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S. S. Seattle, of Seattle, owner, United States. Keel laid August 21, 1917. Sailed with cargo January 14, 1918. First vessel completed of those contracted for by the U. S. Shipping Board Emergency Fleet Corporation.

SHIPYARD EMPLOYMENT

A PLACE FOR MEN TO
HELP WIN THE WAR

PREPARED BY

The Bureau of Vocational Guidance
Division of Education
Harvard University

AT THE REQUEST OF

The Industrial Service Department of
U. S. Shipping Board Emergency
Fleet Corporation



WASHINGTON
1918

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UNITED STATES SHIPPING BOARD EMER-
GENCY FLEET CORPORATION
WASHINGTON

Ships! Ships! Ships! And yet more Ships!

America's first duty in the War is to furnish Ships.

That is the message of our Allies to this nation; that is the Government's message to the people; that is the message of the United States Shipping Board to YOU! The purpose of this booklet is to tell how you can help build ships.

Enroll as a member of the United States Shipyard Volunteers. You do not have to be a trained shipbuilder. This army of 250,000 reserves will be composed of artisans and skilled mechanics, whose ability to handle tools can be turned to account in one of the many lines of work required to perfect a modern ship. If you can handle a tool you can help—you can today serve your country by getting to work on a ship, provided your skill can be turned quickly to account in the yards.

Look over this booklet. It will tell you what branch of shipbuilding work is nearest to your specialty. There or elsewhere, with the training that you will get at the yard, you can fit in.

Your work is needed to make this nation victorious in the War. Your patriotism will be recognized by a bronze button and certificate issued by the United States Shipping Board—and by the honorable acclaim of your countrymen.

Enroll as a Shipyard Volunteer!

EDWARD N. HURLEY,
President of the United States Shipping Board
Emergency Fleet Corporation.



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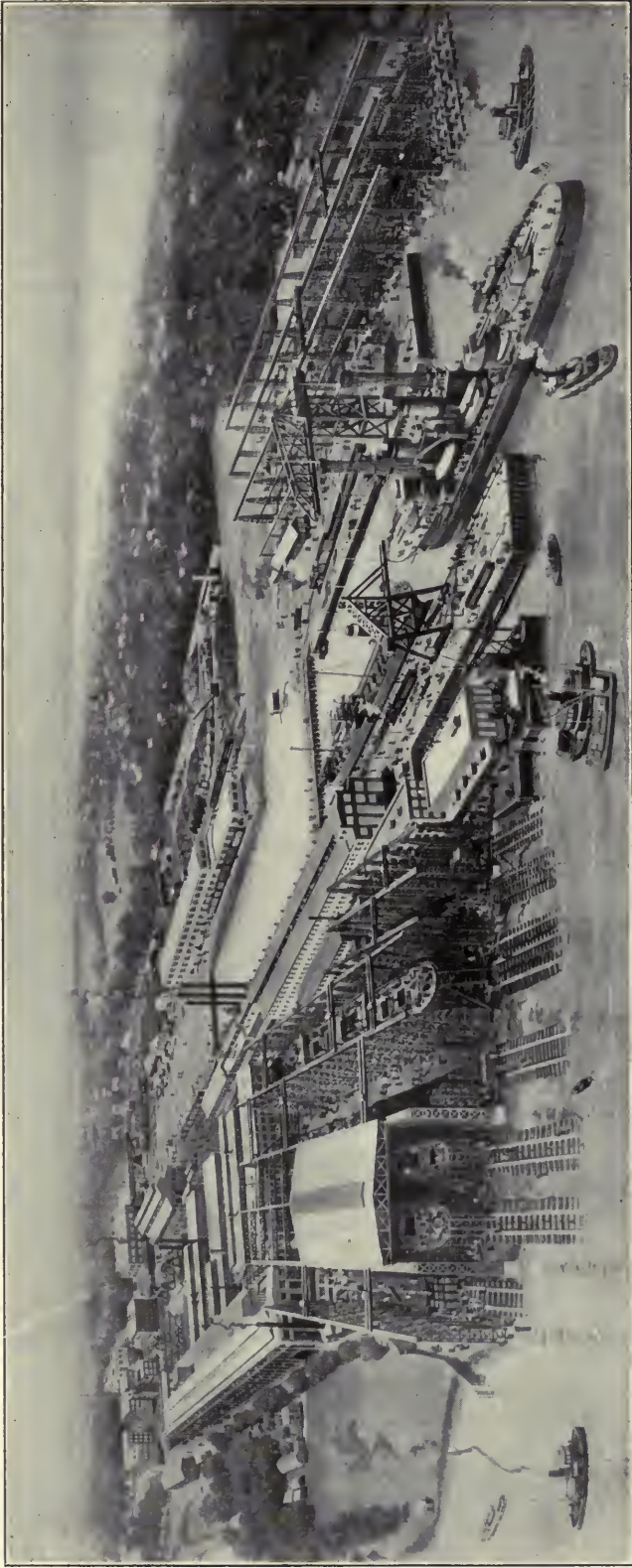
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A Part of the Plant in One of the Large Ship Yards

This shows a shipbuilding community, with homes in the background. Shops and mills occupy the long buildings. In the foreground are the berths or ways in which ships are constructed, and from which they are launched. This yard has ways for building forty ships at one time and employs 10,000 men.

A Word From the President of the United States Shipping Board Emergency Fleet Corporation

The primary object of this booklet is to offer a description of the shipbuilding trades which will interest workmen who desire to serve their country in shipyards at such work as they are qualified to perform.

There are really two problems bound up in the task of supplying labor for building the ships which are so vitally necessary to our whole war program. First, a very large number of men must be found who are capable of undertaking this work, and second, they must be kept steadily at work until the present crisis is over. No one knows just how long this may be. It may be one year, or it may be several years.

The second part of our task cannot be accomplished unless the ship yards get the right men on the right jobs. There are undoubtedly thousands of men throughout the country whose experience and general qualifications especially fit them for this service. In order to help these men to decide for themselves whether or not they are qualified, by placing before them the numerous and varied opportunities for employment in ship yards, the Bureau of Vocational Guidance of Harvard University was asked to prepare this manual. It presents the best judgment of trained men who have visited the yards and talked with many skilled workmen and others who know every detail of the different trades. We regret that it is impossible to print a list of the persons who have contributed suggestions and information or who have written parts of the text.

Men who accept this service must realize that it is only by their faithful, steady, and conscientious work that the ships can be built and the war won. I cannot too forcefully impress upon each individual the great importance of enrollment in our ship yards at the present period of national distress. Furthermore, when the history of this World War is written, full credit will be given the workmen who actually built the ships.

EDWARD N. HURLEY,
President of the United States Shipping Board
Emergency Fleet Corporation.

WILL YOU HELP TO BUILD OUR SHIPS ON TIME?

THE prompt building of ships is at the very foundation of our success in this war. We are fighting the German Empire with war supplies quite as much as with men. From Belgium and England the cry is coming for food to sustain starving women and children as well as the troops at the front. Coal is needed in Italy, steel in France, and munitions, clothing, and a great variety of supplies in each of the allied nations. We ought to send these soon and in enormous quantities, but the ships to take them are not yet built. We must transport a large army to Europe and furnish it with the millions of tons of material needed in an aggressive campaign. Men are at work night and day building a fleet of thousands of aeroplanes for use on the Western front. How are we to get these materials and men across the three thousand miles of sea that stretches between the United States and Europe? There is just one answer—new ships and plenty of them.

THE SUBMARINE MENACE AND HIGH SHIPPING RATES

Under peace conditions, the task would be exceedingly difficult. Now we must accomplish it in the face of a relentless submarine warfare. Although Germany is far from destroying as much as she hoped to in the beginning, her mines and her submarines were sending some time ago nearly 500,000 tons of the world's ships to the bottom monthly. Even with England and France to help, this situation means building ships in America on an unprecedented scale.

By January of last year, the demand for supplies to carry on the war had placed vessel space at a high premium. Cargo steamers could be chartered in the spring of 1914 at about \$1 a deadweight ton a month. In the latter part of 1916 this figure, even in waters well removed from the war zones, had risen to an average of \$13.88 per ton a month. Within the danger zones the charter-rates ran as high as \$20 and \$21 a deadweight ton a month. It cost 35 cents a hundred pounds to ship cotton from Savannah to Liverpool in the spring of 1914 and thirty-six months later it cost \$6 a hundred pounds. No wonder that every tramp steamer that could possibly turn a screw in water was being repaired and sent into service.

A FEDERAL CORPORATION ESTABLISHED TO BUILD SHIPS

It was to meet this situation that the United States Shipping Board came into existence at the beginning of 1917. For some years there has been an urgent need for a revival of our merchant marine, but no power short of an effort organized and financed by the Federal Government could bring it about. The critical shipping condition which the war produced created a fresh demand for such an effort, as well as for some sort of fair regulation of shipping charges. The Shipping Board was organized to meet both of these necessities. In order that it might work at higher efficiency and, if necessary, in active competition with private companies, the Emergency Fleet Corporation came into being, about four months later.

The Emergency Fleet Corporation does not exist for the purpose of earning any dividends upon its stock, which is held entirely by the United States Government. This corporation is not a money-making institution, nor is it a charity, like the Red Cross, nor a distinct arm of the service, like the Army or the Navy. Its work is only business of the most practical sort. To the original plan of an organized and nation-wide revival of our merchant marine has been added the great demand for battleships, destroyers, and submarines for carrying on the war. This calls for an emergency program, and especially for workers in vast and increasing numbers. Failure to secure them quickly means delaying the activities of the ship yards and, in turn, hindering the great cause overseas.

THE PROBLEM OF PROVIDING LABOR FOR THE YARDS

Chairman Hurley, of the United States Shipping Board, testified recently at the senatorial inquiry that there are now shipyards in 25 States on both coasts and on the Great Lakes, where in many instances there were only ocean waves and sandy beach a few months ago.

Already there are approximately 200,000 men at work in the ship yards. At least an additional 250,000 workmen, possibly 400,000, will be required before the end of 1918. Many single yards now employ from 6,000 to 12,000 workmen. One of the largest plants expects to employ 35,000 persons when its work is fully under way.

The war shipping program includes by far the most stupendous plan of ship construction ever adopted by any nation, or by any private corporation. In addition to the hundreds of ships now under construction, contracts have been let for many more. Even should peace be declared at an early date, these plans would be carried out and the contracts completed. There is certain to be steady employment for many men in the yards for several years to come. Not only this, but because of the increase in American commerce, shipbuilding is sure to be placed on a firmer basis than ever before.

KEEPING THE MEN ON THE JOB

Although the war program of the Emergency Fleet Corporation is ambitious and daring, it is also dependent. The only hope of putting it through is based upon a continuous and plentiful labor supply. This means that workmen must not only be secured but that they must be kept constantly and contentedly at their tasks.

The Emergency Fleet Corporation proposes to do its best to maintain conditions of contentment. Its Industrial Service Department has labored and will continue to labor to maintain the best possible living and working conditions in the ship yards and in the communities in which they are situated. The number of excellent plans already put into operation clearly indicate that the Emergency Fleet Corporation will keep its part of the contract. It lies with the workmen of the nation to do the rest.

A PATRIOTIC SERVICE

More than half a century ago the merchant marine of the United States was known the world over for the excellence of its ships. They could not be equalled anywhere for speed or for trustworthiness.

The shipbuilders of the United States then as now were better paid and better treated than most of their fellows overseas. As the result of those conditions, we produced the fleetest and the finest ships of that day and generation. The shipbuilders had every right to feel a real pride and dignity in their calling.

The workmen of 1918 who enter the ship yards are going to have a part in a greater achievement than any accomplished by the shipbuilders of old New

England. Now we must not only build the best ships afloat, but we must build them faster than was ever possible before. Much more than that, every shipyard workman is doing his part with his own hands for the common cause of democracy.

One of the best paths to honorable service lies through the ship yards. It may not be an easy pathway, but it will not seem hard to men who work with loyalty and fine patriotism upon the building of these ships.

Will you look for a place to do your part?

A GLIMPSE OF A MODERN STEEL SHIP YARD

There are at present in the United States over one hundred and thirty plants engaged in shipbuilding. More than half of these are new yards, built within a period of one or two years. Naturally, no two of them are quite alike, but a description of any one of them will give a fair idea of what is found in every yard. The smaller yards differ from the following account only in extent. They all have the same plan of equipment and work.

On page 12 is a diagram showing the organization of the typical yard described below. The sections of the book which follow this deal with each of these divisions in detail.

A ship yard is really a fair sized community devoted to a single purpose. Like every well regulated community, it must have an effective form of government. The executive in the plant who represents the owners is the superintendent or general manager. With the help of his corps of assistants in the main office, he must direct and supervise over 10,000 men. He plans the work of eighteen or twenty shops and factories scattered over a hundred acres of land and manages an extensive railroad and transportation system. He is responsible for the purchase of thousands of tons of steel and other materials and for the completion of all contracts taken by the yard. All these are only preliminaries to the actual erection of the fifty odd submarines, destroyers, and cargo ships lined up along the water front in all stages of construction.

In the main offices are the officers, clerks, and stenographers of the company who are needed to do the immense amount of executive and clerical work connected with such a large concern. They purchase supplies, keep account of costs, hire new employees, and keep the records of wages and time of service. In the same building are the drafting rooms, where the plans are drawn for the ships and for their equipment of engines and machines.

