industrial machinery repairmen in addition to their regular work. They should have considerable knowledge of the structure and operation of the equipment on which they work. Millwrights usually specialize on particular types of industrial machinery, such as paper-mill machinery or machine tools.

Where Employed

Millwrights are employed in most manufacturing plants which use heavy machinery and equipment. Many of these workers are in the metalworking industries, such as machinery, automobiles, and iron and steel. Automobile plants alone employed about 4,000 in early 1950. Other large groups are employed in various nonmetal industries, including pulp-and-paper mills, sawmills, and flour mills. Some millwrights are employed by building contractors in the installation of machinery and equipment in new factory buildings. A small number work for machinery manufacturers who do the installation of their machinery in customers' plants.

Millwrights work in every State. However, most of the millwright jobs are in the major industrial areas of the Midwest and Northeast, with Michigan, Ohio, Pennsylvania, New York, and Illinois the leading States.

Training and Qualifications

Entry into this occupation is usually through a millwright apprenticeship or equivalent on-the-job training. The apprenticeship period is generally 4 years and the training customarily includes blueprint reading; use of hoisting equipment; installation, assembly, and repair of industrial machinery and equipment; and acetylene burning. However, inexperienced workers may be hired as helpers or laborers and pick up the occupation while working.

Outlook

Some increase in the number of millwrights is probable during the early fifties, as new plants and equipment are added to meet expanding defense needs. In late 1949, the number of millwrights was well above prewar (1940), when about 40,000 were employed. A major factor in the high postwar level of employment of millwrights has been the large expenditure made by industry for new plants and equipment during the last few years.

The outlook in the longer-run is for a fairly stable level of employment in this occupation. Although new plant and equipment expenditures may fall off somewhat, employment is expected to hold up fairly well. These workers have continuing functions in plants using heavy equipment, in connection with repair and rearrangement of the equipment. Moreover, the growing mechanization of industry has a tendency to expand the need for millwrights. Job opportunities for new workers will result mainly from the need to replace experienced millwrights who switch to other jobs, retire, or die. Death and retirement alone may create about 1,000 openings each year.

Earnings and Working Conditions

Recent information on wages for most industries employing millwrights is not available. However, average straight-time hourly earnings for millwrights employed in passenger car manufacturing plants in February 1950, were $1.80. In a wage agreement made in July 1948 between the United States Steel Corp. and the United Steelworkers of America (CIO), a standard hourly rate of $1.77 was specified for millwrights in iron and steel plants.

Millwrights are generally unionized. Their un-

ion affiliation varies according to the industry in which they are employed. Some of the more important unions include the International Association of Machinists (Ind.); United Steelworkers of America (CIO); United Automobile Aircraft and Agricultural Implement Workers of America, International Union (CIO); International Brotherhood of Carpenters and Joiners (AFL); and International Brotherhood of Pulp Sulphite and Paper Mill Workers (AFL).

See also Industrial Machinery Repairmen, p. 180.

Riveters, Pneumatic (Manufacturing)

(D. O. T. 4-84.060; 6-95.080 and .082)

Outlook Summary

Employment of riveters is expected to decline gradually over the long run. However, prospects in the early fifties are more favorable.

Nature of Work

These workers use riveting equipment which is driven by compressed air to fasten together metal parts. Pneumatic hammers are most commonly used, although specialized pneumatic-riveting machines are used in some manufacturing plants. Where heavy steel plates have to be fastened, as in ship construction, the large rivets which are used must be heated before they are hammered. In hot riveting, the riveter is assisted by a rivet heater and a worker usually called a bucker who backs up the rivet while it is being hammered by the riveter. Rivet heaters are not needed in cold-riveting and some pneumatic-riveting equipment, especially in aircraft plants, can be operated by the riveter alone.

Pneumatic riveters who are employed in manufacturing industries are found mainly in plants making aircraft, industrial cars and trucks, and agricultural equipment; boilermaking shops; locomotive and car-building and repairing shops; and shipyards.

The more skilled riveters do many types of work; they must be able to read blueprints, use riveting hammers of varied types and sizes, and select appropriate hammers, dies, and rivets. Some of the more skilled riveting in certain industries, boilermaking and shipbuilding, for example, is done by journeymen qualified in other occupations, such as structural iron workers, boilermakers, and sheet metal workers. However, most riveters in manufacturing plants do repetitive work which does not call for the skills of the all-round riveter.

The less skilled pneumatic riveters are generally trained in several months on the job. Boilermakers, sheet metal workers, and other journeymen who do skilled riveting have had formal apprenticeships in their trade or the equivalent in experience.

Outlook

During the early fifties, there will be many openings for new workers in this occupation to meet the needs of the expanding aircraft and other defense industries employing riveters. Other openings will be created in the event that shipbuilding and repairing are greatly expanded as a matter of national policy.

The long-run outlook is for a gradual decline in the number of riveters. This will result mostly from the substitution of welding for riveting in the fabrication of many products. Welding has been replacing riveting in recent years, and this trend is expected to continue in the future, particularly in the shipbuilding and boilermaking industries. In addition, the development of specialized high speed riveting equipment, especially in the aircraft industry, will permit more work to be done by fewer riveters. However, there will be some job openings for new workers to replace experienced men who leave this occupation.

Earnings and Working Conditions

In airframe plants in May–June 1949, average straight-time hourly earnings of riveters were $1.43 for Class A workers and $1.24 for Class B.

Riveting is noisy work, and much of it is done in cramped positions (for example, inside aircraft fuselages).

See also Aircraft Manufacturing Occupations, p. 273, and Shipbuilding and Ship Repairing Occupations, p. 259.

U. S. GOVERNMENT PRINTING OFFICE: 1953