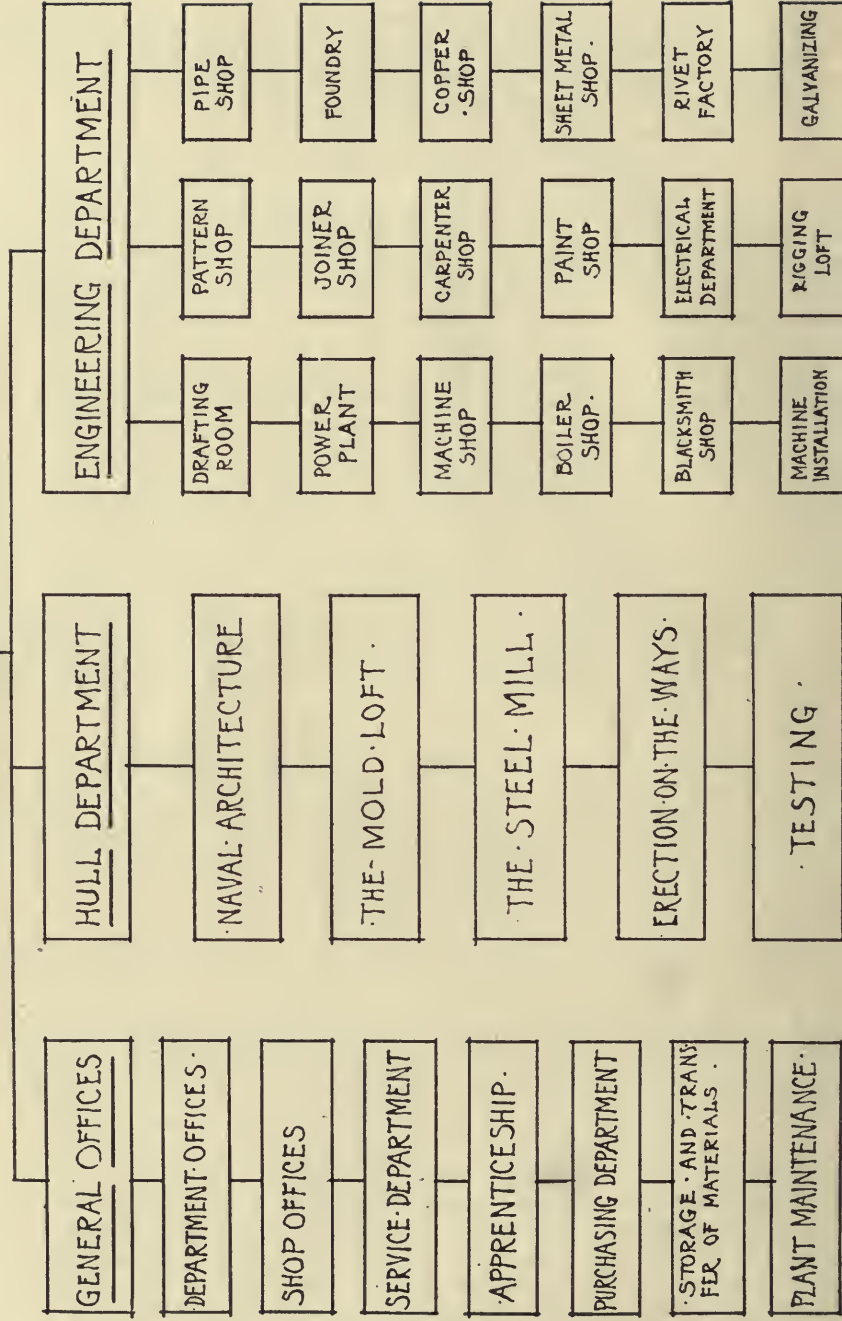
Inside the yard, we find ourselves in the midst of active operations. On one hand are the long yards and racks where are stored the plates and other forms of structural steel for the construction of the ships. On the other side are sheds piled high with lumber to be used for scaffolding and keel blocks, and for the pattern and joiner shops. Freight trains are carrying completed parts from the mills and shops to the ships on the ways or at the docks. Engine hoists and traveling cranes are lifting steel plates and girders from the yard and transporting them to the steel mill to be made ready for their places on the hulls.

Every corner of the great yard is filled with the din produced by more than a hundred gangs of riveters. From the boiler factory, the forge shops, and the steel mill comes the constant clang of heavy hammers.

The completed blueprints for the hull of a ship go from the drafting room to the mold loft. Here we find a great room where full size plans for each part are laid out on the floor. From them, wooden molds or templates are made by which the ship fitters mark each piece of steel. Their marks indicate how the steel must be cut or punched or hammered into shape, and also show where each part belongs on the ship.

Other plans go to the shop where patterns for castings are made for the foundry, others to the joiner shop where furniture and pilot houses are built,

SHIP BUILDING
IN A STEEL SHIP YARD



and still others to the electrical department, the machine shops, the rigging loft, or the pipe shop to indicate how a great variety of equipment is to be built and installed on the ship.

All of the activity of the yard converges toward the ships under construction. We are likely to find them in every stage of progress from the first laying of the keel to the completed hull that has been launched and towed to the dock where the engines, boilers, and other machinery are to be installed.

ERECTION ON THE WAYS

The central work of the yard is the erection or construction of the ship upon the ways. Structural parts have been prepared in the steel mill, and machinery and other parts in the various shops of the yard. As many smaller parts of the body of the ship as it is possible to assemble before putting them in place, have been brought together in or near the steel mill, or are now assembled alongside the ways or berth in which the ship is to be built. ✓

Shipwrights, or carpenters, prepare the berth and keep it in order until after the launching of the ship. They are usually assisted by yard riggers and bolters. The shipwrights first lay keel blocks down the middle of the ways on a slope suitable for launching. Later they place side blocks under portions of the ship where extra weight is to be sustained, and carry stagings up the sides as work progresses on the hull of the ship. A central line is run along the keel blocks to determine the place of the keel, which is brought from the steel mill in sections and marked with a central line. This flat-plate keel is laid upon the blocks so that the marked lines correspond, and butt straps are bolted on to fasten together the connecting ends of the keel sections. Then a "vertical" keel is erected upon the first one, and all parts are bolted firmly in place. Ship erectors now put in place one part after another, making all ready for the bolters, riveters, and other workmen who are to follow.

After the laying of the keel a bulkhead "head" or frame is set up across the middle of the keel as a beginning of the erection of the hull. Other bulkhead frames are erected at spaces of forty or fifty feet on each side of the first, so that work may proceed on both the bow and the stern of the hull at the same time. Between the bulkhead frames are placed other frames or "ribs" of the ship. All these frame portions, and later shell plates and other parts, are brought into place by overhead cranes. These cranes pick up the parts, carry them along and hold them in place until they can be fitted into exact position by the erectors and bolted up. The sheets of shell plate, or "strakes," are bolted upon the outer framework of the hull and upon the deck girders at the same time. Riveting proceeds constantly while the plates are being put in place and calking, or making water tight, follows. In the meantime machine parts are being installed in the hull by workers from the machine shops of the yard.

The workers who take part in the erection of a ship are as follows:

1. Shipwrights, or Carpenters
2. Erectors
3. Fitters ✓
4. Reamers
5. Bolters
6. Riveters
7. Calkers
8. Water Testers

The work of each of these trades is described in greater detail in other parts of this book.

Few persons reach this department of shipbuilding through apprenticeship. Green men are broken in as helpers, and men are drawn from outside trades. Strong, able-bodied men are needed for holding in place and working upon the

steel frames and plates that enter into hull construction. They should be able to endure exposure in outdoor work in severe weather.

About one-fifth, or twenty per cent. of the workers of the ship yard are engaged in the erection of the ship upon the ways.

KINDRED TRADES

IF YOU ARE EXPERIENCED IN ANY OF THESE TRADES, OR IF YOU ARE CAPABLE OF DOING SIMILAR WORK, YOU MAY FIND A PLACE IN A SHIP YARD

A prominent lawyer recently applied for a position in a ship yard. He felt the need for haste in building ships and wanted to be of service. "My experience and training ought to help me to qualify very soon for some important executive or advisory position," he told the employment manager. There was no place open for the lawyer, but the employment manager courteously referred his application to the superintendent. The reply came back without any hesitation, "Just now we don't need any more foremen or superintendents or efficiency experts. Tell your lawyer friend who wants to help to go out and hustle up all the husky laborers he can find."

The ship yards want mechanics who have had some experience in trades similar to those found in shipbuilding. There is a constant demand for strong, active men who are willing to do ordinary labor and act as helpers.

If you are engaged in any of the occupations listed below, *where your work is not needed in carrying on the war*, you may find something to do in a ship yard. Read the pages set opposite the trades in which you have worked.

<i>Trade</i>	<i>Page</i>	<i>Trade</i>	<i>Page</i>
Acetylene cutter or welder.....	20, 31	Electrical trades.....	36-38
Anglesmith	20, 31	Engineer, steam.....	17, 42, 43
Architect	16, 38	Foundryman (iron or brass).....	30
Asbestos worker.....	43	Furnaceman	20, 32
Auto repair man.....	20, 31	Galvanizer	20, 34
Blacksmith	20, 31-32, 45, 47	House carpenter.....	19, 38, 39, 42, 45
Blueprint machine operator.....	17	Joiner	20, 21, 38-39, 45, 46
Boat builder.....	22, 23, 38-39	Lumber mill hand.....	38, 39, 44
Boiler maker or helper.....	20, 30-31, 32	Lumberman or lumber jack	38-39, 42, 46
Bolt factory.....	26	Machine draftsman.....	17, 18, 19
Bolter up.....	23-24	Machine shop (all trades),	31, 32-33, 36
Box factory.....	42	Marine engineer	43
Bridge builder.....	22	Mason or bricklayer.....	30, 42
Cabinet maker.....	19, 38-39	Mechanical engineer.....	17-19, 31-33
Carpenter.....	13, 21-23, 31, 38-39, 42, 45	Millwright	21, 38-39, 45, 46
Cement worker.....	40-41	Molder	30
Chipper and calker.....	28-29, 36, 45	Paint mixer.....	41
Civil engineer.....	43	Painter	40-41, 45, 47
Clerk.....	41, 43, 44, 45	Pattern maker.....	29-30
Coppersmith	34-35	Pile driver.....	42
Core maker.....	29, 30	Pipe covering.....	43
Counter	43-44	Pipe fitter.....	35-36, 43
Crane operator.....	19, 31	Plumber	35-36
Dock builder.....	23, 42	Pneumatic tool operator,	24-26, 31, 32, 36
Draftsman	15-18, 38, 45	Power plant (engineers, firemen,	etc.)
Drilling or reaming (air or electric tools)	24-26, 31, 36	Quarryman	24-29
Drop forging.....	31-32		
Electric welder.....	20		

<i>Trade</i>	<i>Page</i>
Railroad employee.....	42
Rate setter.....	44
Reaming or drilling (air or electric tools, or drill press) 13, 24-26, 29, 31	
Reinforced concrete worker.....	42
Rigger23, 31, 39-40, 45, 47	
Rivet driver.....	26-28, 31
Rivet factory.....	26-28
Riveter13, 26-28, 31	
Sailor39-40	
Saw mill hand.....	38-39, 47
Section hand.....	42
Sheet metal trades.....21, 32, 33-34	
Sign painter.....	40
Silversmith34	
Spar maker23, 46	
Stationary engineer42, 47	
Steel construction....19-21, 23-29, 39	

<i>Trade</i>	<i>Page</i>
Steel mill or boiler factory (operator or helper on countersink, drill, furnace, planer, punch, rolling and flanging machines, shears, etc.).....	19-20, 29-31
Stenographer17, 41, 43-44	
Stock clerk37, 39, 41	
Teamster41, 45, 47	
Template maker.....	18-19
Tent and awning maker.....	40
Time keeper.....	44
Tinsmith34	
Tool maker or tool grinder, 30, 32, 39	
Wagon maker30-31	
Warehouse and storage.....	41
Wheelwright31-32, 38	
Wire and cable makers.....	36-38

This list is not complete, but it suggests the kind of workmen needed. If you wish to learn a trade you will find opportunities described in each section of the book.

A list of the employment agencies where you can get more information is printed on page 51. If there is a ship yard in your vicinity apply there for employment.

NAVAL ARCHITECTURE

This is the division in which the designs and plans of a ship and its machinery and fittings are drafted and blueprinted. The drawings made in this department serve as guides for every division of the work that follows. They are graphic letters of instruction to workmen. The line between the two great divisions of shipbuilding, the hull division and the engineering division, begins in the drafting room. Some yards treat the engineering drafting division as a separate department altogether, applying the term naval architecture only to drafting plans for hull construction. A few yards make a third division which includes the estimating work necessary in connection with drafting.

Designing ships for construction precedes drafting. Designs may be worked out in the department, under the naval architect, or plans and specifications may be submitted to a ship yard with an order for building received from some outside source. At the present time the yards are building ships for the Government upon standardized designs.

Naval or marine architecture has two divisions, hull drafting and engineering drafting, which are closely interrelated. The first deals with plans for building the body of the ship; the second, with plans for machinery and other accessory parts.

I. THE HULL DRAFTING DEPARTMENT

There are usually four leading departments or divisions in hull drafting, with a man in charge of each, as follows:

1. Structural drafting.
2. Ventilation drafting.
3. Hull pipe drafting.
4. Hull engineering drafting.

Designing, when done in the department, constitutes a fifth division which precedes the four given above.

From the specifications of a design, drawings are made to scale for all parts of a ship from the keel to the decks, deck houses, and superstructure. Several

blueprints are made of each of these drawings so that they may be sent in duplicate or triplicate to all the departments or divisions of the yard, such as mold loft, steel mill, joiner shop, or paint shop. One copy of each drawing is kept in the department as a record, and the foreman on every job has a copy.

The estimating division reckons costs, draws up new designs, makes calculations for launchings, and for capacity and general strength. Estimating calls for much more ability than does structural drafting. In drafting, a good memory and drafting ability are most important, while making estimates calls for originality and much higher mathematical training.

The staff of workers down through the hull drafting department in a typical yard is as follows:

1. Naval architect.
2. Chief hull draftsman.
3. Assistant hull draftsman.
4. Four leading draftsmen.
5. Draftsmen.
6. Tracers.
7. Apprentices.
8. Stenographer.
9. Clerk.
10. Messengers.
11. Head man in blueprint room.
12. Helpers, men and boys, in blueprint room.

REQUIREMENTS FOR WORKERS IN NAVAL ARCHITECTURE

The best entrance to ship drafting is through apprenticeship in the yard, since it gives one a knowledge of the various parts of a ship and of the steps in ship construction. Draftsmen trained in technical schools or courses make rapid advancement after they become familiar with ship work and ship terms. The apprentice coming up through the line usually becomes an expert draftsman in two years' time.

There are many grades of the work in drafting which require little or no experience. It is quite possible to arrange the different parts of the work in such a way that beginners who have had no previous experience in drafting can be allowed to do certain parts of it. Tracing represents one of the simplest tasks assigned.

Those who enter this work may be divided into three classes. First, boys with little or no training, who may begin as messengers, or office assistants, or pass through apprenticeship classes; second, men with college preparation; and third, draftsmen from kindred trades. It makes very little difference what line a man has followed as a draftsman, in or out of the yard, provided he has a thorough understanding of his work, and is skillful in the use of the ordinary drawing implements. Many men have been taken away from the drafting rooms to take charge of other departments, or to fill important positions in other plants, thus creating a large demand for experienced draftsmen.

The untrained person may be taken into the department as a clerk or as a helper on simple pieces of work. He may next become a tracer of drawings, and by taking the training given in the yard he may become a draftsman.

The draftsman is much helped by having a working knowledge of arithmetic, simple processes in algebra, and some knowledge of geometry and trigonometry, but these requirements are not always insisted upon.

The naval architect must be a high school or college man who has taken extensive courses in naval architecture and who has had fifteen or more years' experience in a yard, coming up from the position of draftsman. There is greater opportunity than ever before for the naval architect trained in this country.

The naval architect usually employs the workers in his department. Applicants for apprenticeship usually apply in person; applicants from architects' offices, or having experience to offer, usually apply by letter.

II. THE ENGINEERING DRAFTING DEPARTMENT

This is the department which deals with all plans and drawings having to do primarily with machinery. The draftsmen in this department are really engineers, having a thorough knowledge of engines; training in drafting is supplementary to their other training. The best of them are mechanics and could do or direct any work in the yard having to do with machinery. They usually obtain their general knowledge of machinery in a machine shop, and their knowledge of drafting in night schools or classes. Sometimes the engineering draftsman leaves the shop and attends day courses, and comes back to the shop again. On the other hand, the office boy may be trained in night courses and work gradually into the occupation while serving the company. This is rare, however, because of the high demands of this particular division of drafting.

Numerous details of ship fittings deal with machine work. It is quite impossible to handle these mechanical details without adequate knowledge of shop methods. In designing work which must be done in the blacksmith shop, such as drop forgings, it is necessary to plan them in such a way as to permit them to be manufactured on up-to-date machinery.

The workers in engineering drafting are divided as follows:

1. Chief engineer.
2. Chief draftsman.
3. Head or leading draftsmen of divisions.
4. Draftsmen.
5. Tracers.
6. Apprentices.
7. Computers.
8. Stenographer.
9. Messengers.

The leading kinds of drawing in engineering drafting deal with the following:

1. Main engine; boilers, with equipment of water tubes, smoke stacks, uptakes, etc.
2. Shafting and propellers.
3. Auxiliary machinery, as pumps, condensers, feeders, and evaporators.

The work here is of the most detailed kind; every pin or screw must be accounted for in the drawing, and great care is needed in checking all work, as a single error may throw out an entire plan.

The computers are draftsmen who figure only on new ideas and plans before they are given to draftsmen to lay out on paper. They must have the highest training and usually come direct from the colleges.

The engineering draftsmen may be called on for duties throughout the yard. Tests of special machinery are made before a final design is adopted, and technical reports on all such machinery must be made to the department. When new vessels undergo trial to see whether they meet the specifications under which they have been built, draftsmen are detailed to calibrate the instruments used, and to see that all machine conditions are ready for inspection by the Trial Board. They also take readings and observations on the trials made.

In some yards girls are employed as tracers in this department.

Blueprinting is done in a special room in connection with the department. The man in charge of the blueprint room needs no special technical training, but must have had extended experience in this kind of work. His helpers may be

drawn from any source. The work consists in operating the blueprint machine in immersing the prints in a water bath or an acid bath, and in drying them on a machine. In some yards the work is all done on one machine.

In addition to the course in drafting given in the yard apprenticeship school some yards conduct a course in naval architecture for persons who aim to become "leading men." In this course men employed in the department study the elementary principles of naval construction and learn the terms employed. Many of those who take these courses are college-trained men and the others have a good general education. They receive practical instruction that will be a direct benefit to them in the work they are doing.

THE MOLD LOFT

A mold loft is a room with a specially prepared floor large enough to lay out ship plans in actual size. The largest lofts are one hundred or more feet wide and as much as six hundred feet long. There are also small lofts, in which plans for parts of ships may be handled.

The mold loft division makes molds, or "templates," of heavy paper and of thin wooden strips, from the drawings received from the drafting department for all the structural parts of a ship.

A template for a steel plate consists of a full size pattern of the plate marked out and showing in detail all punched or counter-sunk holes, and scarphs, bends, angle lines, etc. In making templates some yards use paper extensively. This has some disadvantages, as the paper contracts or expands so much that it is sometimes necessary to make many corrections on the ship. Templates of bass wood or white pine are better, and can be easily stored.

The shipbuilding company has a schedule of dates for laying the keels of ships. The mold loft receives these schedules and the drawings for the parts of each ship from the hull drafting department. First a "line plan," or plan for line work, is drawn up. From this is laid out upon the floor a full-size working body plan for the ship. Eight or ten plans may be on the floor at one time. These plans include the structural portions of the ship body, such as shell, decks, inner bottoms, bulkheads, etc. All measurements and details for body plans for the guidance of loft work are found upon the blueprints or drawings supplied by the hull drafting room. Each pattern laid out upon the floor is checked up by the blueprint specifications. Then the template maker constructs the paper or wooden patterns or templates from these lines upon the floor.

The drawing of lines upon the floor to scale is the central and most important part of loft work. The "loftsman" is the distinctive name of the person who does this work. He must be one who thoroughly understands blueprint reading and who can do a first-class structural job in the loft. In many yards he is called a "linesman."

A second distinct feature of mold loft work is the making of molds or templates. Except on small jobs men in the mold loft work in groups or gangs named after the more important parts of the ship. Thus the "framing gang" makes molds for all framing parts, and the "deck gang" makes deck templates.

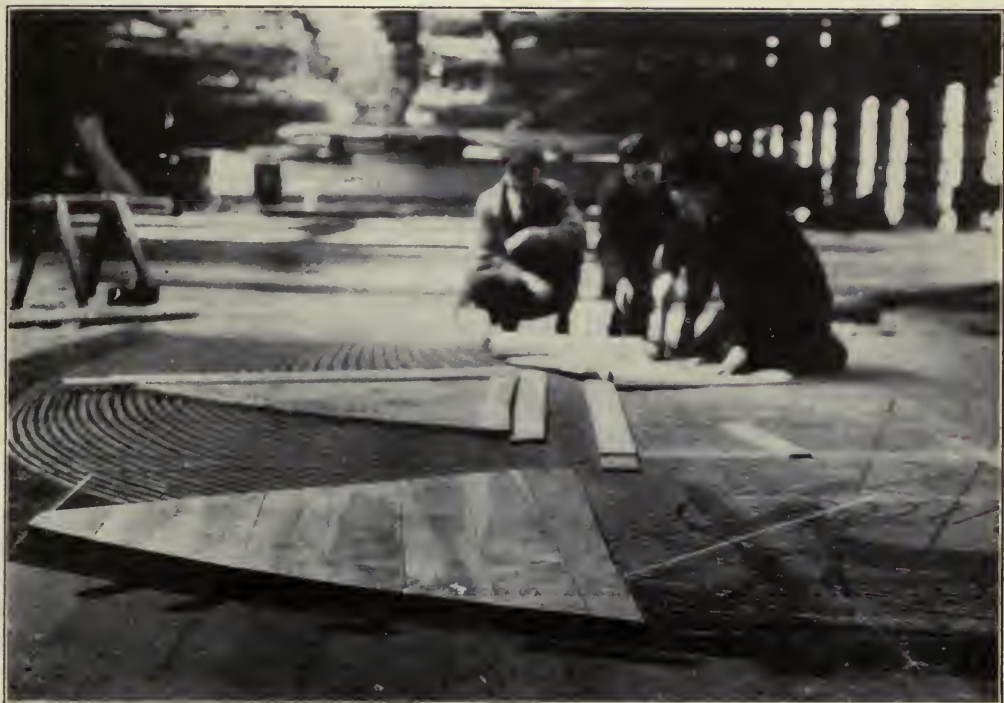
The division of workers in the mold loft is as follows:

1. Loftsman or foreman mold loftsman.
2. Assistant loftsman.
3. Loftsman, or linesman.
4. Template makers.
5. Apprentice loftsman.
6. Helpers.
7. Man in charge of templates.

The Mold Loft



Laying out work preliminary to construction of vessels. (Courtesy of "American Machinist.")



Section of the Loft, showing the lines from which templates are made.



REQUIREMENTS FOR WORKERS IN THE MOLD LOFT

The making of molds from the lines on the floor is skilled work in wood. It may be done by an ordinary carpenter, but calls for great carefulness and exactness. There is little opportunity for unskilled men in the mold loft.

At the present time it is impossible to get the necessary number of loftsmen in the various ship yards. Shipbuilding in this country has not formerly been extensive enough to train a large number of these men, and actual training in the yard is necessary to produce them. This is now being provided under the direction of the Emergency Fleet Corporation. The usual entrance to the occupation has been through apprenticeship in the yard. The ship fitter may become a good loftsmen and is sometimes transferred to the loft. The ship carpenter, patternmaker, or joiner may become loftsmen.

In some yards untrained boys or men are taken only as helpers; other yards use many men who have had experience in mechanical drafting, steel construction work, house carpentering, or cabinet making. Much of the ship, such as bulkheads and decks, may be represented on a flat surface. Drawings for these parts are similar to those made for any structural work. In some cases beams are bent in order to allow for the curvature of the decks, but there is no special difficulty attached to making the templates for them.

For all of this flat work men with ordinary experience can be readily utilized. A few men are, of course, necessary who can see the work as a whole and assign the simpler portions to men from other trades or to helpers and beginners.

The work must be done upon one's knees on the floor on a very extensive scale, with absolutely correct measurements, and men used to working under ordinary conditions find it difficult at first.

Apprentices are frequently sons or acquaintances of loftsmen, ship carpenters, fitters, or other employees of the yard. The first year they are largely engaged in running errands and keeping the loft clean. The second year they start as helpers in a gang. The third year they begin to run lines and lay down small jobs, until, becoming more experienced, they are rated as loftsmen.

The service of the loftsmen, the chief worker in the loft, is very important in the shipbuilding industry, is thoroughly appreciated and well paid, and must be done without haste. The person who comes into it through apprenticeship, or who enters otherwise and remains beyond the first stages of experience, is usually well satisfied with his occupation and successful in it.

THE STEEL MILL

The steel yard or "plate yard," as it is sometimes called, should be mentioned in advance of a study of the steel mill.

A large space is set apart in the ship yard for the storage of steel plates and frame bars. These materials, marked with exact measurements, are bought from manufacturing steel mills by the purchasing department of the yard. The amount of material to be used in constructing a ship is determined by the drafting department, and the specifications for materials are marked upon the templates and upon cards coming from the mold loft. From these cards an order clerk calls for the stock necessary for the coming work in the steel mill.

The workers in the steel yard have charge of material in storage, and select and bring it to the steel mill upon the requisition of the clerk. The workers are:

1. The man in charge of the steel yard.
2. Checkers, for checking up materials.
3. Unskilled men, or laborers, to handle materials.
4. Crane men, either engineers of locomotive trains or unskilled men on electric cranes.

The man in charge of the yard must be intelligent and capable. He must see that all the material comes as ordered from the manufacturing mills, that the

checkers do their work properly, and that materials are sent to the steel mill when asked for. He is responsible for the general good condition of the yard.

The steel mill is the place in which the steel frames and plates which constitute the hull of a ship are bent to the desired shape. It is sometimes called the plate shop or fabricating department. It properly includes the milling or shaping and assembling of parts in sections for erecting upon the ship.

The mill is a large, long building open at both ends. It is high enough for the use of cranes and consists of two sections or sides with car tracks running lengthwise. All frame parts, or "shapes," are handled upon one side, and all plate parts upon the other, the work going on simultaneously.

First there is a layingout department or division of workers. This department secures the molds from the mold loft and "lays out" or marks off their specifications upon the shapes and plates brought in from the yard. After this the parts go through the various operations of punching, drilling, shearing, planing, scarphing, countersinking, rolling, and flanging. The parts for some portions of the ship are then assembled in shops inside the mill, or in the open air outside the mill. Where parts are to be bent but slightly the work may be done without heating, but where much bending is required both plates and shapes are heated in forges and furnaces. The work of the mill includes also angle-smithing, acetylene cutting, electric welding, weighing, and galvanizing.

The list of workers of the mill is as follows:

- | | |
|--------------------------------------|--|
| 1. Foreman. | 8. Planers. |
| 2. Assistant foreman. | 9. Rollers and flangers. |
| 3. Leading men for shifts and gangs. | 10. Furnacemen. |
| 4. Layout men. | 11. Galvanizers. |
| 5. Drillers and Countersinkers. | 12. Angle furnace man and angle-smith. |
| 6. Punchers. | 13. Acetylene cutters. |
| 7. Shearers. | 14. Electric welders. |

REQUIREMENTS FOR WORKERS IN THE STEEL MILL

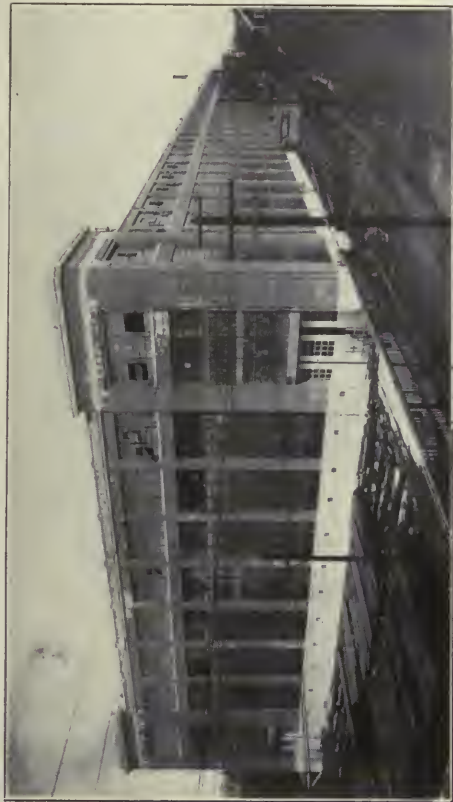
The work of the steel mill is difficult and exacting. It calls for strength and skill. It is carried on by various gangs who are engaged in laying off, in different operations on the plates and frames, and in angle work and assembling.

The angle furnace man or frame bender shapes bars of angular cross sections, using a large furnace for heating. He works from molds and bends the bars into the exact form desired. The anglesmith shapes small lengths of bars, heating them in a forge, and bends and welds flanges. He usually works from patterns. A blacksmith can be trained to do this work.

Anglesmiths and furnace men must know how to read blueprints, and must have a general knowledge of ship work, and the terms used. The men employed as machine operators in the various processes of the mill must have a fair knowledge of the symbols and marks used in laying out ship work. Furnace work demands the heaviest and strongest men that can possibly be secured for work in the ship yard. In hand work use is made of sledge hammers up to forty pounds in weight.

The best men secured for work in the steel mill have been structural iron workers. Boilermakers, blacksmiths, ship carpenters and joiners, and men who have been used to doing heavy and laborious work are employed in the mill. Frequently it is necessary to search out such men in the ship yard and transfer them to mill work.

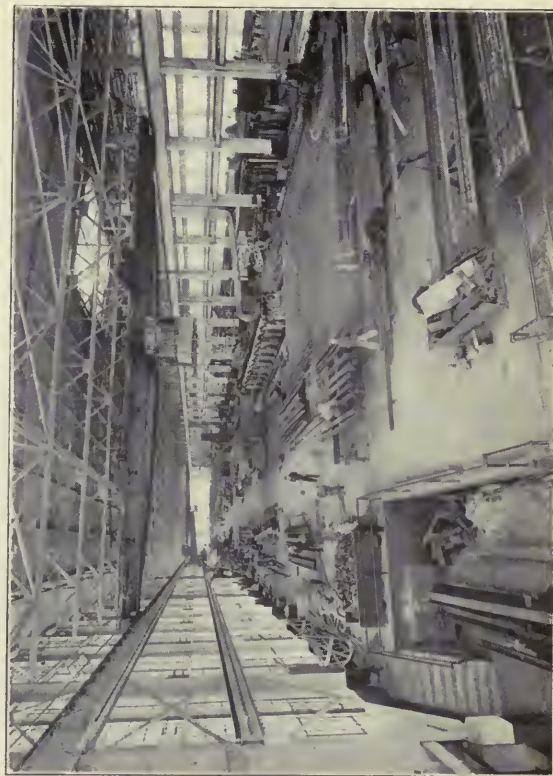
The trades of the steel mill are not usually open to boys. They are generally filled from the ranks of helpers who learn by actual experience in gangs.



The building where plates and frames are prepared for the ships. The mold loft occupies the upper story.

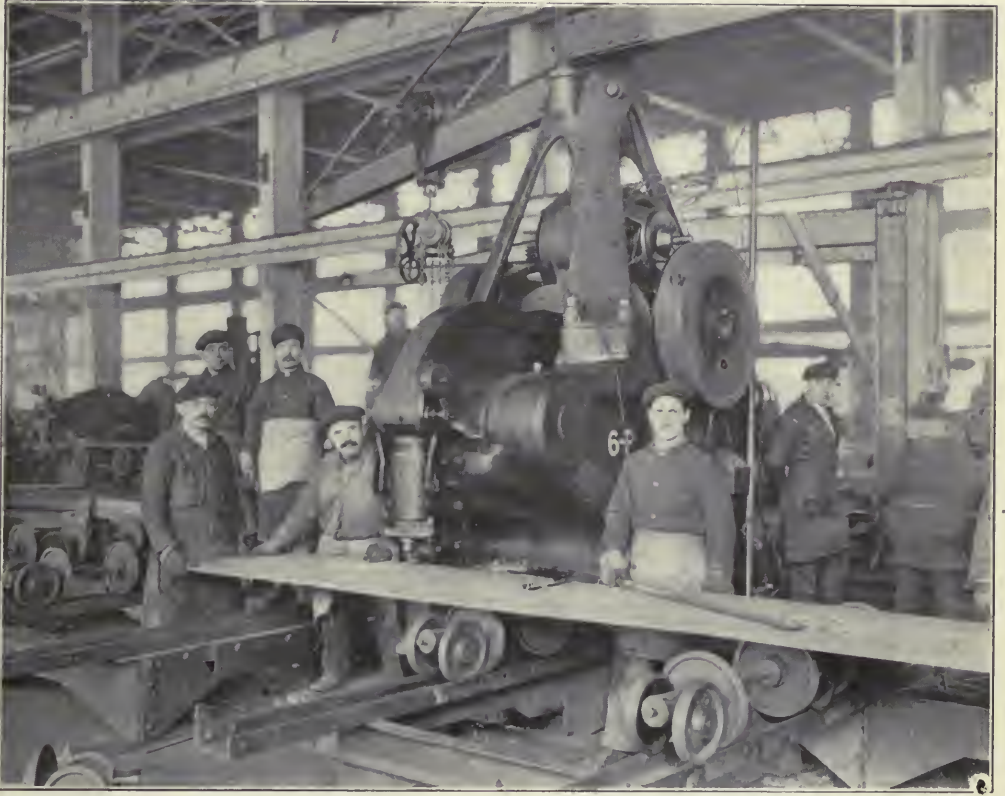


The ground floor is in two divisions. On one side, plates for the hull are



On the opposite side, the framework of the hull is manufactured.

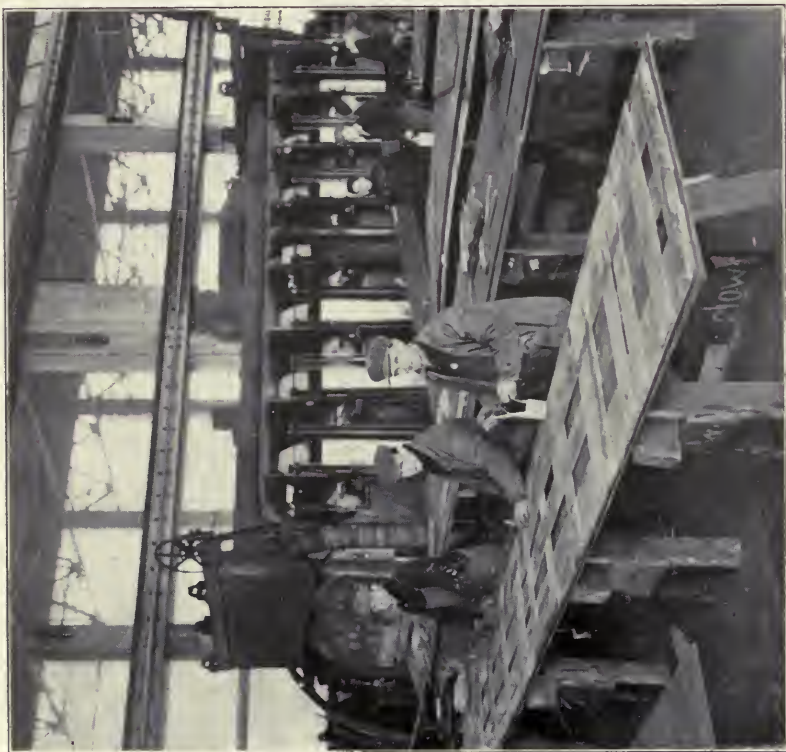
Work in a Steel Mill



(1) The Plate Puncher, on which are punched holes for riveting in a steel plate, or "strake," which goes on the outside or upon the deck of a ship. The plate is carried upon a track of revolving wheels, and the holes are punched by a heavy automatic machine.

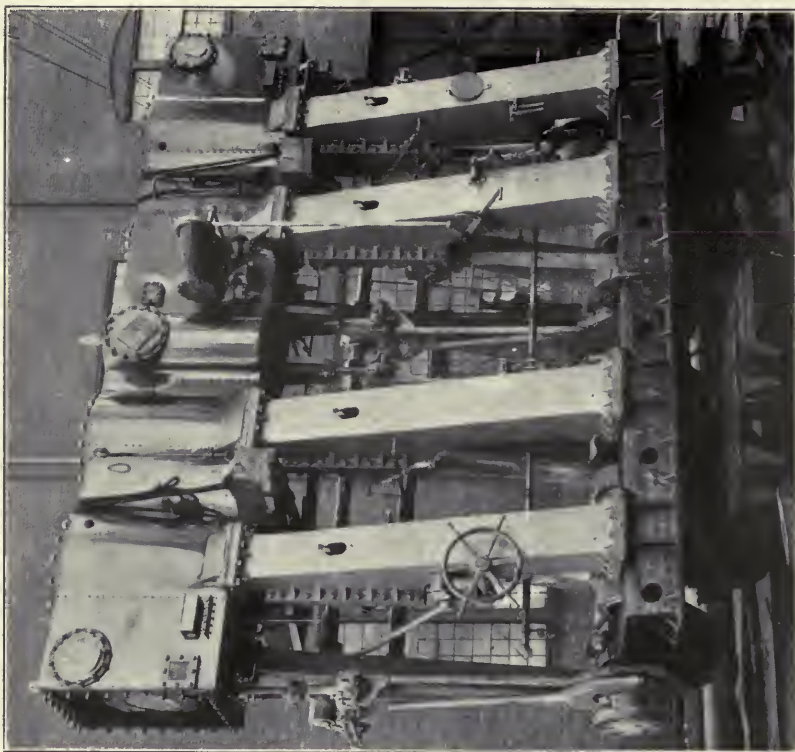
(2) The Anglesmith, bending a small bar into the shape required for use in a ship.





Ship Fitters, or Layer Outs

These men lay the templates from the mold loft, upon steel plates, frames, and bars, and mark them for punching, shearing, and bending.



A Marine Engine

One of the products of a ship yard machine shop.

Unskilled men are put on as helpers, doing rough work at first, assisting angle-smiths, furnace men, and other expert workers, and as they progress they are put on small jobs of frame bending and shaping, and machine operating. A man who does not prove effective at one kind of work is usually tried upon another kind.

In a ship yard employing ten to twelve thousand men, seven or eight hundred are found in the steel mill.

SHIP FITTERS

Ship fitting consists in the marking of steel plates, channels, and other parts preparatory to their fabrication in the steel mill and installation on a ship. Ship fitters have charge of assembling and erecting all metal parts upon the hull of the steel ship. They measure up pieces of work, make templates, and fabricate certain parts when necessary and bolt them into place. The work is somewhat of the nature of that done by the loftsmen. It embraces the following divisions:

1. *Lifted Work*—When the mold loft has not supplied a template, it is sometimes necessary to make one from a part of a ship already in position. The fitter then lays the pattern material upon the part to be reproduced and marks it off for hole punching and shearing, thus producing a template. He may also place shapes and plates where they are to go and mark them off in the same way.

2. *Mold Work*—This calls for getting molds and instructions from the mold loft, and from them marking and working upon the material to be fitted for installation upon the ship.

3. *Laying Out*—In this division a fitter takes a drawing and lays out or marks off the holes by using only the rule, square, and compass. He also indicates the lines for any necessary trimming or shearing.

Fitters work in gangs under leading men who thoroughly understand the requirements of shipfitting. The gangs are grouped as follows:

1. The shell gang, working on the outside hull of the ship, and doing laying out on the plates.

2. Framing gang, fitting frame plates and beams.

3. Bulkhead gang.

4. Deck gang.

5. Stringer and deck girder gang.

6. Miscellaneous gangs, doing fitting work on smaller parts of the ship.

SPECIAL QUALIFICATIONS FOR THE WORK OF SHIP FITTING

The fitter is usually expert either upon framing work or upon plate work. A person learns ship fitting either by apprenticeship or by working as a helper. Sheet metal workers, structural steel men, and joiners generally make good fitters. It is necessary to be able to read drawings, and a few persons in this occupation are usually familiar with the fundamental principles of plain geometry, such as erecting a perpendicular to a line. It is necessary also to become familiar with the names of the various parts of a ship.

THE SHIPWRIGHT

The term shipwright properly means ship workman, or one working on wood and on iron parts associated with wood. The term ship carpenter is also in general use, but in distinction from that of joiner or wood finisher.

The shipwright does all the woodwork about a ship except cabinet work and finishing. He builds foundations, erects and trues the way in which the ship is constructed, lays keel blocks, sets up shores, erects stages, sets, backings, for riveters, and prepares the ship for launching.

PREPARING THE BERTH

The first step in the construction of a ship is the preparation or repair of the berth, which if kept in good condition will serve for the building of many ships. As the work must be done at the water's edge piles are driven in the ground and heavy timbers placed upon them to sustain the great load of the ship when erected. In some cases heavy concrete foundations are laid.

LAYING KEEL BLOCKS

After the slip is prepared the keel line of the ship to be built is determined, and a tight line or ribbon is stretched down the middle of the space to fix the position of the keel on the keel blocks. The blocks are laid crosswise upon the foundations of the berth. The top of the keel blocks is built up to a straight line except at the ends where the curve is determined by a template.

The shipwright or carpenter assists in placing the keel upon the blocks, and in stretching other lines to determine the shape of the bottom of the ship. He helps also in putting the bulkheads in place.

SHORING

Shoring consists of placing and wedging the supports of the ship as it is being built. These supports are put under parts of the hull where extra weight comes to bear.

OUTSIDE STAGING

The staging or scaffolding necessary for the construction of a ship is built up in movable sections, with parts usually bolted together, so they may be easily taken down and used again. Staging consists of strong upright timbers and heavy planks, capable of bearing considerable weight. Platforms of planks are built one over another, six feet apart, running up to the extreme height of the ship, and three feet clear of the hull. When the ship is completed the temporary staging at the stern is removed for launching, but the other remains in place and is taken down afterwards. This work is repeated with the building of every ship.

INSIDE STAGING

Stagings are built inside the hull and bolted solidly to the frame of the ship as inner construction proceeds.

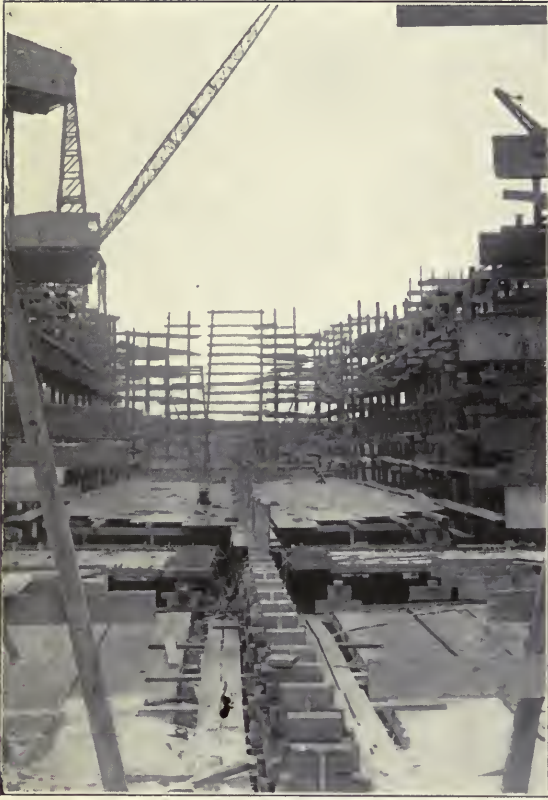
LAUNCHING WAYS

As the vessel nears completion the preparation of launching ways is begun. These consist of two separate parts, ground or fixed ways, and sliding ways which carry the ship down along the surface of the fixed ways. Both the fixed and the movable parts and the surfaces and the joints are all carefully smoothed. The ends of the timbers are bolted firmly together with special iron fastenings. The ways are built upon the same slope as the keel, and along each side of it. Setting-up wedges are driven in on top of the sliding ways, filling the space between the ways and the hull of the ship. Finally the ways are greased, shoring and keel blocks are removed, and the weight of the vessel falls entirely upon the ways. It is held in place, however, by stout oak planks which are sawed out when launching takes place.

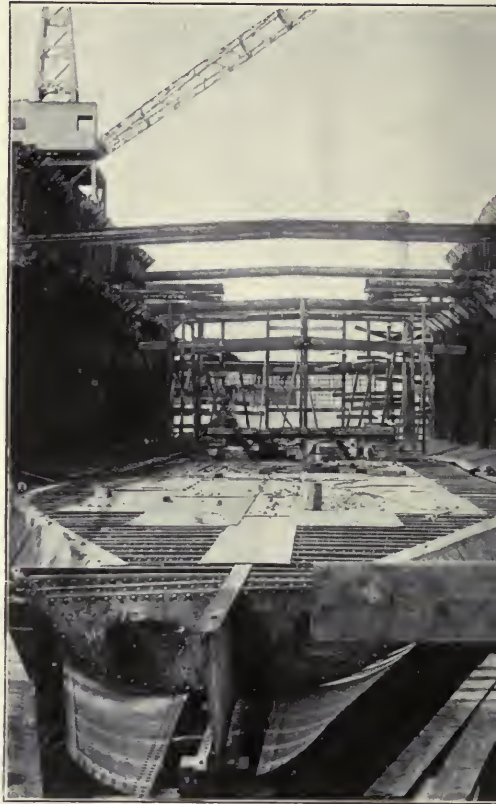
LEADING DIVISIONS OF THE SHIPWRIGHT'S WORK

All other work in the divisions just enumerated, many subdivisions of work connected with them, and other similar work where heavy wooden parts and metal parts come together, in connection with ship framing and machinery, are

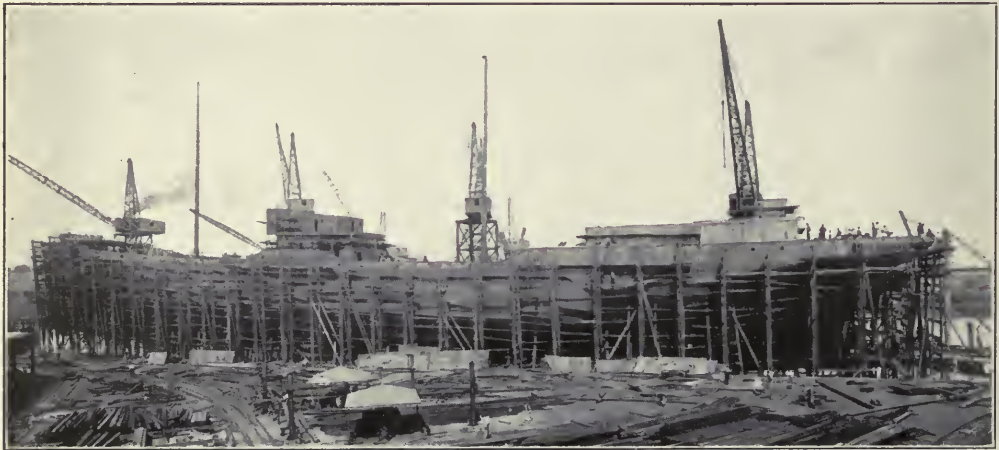
Three Stages in the Building of a Steel Freighter



Ship carpenters have erected the scaffolding about the "berth" and laid the keel blocks down the center.



After several weeks of work by gangs of erectors, drillers, reamers, bolters, and riveters.



Nearly ready for launching.



An Erecting Gang at Work on the Hull of a Steel Ship



Scaffolding About a Ship Under Construction

Part of the work of the ship carpenter. Workmen in the outdoor trades must expect certain hardships. Even as far south as Virginia, the winters on the coast are cold and disagreeable.

done by the shipwright. These duties altogether constitute at least twenty-four distinct divisions.

The list of workers is as follows:

- | | |
|----------------------------|--------------------|
| 1. Foreman, or shipwright. | 6. Fasteners. |
| 2. Assistant foreman. | 7. Stage builders. |
| 3. Leading men. | 8. Helpers. |
| 4. Shipwrights. | 9. Apprentices. |
| 5. Ordinary carpenters. | 10. Spar makers. |

This division of ship workers includes about four per cent of the employees of a ship yard, and two-thirds of the number are usually ordinary carpenters. Where a distinction is made between shipwright and ship carpenter the former term means the more expert and experienced workman.

REQUIREMENTS FOR WORKERS

A few apprentices are found in this department, but in most cases the workers are recruited by helpers who are trained in service, and by wood workers and other mechanics who are secured through the employment department of the yard.

The best shipwrights are men who have been employed in building fishing boats and wooden ships. Many shipwrights have come from the small towns along the rivers of the Atlantic coast where small boats are being built. Good house carpenters can be trained in ship carpentry. Structural steel men also can be trained.

The work of the shipwright requires some skill in checking up lines in order to be certain that they are accurate. Much of the work is done with the broad axe and adz. Carpenters accustomed only to using a hammer and saw and other lighter tools will find themselves at a disadvantage.

The qualifications necessary for the trade of the shipwright may be summarized as follows:—Good health and strength; ability and willingness to work out of doors; a good eye for sighting lines; grammar school and preferably high school education, particularly a knowledge of practical geometry for lining and squaring; ability to read blueprints, make rough sketches, and measure accurately; a knowledge of the size, strength, proper use, and management of timbers and shoring; for all special ship work a knowledge of the name, form, location, and use of the different parts of a ship, including metal as well as wooden parts; skill with carpenter's tools.

ERECTING

After the riggers deliver the plates and frames to the ship, it is the work of the erector to place them in their proper positions. Each erector has working with him several bolters, carpenters, and unskilled helpers.

After the carpenters have lined up the keel blocks, the erecting gang places the keel and begins the work of putting in place the steel framework, floors, and steel plating for the outside of the hull.

Every part is marked in such a way as to indicate its exact position. The erector must learn this system of marking. He must be thoroughly familiar with the various parts of the ship and with the reading of blueprints.

Skilled men, having considerable experience in the yard, are required to direct this work, but unskilled men can readily be trained to act as helpers.

BOLTING PLATE SETTING

When the plate is hung by the erecting gang, it may be held by a bolt or two through holes that are several spaces out of place. Adjusting the plate to its proper position usually requires a plate setting gang consisting of two men, a

plate setter and a helper. They first size up the job to see just where the plate is to go. The frames, plate, and surrounding plates are studied. Then the plate is forced to its proper place by the use of drift pins, tapering pieces of steel driven in with a maul. Enough bolts are put in to hold the plate securely in place. By studying the size of the openings and the position of the plate, a skillful setter will draw the plate to its place without binding the bolt and stripping the threads or breaking it. A small bolt is inserted first, then larger ones until the necessary force can be exerted.

The work requires skilled men. They usually begin by bolting up. A hand riveter or a fitter may take up plate setting, but this is an exception to the general practice because most yards pay less for plate setting than for riveting or ship fitting.

LINING

Liners are filling pieces made from liner steel or packing. Tapered liners are used in the shell plating at every overlapping end joint in order to make the work perfectly tight. They are usually made long enough to take three or four rivets. Bolters assist the erectors in lining various parts of the hull and fit special liners in places where the plates cannot be drawn together.

OTHER DUTIES OF THE BOLTER

Following the erectors and plate setters, comes a large gang of bolters who further line up all holes by drifting and bolt everything solidly together. If the joints are not tight, or if the bolts are too far apart, the hot rivet swells out between the inner surfaces of the two plates being riveted. Driving the rivet does not draw the plates together in the least; they must be bolted solidly to begin with.

REQUIREMENTS FOR WORKERS

Although bolting is an important operation, since many rivets can be spoiled and work is lost if it is not well done, it can be easily learned and there are no special requirements. Any man of average strength and intelligence who is willing to work outdoors can take up this trade. If he is capable, there is ample opportunity for promotion to more skilled occupations.

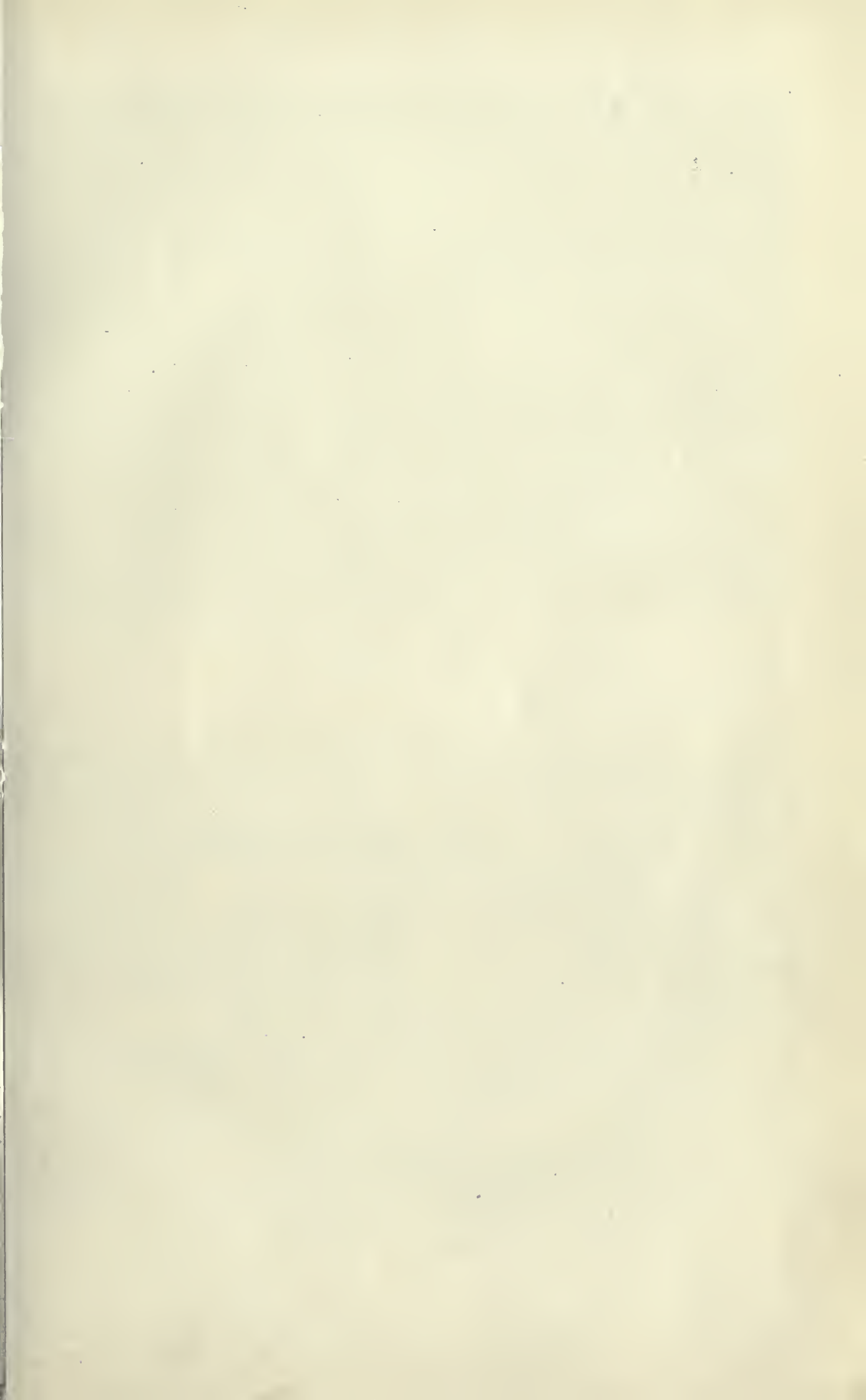
DRILLING AND REAMING

The drillers and reamers in shipbuilding drill, ream, and countersink holes in various parts of the ship which must be machined after they are in place on the frame. Pneumatic and electrically driven machines are used for this work.

Drilling consists in boring holes in wood and steel, in preparation for the work of installation done by electricians, joiners, plumbers, and sheet-metal workers. A considerable amount of heavy drilling is required in the erection of smokestacks, and on the decks and shells of destroyers and submarines. Bad rivets of the countersunk type are removed by drilling a hole part way through the rivet and forcing it out with a punch.

The illustration facing page 28 shows one of the special "rigs" used to steady the tool and to force the drill into the metal. On light work only one man is required, but on heavier jobs, two work together.

After erecting and bolting, many rivet holes fail to appear perfectly clear due to the fact that the plates have not been punched accurately, or because the two plates do not fit exactly together. Besides enlarging these holes, the reamer tapers, trues up, enlarges and countersinks holes wherever it is necessary. The work closely resembles drilling except that no rig is used to hold the tool. Two men are required on heavy work.





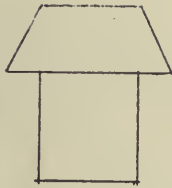
Three Important Shipbuilding Trades

From left to right, reaming, riveting, and bolting up.



Cutting Steel Plates With An Oxyacetylene Torch

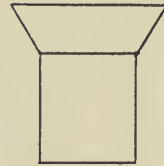
The intensely hot flame easily cuts through several inches of steel.



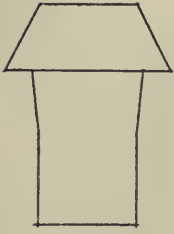
CONE OR PAN
HEAD RIVET



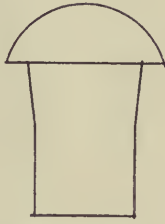
BUTTON OR
SNAPHEAD RIVET.



COUNTERSUNK
RIVET.

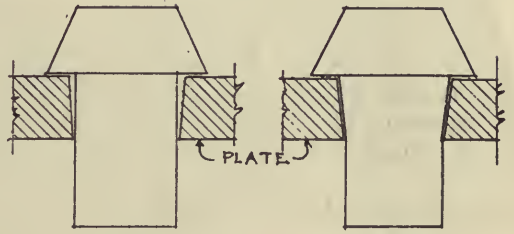


PAN HEAD



BUTTON HEAD

SWELL NECK RIVETS



"A" SPACE FILLED MORE COMPLETELY
BY A SWELL NECK RIVET "B".

Styles of Rivets Used in Building Steel Ships

Swell-neck rivets are used for punched plates in order to make the joints water-tight.

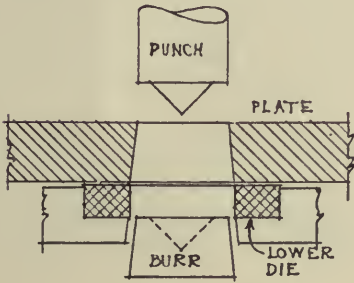
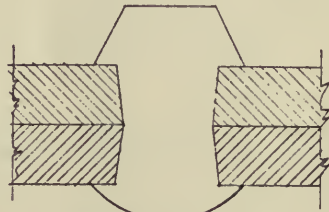


Fig 1.



DRIVEN RIVET

Fig 2.

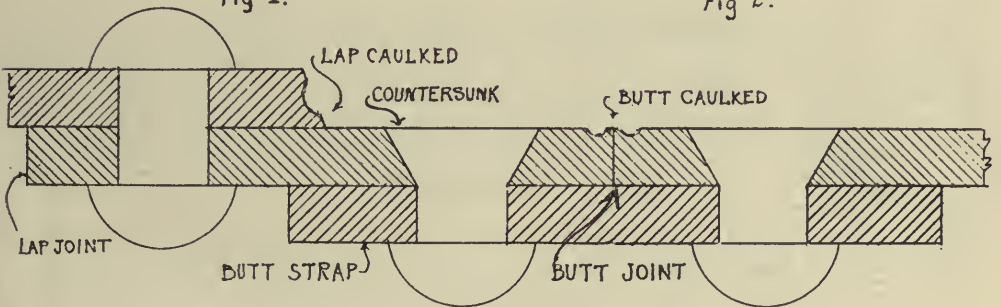


Fig 3

Riveting and Caulking

Fig. 1. The punching machine makes a cone-shaped rivet hole in the plate.

Fig. 2. A swell-neck rivet in place.

Fig. 3. Caulking, joints, and riveting.

REQUIREMENTS FOR WORKERS

Men with good health and a willingness to work out of doors are the only ones who make good drillers and reamers. It is not necessary that a man be able to read blueprints, as all the work is laid out for him. In drilling, he must be able to use ingenuity and judgment in order to choose and place the proper rig for each job. He must acquire skill in handling the drill so as to drill straight and to the right depth and no more, and it takes some time to learn the proper speeds to be used for the different sizes of drills and different metals so as to drill as fast as possible without overheating or injuring the drill. It is also necessary to hold and control the tool in all manner of places and positions, and this comes only by actual experience.

No apprentices are trained in this division. Men accustomed to using drills of any kind, such as quarrymen, stone-cutters, and drill-press hands, can very readily take up this kind of work. After two or three weeks working with an experienced man, they can be put on odd jobs and by actual experience accuracy is acquired. Men who have been accustomed to drilling or reaming with air tools on structural steel work of any kind are fully qualified to undertake this work.

RIVETING AND THE MANUFACTURE OF RIVETS AND BOLTS.

In the steel ship, the principal outward features are the shell plating and the decks composed of numerous plates riveted together, but such a hull would lack many of the essential qualities of a sea-going vessel. A ship must have enough strength and rigidity to support the heavy machinery and other equipment, and when deeply immersed with heavy masses of cargo, it must withstand the tremendous water pressure tending to collapse the sides and bottom. It must likewise bear the violence of the sea in pitching and twisting and rolling from side to side. In order to provide against these straining forces, the designer employs a system of frames, bulkheads, floors and other bracing devices, depending upon the type and size of the ship.

The different plates and angle irons must be put together in such a manner as to prevent any perceptible bending of the hull or of the parts; otherwise the numerous riveted joints would soon become loose and admit water or give way entirely. On the trustworthiness of the rivets life and property depend. Much attention is given to the quality of material used in their manufacture and to the workmanship of fixing them in place.

THE MANUFACTURE OF RIVETS AND BOLTS

Both bolts and rivets are made from round bars of steel of diameters corresponding to the sizes needed. The process is essentially the same in both cases.

The bars are first heated in a furnace and then fed into a machine which automatically forms the rivet heads and cuts the bar into the right lengths.

One machine can turn out 14,000 to 17,000 pounds of 1-inch or 8,000 to 10,000 pounds of $\frac{3}{4}$ -inch rivets per day.

One or two skilled workmen are needed to tend the machines. All the other work is done by unskilled laborers.

KIND OF RIVETS AND THEIR USES

Rivets are worked while red hot. In this condition, they are pushed through holes in the plates to be joined, the head is set up against the plate on one side, while a new head (called the point) is formed on the opposite side by blows from a special hammer. The various kinds are named according to the shape of the head. (See illustrations on page 25.)

For ship work on punched plates where water and oil tightness is necessary, a special form called a swell-neck rivet is used having the portion of the shank near the head slightly tapered. It more completely fills the hole in the plate, since a punched hole is slightly larger on the side from which the metal is punched out than on the side from which the punch enters.

For drilled holes, the straight-neck rivet is used for water-tight or oil-tight work.

DRIVING OR "STAVING" THE RIVETS

Riveting is done both by hand and with automatic hammers operated by compressed air. On machine riveting, a gang consists of a riveter, a holder-on, a passer, and a heater.

The rivets are heated, five or six at a time, in a small portable furnace. Coke, gas, or oil is used for fuel and a blast from the compressed-air hose produces a hot flame. Just before the rivet grows hot enough to throw off sparks, the heater removes it with a pair of long-handled iron tongs and tosses it to the passer. The latter catches it in a keg or bucket if it must be thrown a considerable distance, as is often the case when riveting on parts of the hull where it is difficult to support the furnace near the work. Seizing it with his tongs, the passer inserts the red hot rivet in the hole. The holder-on holds it solidly in place with a heavy hammer, called a "dolly," or a pneumatic tool placed against the head, while the riveter shapes the opposite end with his riveting hammer.

The illustration on page 25 shows the various ways in which rivets are headed up or staved.

At first the rivet is struck by the hammer fairly on the end, so that the shank may be thickened and fit the hole throughout its length. If it is a countersunk point and the rivet shank is rather long, it is then struck slightly to one side of the center. This bends it over in such a way that the extra material not required to fill the countersink bulges to one side and can be readily chipped off while it is hot. The riveter then lays aside his riveting hammer and uses an air-driven chipping tool to cut away the extra metal.

While the first rivet cools, a second is placed and staved up. The riveter then returns to the first rivet and gives it a second series of well-directed blows around the edge, so placing his hammer that the metal rises slightly at the center. This process calks the rivet and finishes it off smoothly. If the riveter is skillful, it will be difficult to tell exactly where the rivet is located in the plate because of the finish thus produced.

HAND RIVETING

This method does not differ essentially from machine riveting. It is especially adopted to cleaning up odd pieces of work because no hose line for air needs to be laid. It is also used for light work, on places like the bilge of the boat where two edges meet that need to be drawn together, or on finished surfaces where the air machine is likely to scar the surface to a greater extent. A right-hand and a left-hand riveter strike together, standing on either side of the rivet.

TESTING

All rivet work is tested in order to be sure that the rivets are tight and sound. The closeness of a joint may be tested by means of a thin-bladed knife, the insertion of which between the surfaces should not be possible. Testing may also be done by striking with a light hammer, the sound and vibration being used as a gauge of whether or not the rivet is tight.

Rivets are cut out only when very loose. "Hardening" is usually resorted to. This operation is the same as ordinary riveting save that the rivet is cold. In this work, the holder-on usually runs his hammer simultaneously with the riveter. In case it is necessary to remove the rivet, the head is cut off or a hole is drilled through it, and the rivet is driven out with a maul and "backing-out" punch.

RECLAMATION OF USED BOLTS AND RIVETS

All waste bolts and rivets are gathered and sorted. Old men, or persons injured in the yard, are frequently employed for this work. All bolts that can be used again are rethreaded and retapped. Some bolts are cut down from $1/16$ inch to $1/4$ inch to save them. Many damaged rivets are shortened up to make a smaller size.

COKE OR FUEL HANDLER

These workers supply coke or other fuel to the rivet heaters in the different riveting gangs. The work is not particularly heavy, and is often done by boys or old men.

WORKING CONDITIONS AND THE KIND OF MEN WANTED FOR RIVETING GANGS

Practically all of this work is done outdoors. Part of it, such as putting together bulkheads, frames, and braces, goes on in the yard, but the bulk of it is done on the ships under construction. The tools are heavy and in order to handle them effectively the workman must be strong and well built.

One of the difficult things to learn is to rivet either right or left handed and in any position. Experience in any kind of riveting is a help, but men not accustomed to making water-tight joints must learn to exercise more care and skill. Workmen who have done light riveting in any form of structural steel or who have riveted on boiler work can quickly learn to do the same type of work in shipbuilding.

It requires from three weeks to three months to develop a machine riveter. As a usual thing a man must work at least three months before he can be considered efficient. In learning the trade, many begin at holding on. In training a workman, he is put first on snap riveting. After he gains in skill, he is put on flush riveting or water-tight work. Persons accustomed to the use of air machines, such as chippers, calkers, and reamers, readily take up this work.

The holder-on requires less skill and training than the riveter. His work requires strength and quickness; young men or active middle-aged men are desired.

Heaters and passers can be trained in a few days.

The riveting gang is paid on a piece-work basis, the rate depending upon the size and style of the rivets driven and upon the ease with which the parts to be riveted can be reached.

CHIPPING AND CALKING

The chipper trues up all irregular plates, cuts off plate edges that are too long, smooths rough castings, and cuts out loose rivets. An air tool, similar to that used by the riveter, driving various kinds of chisels, is used for this work as well as for calking.

By calking is meant the forcing of one surface of metal hard against another, thus producing a water-tight joint. A "splitting" tool is first used to make a narrow furrow along the edge of the plate about $1/16$ inch deep. A "setting" tool is then used to square out the groove and force the lower edge of the split against the other plate. It leaves a furrow in the metal from $1/18$ inch to $3/16$ inch wide and about $1/16$ inch deep. If very nice work is wanted a third tool, known as a "finisher," is applied lightly.

On light work that must be water-tight, it is often better to weld than to attempt to calk the seam, since the operation in that case is very difficult.

Calking is used to pack the joints of frames and beams where the bolter-up fails to bring the surfaces together. Where the rivet can be seen by looking between the two plates, a wedge-shaped piece of metal (a "shim-liner"), slotted-



Operating an Air Drill

A special rig, or "hook stick," is used to steady the drill and exert enough pressure to force it into the steel plate.



A Southern Teamster

Thousands of unskilled laborers are needed in the ship yards. They are a most necessary part of the working force, handling materials, supplies, etc.



to fit around the rivet, is driven into the opening. The extra metal is then chipped off and the seam is calked. A skillful calker is highly valuable, since he can save cutting out many bad pieces of work by putting in packing and calking up.

The calker tightens up all shell-plate edges and seams, water-tight floors and bulkheads, trimming tanks, storage tanks, the tunnel for the propeller shaft, and many places on the decks. Some difficult work is done by hand, but probably 90 per cent of all chipping and calking is done with air machines. The operations on hand work are not essentially different from those described above.

CONDITIONS OF EMPLOYMENT AND REQUIREMENTS FOR WORKERS

The qualifications for chippers and calkers are similar to those for riveters. A good healthy body, ability and willingness to work out of doors, ability to work either right or left handed and to hold the tool steady are required. Considerable skill is necessary in order to hold and control the tool in all places and positions. This skill can be acquired only by actual experience. Chippers and calkers often become riveters. Quarrymen, foundry chippers, and others accustomed to handling pneumatic hammers can very quickly learn to do this work.

Piece work is the usual method of payment for all work of this character.

THE PATTERN SHOP

In this shop are constructed the wooden patterns from which castings of iron, brass, and other metals are to be made in the foundry. Shipyard work very closely resembles that done in any pattern shop engaged in preparing patterns for machine parts and structural steel.

A large shop will employ from 50 to 80 men. It may have from 5 to 15 apprentices and a few helpers.

All drawings come to the pattern shop complete from the hull or engine drafting room. A small job is done by one man; a larger one is assigned to a first-class man who will have from one to ten men to assist him, depending on the size of the pattern.

In some cases, a special framework, called a "mock-up," is built to represent the section of the ship for which the pattern is intended, so that a complicated or irregular part can be made which it would be very difficult to describe on a drawing. Struts and casings for turbines are of this character. Patterns for hawse pipes, strainer boxes, sea chests, or other parts which must fit directly to the hull of the ship are made in this manner to avoid waiting for the hull to be built before the casting is made.

In building the mock-up, the lines of the ship are secured from the mold loft templates. In other cases, the work is done from templates or drawings, or is fitted directly to the ship.

The following machines are in common use in shipyard pattern shops:

Lathe.

Band saws.

Circular saws.

Jig saws: rip and cross cut.

Planers: surface and buff.

Sanders for finishing.

Core box machine or core box planer.

Drill.

REQUIREMENTS FOR WORKERS IN THE PATTERN SHOP

While work in these shops differs in some particulars from that done in other pattern shops, any experienced pattern maker who is familiar with reading working drawings can soon become accustomed to it. Because of the great variety of work done, the shop offers an exceptionally good opportunity for a young man

to learn the trade. Men from the pattern shops of valve works, electric plants, or locomotive shops make good workers.

The larger shops carry from 5 to 15 apprentices, who follow a well-planned course of training. Boys who wish to take up this trade should have a high school or trade school education, or have some knowledge of practical plain and solid geometry and mechanical drawing.

Two men are employed to keep the stock and patterns, and one man sharpens and repairs tools and machinery. Aside from them, there are relatively few helpers or unskilled pattern makers.

The work is all done indoors. It is usually clean and healthy in every way, sharing in these particulars the advantages of the joiner shop.

THE FOUNDRY

THE IRON FOUNDRY

A few of the older and larger shipbuilding companies have iron foundries. Such yards find it exceedingly difficult to get experienced foundry workers, such as core men and molders. There are numerous great iron foundries outside of ship yards, which now supply to the yards parts already cast, such as propellers, iron castings, and ship frame work. Men experienced in these foundries and in smaller ones making articles cast in iron and steel can successfully and profitably enter the shipyard foundry.

The foundry in a large yard requires over one hundred men. About 25 tons of castings of various pieces, from bed plates and anchors to small fittings, are produced daily. Some of these castings weigh as much as fifteen tons. Such a foundry sometimes solicits outside work or does work for another yard.

The general work of the yard foundry differs but little from that of the ordinary iron foundry. The men employed are foundrymen, machine molders, core men, sand shovelers, and laborers. The expert workers are recruited mainly from the ranks of helpers.

THE BRASS FOUNDRY

On the other hand, nearly all shipyards have brass foundries in which are cast the parts of red copper and bronze now used in shipbuilding.

The brass foundry of a shipbuilding plant differs from the ordinary brass foundry in that a large part of the work is upon high-pressure valves and pipe fittings. It is therefore found necessary to use a harder and tougher metal which requires special methods in casting. It has been found that the ordinary brass molder does not readily adapt himself to this type of work. A good iron molder, however, easily adapts himself to this work and in a very short time becomes quite proficient. A first-class coremaker easily learns to do the work of the brass foundry of a shipyard, but the steel molder finds difficulty because he is not used to producing molds with as fine definition or as sharp corners as are required in this work.

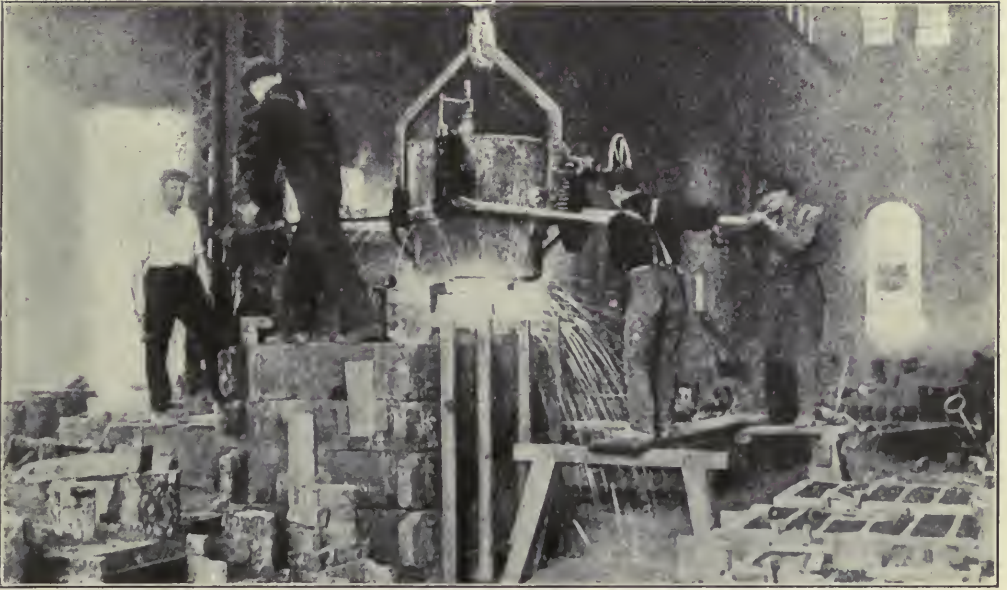
A typical equipment for a brass foundry in a shipyard consists of furnaces of various sizes, reverberatory furnaces, crucible furnaces, molders' benches, flasks, a core oven, core-making machine, sand mixer, and the necessary small tools.

The division of workers in the brass foundry is about the same as that of the iron foundry, including molders, core makers, and helpers or laborers. In both cases helpers may become skilled in the trade. Others learn by serving an apprenticeship of three or four years.

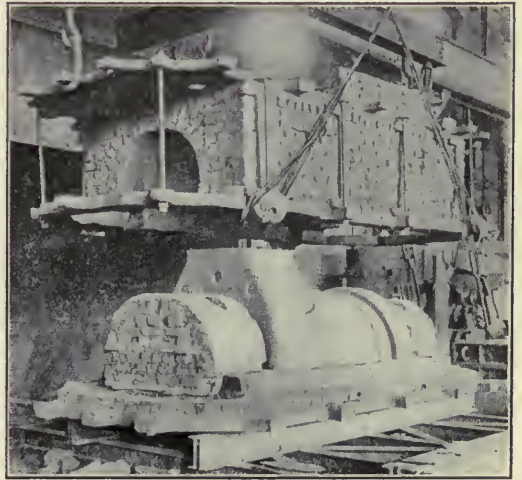
THE BOILER SHOP

This department builds the boilers complete, except for certain work to be done in the machine shop, and installs them in the ship. The brick work is usually laid by masons who are also expected to do the repair work of the yard department.

The Foundry



Pouring steel castings. The molten metal is carried in a great caldron, borne by a crane.



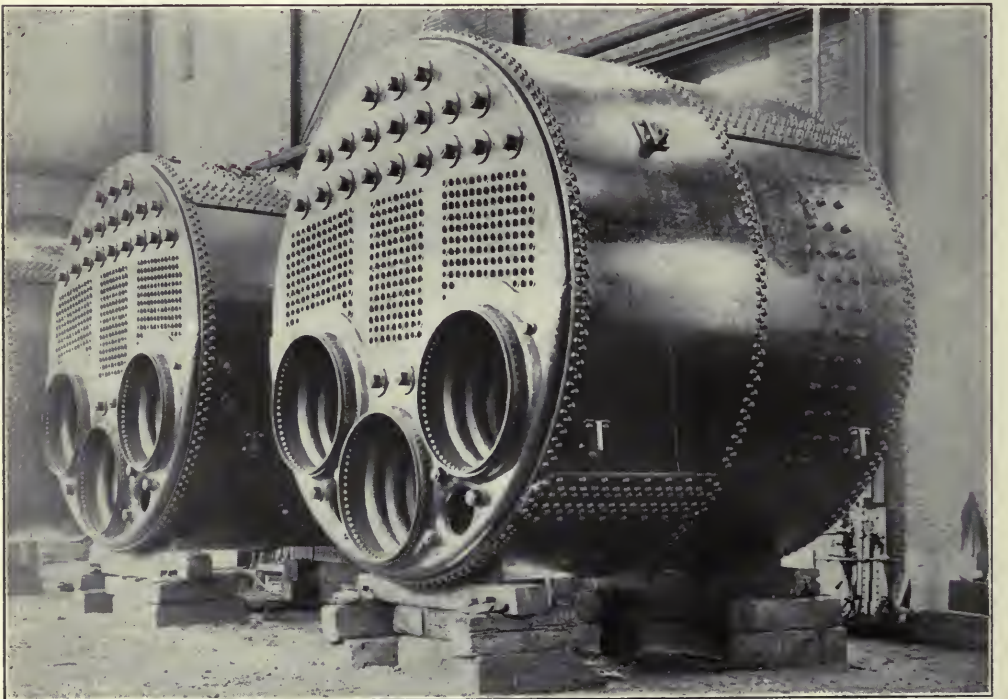
Mold and core for turbine casing.
(Courtesy of "American Machinist.")



Products of the Boiler Shops



Assembling water tube boilers.



Two 78-ton Scotch boilers for freight steamers.

When the plans for a boiler are received from the drafting room, they are first turned over to a "layer-out." It is his duty to develop the plans in such cases as this is necessary, make templates of wood or metal, and mark the plates of steel and other material to indicate how they are to be sheared, rolled, machined, and riveted. In some shops, all material is laid out from the blueprints by measurements, no templates being required.

The boiler factory also builds condensers, smoke stacks, expansion tanks, and feed, filter, and fresh-water tanks, but the operations do not differ greatly from those used in making boilers.

TRADES AND OPERATIONS IN A TYPICAL BOILER SHOP

1. *Acetylene or Oxyhydrogen Men.*—Operations are similar to those in other work on steel. One operator in the shop and one on outside work.

2. *Carpenters.*—One carpenter (a millwright) sets up blocking for boilers to be erected, repairs overhead work for machinery, etc.

3. *Blacksmiths.*—Bend all angle irons used as bands for forced-draft boxes, uptakes, and smoke stacks. Do repair work for the shop. Two smiths and a helper.

4. *Loftsmen or Layer-outs.*—Develop all plans: mark material; make wooden or metal templates if necessary. One or two experts and a helper.

5. *Flanging Machines.*—Flange front and back heads, furnace holes, combustion chamber heads, and various small pieces of different shapes and radii. One or two skilled flange turners and three to seven helpers.

6. *Machinists and Skilled Mechanics.*—Assemble and attach fittings to boilers or tanks; operate radial drill, shell drill, bolt-cutting machine, planer, boring mill, drill press, horizontal and vertical rolls, punch, shears, various air and electrical machines (reaming, calking, drilling), and riveter. Install boilers, stacks, and tanks on the ships. Much of this work is done by unskilled help, or can be readily taught to men of average mechanical ability.

7. *Crane Men and Riggers.*—Two or three crane operators and several riggers to attach chains and ropes to objects to be moved. Similar to crane work in other parts of the yard.

8. *Unskilled Labor.*—Polishing, bending, inspecting, cutting, burring, and trucking tubes; operate drill presses; machinist's and boiler-maker's helpers; assembling casings (as helpers); carrying material; sweeping and cleaning.

REQUIREMENTS FOR WORKERS IN A BOILER SHOP

A few boiler makers learn their trade through apprenticeship, but the customary practice is to promote capable helpers. Helpers soon become able to do second-class work and in most shops promotion is likely to be quite rapid. The work requires strong, able-bodied men who are willing to do hard, heavy work. The ability to read blueprints and perform ordinary calculations is helpful.

Trained boiler makers are difficult to secure. Most shops depend upon hiring blacksmiths, machinists, carpenters, and other mechanics who are capable of doing heavy work.

BLACKSMITHING, DROP FORGING, AND DIE SINKING

The work of blacksmiths in a ship yard does not differ materially from that done in any large shop connected with the manufacture of machinery. They forge many machine parts and various sections of the ship, such as crank shafts, eccentric rods, struts, truss rods, brackets, and a variety of ship fittings. Drop forging is used in making hinges, eye bolts, and ship fittings. Most shops are equipped to handle anything that can be made from billets up to ten tons in weight. A large amount of the work is done with steam hammers and haverlock forging presses.

A typical equipment in a blacksmith shop of a shipbuilding plant consists of steam hammers, pneumatic hammers, oil furnaces, large coal furnaces, small coal furnaces (or fires), shears, anvils, tongs, dies, sledge hammers, hammers and other small tools, and cranes for handling large work.

Much of the work is done on special grades of steel, which are more difficult to work with than soft steel or iron.

The repair and tempering of tools for workmen throughout the yard is an important feature. From 6 to 12 men are usually employed in a large yard in making dies for the power hammers used in drop forging.

REQUIREMENTS FOR WORKERS

In addition to being very heavy, most of the work must be accurately done. Men who have had all-round experience in a country blacksmith shop, or wagon makers, do very well here. Men who have done light work, such as horse-shoeing, are not likely to find shipyard work easy. Men accustomed to the operation of steam hammers, provided the work is done with a fair degree of accuracy, can readily take up the trade here. Helpers must have experience in keeping fires and striking.

Mechanics are developed from helpers. They are started by being given a forge and a helper to do simple work. In the course of a month or two, an alert man is usually able to do almost anything required of him.

Boys who wish to learn the trade should be 18 or 19 years of age, well developed, and willing to do hard, heavy work.

Very few blacksmiths understand blueprints. Foremen may have to make detailed sketches, or wooden templates, for complicated pieces.

MACHINE SHOPS AND OUTSIDE MACHINISTS

The machinist's trade forms a large and exceedingly important part of shipyard work. There are two main divisions of the trade, namely, shop work and that done by outside machinists who install the machinery on the ships.

The shops build reciprocating and turbine engines, propeller shafts and propellers, and fittings for boilers, motors, and pumps. A great variety of parts for the hull and superstructure are drilled, machined to size, and fitted, such as man-holes, scuttles, mast fittings, deck hoists, windlasses, turrets, ammunition hoists, air ports, and gratings. A number of men are always engaged in making and sharpening tools. Some work is done for other shops and other divisions of the yard.

Much of the work requires very large, heavy tools. Boiler plates, propellers, shafts, rudders and many of the turbine and reciprocating engine parts are extremely large and require special machinery.

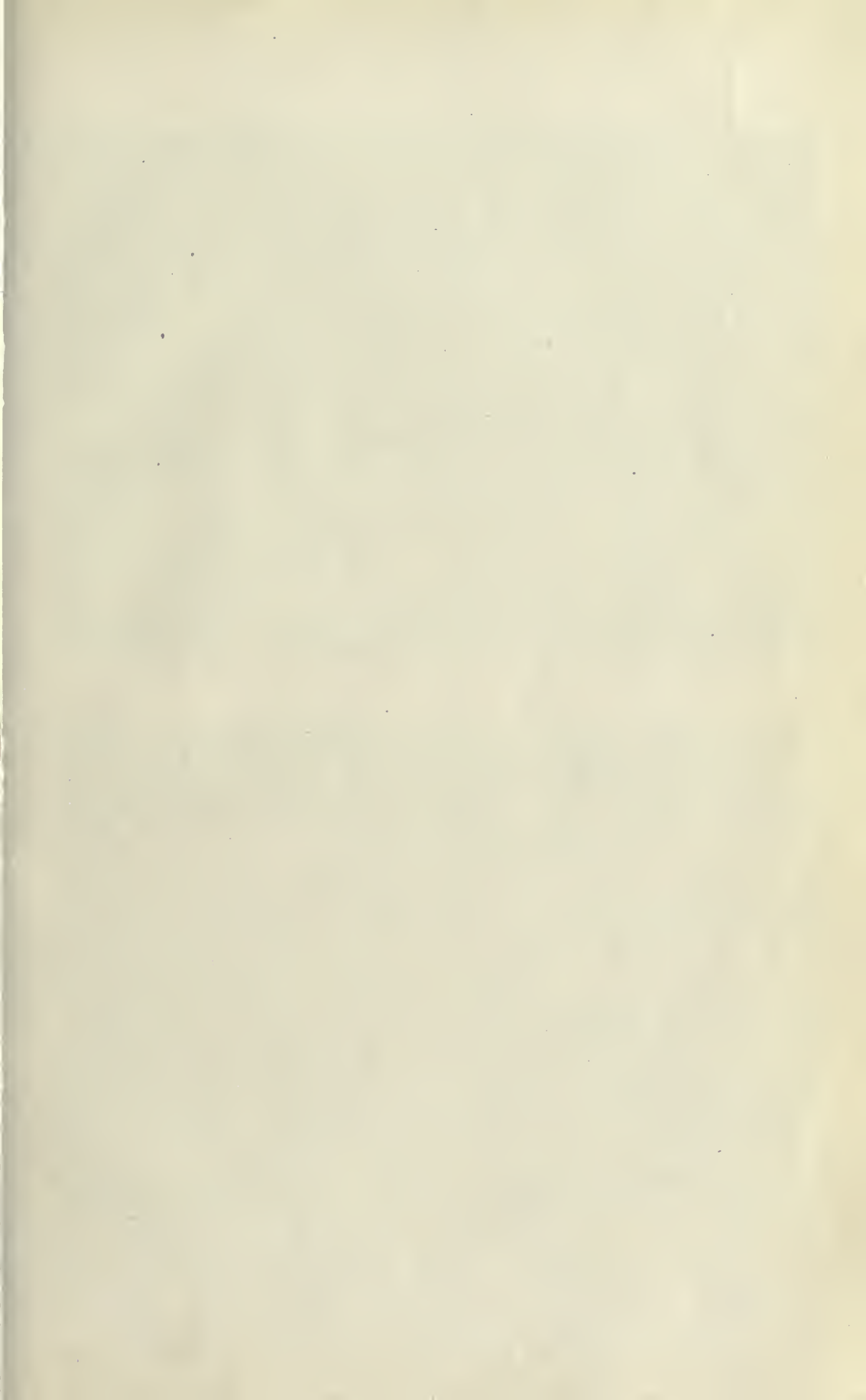
Ship construction requires a great many more brass parts than are to be found in ordinary machine construction. Some work is also done in aluminum and other metals.

From one-third to one-quarter of the men in the shop are employed in fitting and erecting machinery; the rest are employed at bench and machine work.

The machinery and tools in use in the shops differ very little from those used by any modern machine shop. A few large-size planers, boring mills, and slotters for extra heavy work are the only tools with which an experienced machinist would probably not be familiar.

WORKING CONDITIONS AND REQUIREMENTS FOR MACHINISTS

The shops need especially planer hands and lathe hands to machine large castings and shafting, vertical boring mill hands who can do cylindrical boring, and horizontal boring mill hands capable of milling engine frames and boring





Heating Pipe From the Copper Shop With An Oil Blast



A Sheet Metal Shop

Tinsmiths, coppersmiths, and sheel-metal workers are needed in the ship yards.

bearings. Men who have been employed in railroad shops or in making large machinery such as printing presses have had the type of experience most needed. There is a constant demand for tool setters, tool makers and grinders, and especially for all-round machinists who can assemble and install machinery. It is very difficult to find enough men who are experienced in erecting and installing heavy machinery such as that used in paper mills.

Young men who desire to learn the trade should have a good knowledge of the use of blueprints if they hope to advance rapidly. In ordinary times, many of the men learn the trade through apprenticeship. An apprentice gains at least three or four months' experience on each of the following classes of work:

Bench work; laying off table; small machines as lathe, slotter, shaper; large machines as lathe, planer, boring mill; assembly and repair; repair of air tools; outside work erecting on the ships.

It is customary to employ a large number of men who are unskilled as helpers. Any machine shop experience, or experience in any line which involves the handling of tools or the reading of blueprints, is helpful in gaining promotion. Helpers are put on some simple operation of assembly or bench work, or they assist machine operators. Alert workers are soon advanced to machine operation.

High school boys who have had shop practice, or technical school graduates, are much in demand. The "layout table" represents a type of work which they can often do without a great deal of preliminary training in the shop if they are already familiar with working drawings and shop practices.

The work varies constantly in all shops, very few duplicate parts being made. On this account, day rates and contract work instead of piece work prevail in most cases. Day rates apply to handy men, helpers, and a few machine hands, while the rest, probably 75 per cent of the total, are on a contract basis.

THE SHEET METAL SHOP

This department manufactures a variety of articles from sheet iron and tin. The greater part of the work is on metal from 27 gauge to 3/8 of an inch thick. Among the products of the shop are the following:

Tanks, ventilating systems, lining boxes, lockers of all types, wire work, boiler and engine lagging, insulation on the sides of ships, corrugated bulkheads, exhaust and intake headers, fuel oil tanks, dish racks, and ventilating cowles of the Turk head and mushroom types.

Each piece is made up from blueprint specifications made by the drafting department. In most cases, a leading man from the shop takes such a drawing to the ship and checks the location of each part against the drawing. After this, he gives the drawing to a layer out, who makes a paper template and lays out the work on the sheet metal. The mechanics then cut out the metal forms, do such drilling or punching as may be required, bend the article into shape, and rivet, solder, or weld the seams. This work is constantly checked by the leading man or foreman as the work progresses.

A typical equipment in a sheet metal shop consists of brakes, rolls, shears, punches, beading machine, flanging machine, combination angle shear, Smith's quick worker or rotary cutter, hydraulic press, electric spot welder, wire crimper, wiring machine, drill presses, lathes, and shapers.

REQUIREMENTS FOR WORKERS

First class sheet metal men should be able to read blueprints, and ought to be acquainted with the common processes in arithmetic, namely, fractions, decimal fractions, and mensuration. They should be able to lay out patterns when required, should be thoroughly conversant with all the machines and tools common to the sheet metal trade, and able to complete any ordinary piece of work.

The second and third class men should be able to read blueprints, use patterns or molds already made, and make up the less complicated work, such as pipes, tanks, elbows, etc.

Helpers who are capable and anxious to learn can in a few months become second or third class mechanics.

Any sheet metal worker, tinsmith, corrugated iron worker, or heater and range man can readily adapt himself to this work. All first-class sheet metal workers are recruited from the ranks of helpers.

GALVANIZING AND PICKLING

GALVANIZING

It is necessary to galvanize ship fittings and certain castings and forgings exposed to sea air and dampness, to prevent corrosion. Galvanizing consists in covering the surface of the metal with a thin coating of zinc. Among the fittings which must be protected are the following: Guard rails and stanchions, cooking rims, covers and gratings, ladders, lockers, such articles as basins, troughs, and racks in washplaces, mess racks, and fittings on mess stools and tables. Many of the structural parts of torpedo boats and destroyers are galvanized.

The process of galvanizing has two main divisions—cleaning and coating the parts with zinc. After burning off the paint or oil and cleaning with wire brushes, the castings are immersed in tanks containing hydrochloric acid and water. Coating with zinc is accomplished either by placing the parts in a hot zinc solution or by an electric process.

The work is done in a building quite open to the weather, so that the fumes of the solutions used may readily pass away on the air. There is usually a series of three or four long narrow tanks of concrete or masonry, with derricks swinging overhead capable of carrying the heaviest fittings. A variety of baskets and special hooks are used for holding and handling the material to be treated.

REQUIREMENTS FOR WORKERS IN GALVANIZING

This department calls for one or two expert galvanizers and a considerable number of unskilled helpers or derrick operators and handlers of parts. There may be five or six helpers to one expert. Foremen in this work usually learn the trade through practical experience. They must know how to make the bath solutions and how to handle and dry the parts treated.

PICKLING

Steel plates as received from the mill have a scale which must be removed before they can be painted or cemented. If this is not done, bare spots are left when the scale falls away. The plates are cleaned by standing them on end in a weak solution of sulphuric acid for about twelve hours. They are then dipped in lime water, thoroughly washed with clear water, and dried. Boiler plates are an example of material which must be treated in this way.

The work is all heavy labor, requiring no special skill or experience.

COPPERSMITHS

Coppersmiths in the ship yards make in the shops and install on the ships a great variety of copper pipes and connections. These include among others copper and brass pipes and fittings for the main and auxiliary steam connections, and pipes for discharge exhaust, fire mains, and bilge suction. As a rule, these pipes are from 2 to 5 inches in diameter, but may be as large as 35 inches in diameter. Much of the work is hard and involves the use of heavy hammers in shaping the pipes. Material up to 1/2 inch in thickness may be used. The larger yards employ from 30 to 60 coppersmiths and helpers.

THE WORK OF A COPPERSMITH

A blueprint is furnished the shop, showing the dimensions and shape of the pipe or fittings to be installed. Flat copper pieces are cut, according to the size of the piece to be made, and roughly shaped, as indicated by the blueprint.

The coppersmith then goes to the ship and plans, from the surfaces to which the pipe must be attached, a wooden template upon which the pipe can be constructed in the shop. For small pipes this wooden form is not necessary. They are bent in the shop and fitted directly to connections on the ship.

The large pipes are fitted to the template in the shop, the necessary connections are attached, and the flanges are brazed or riveted on.

Conditions vary greatly in this trade in the ship yards. Some shops do practically all the work by hand, while others have installed a considerable amount of modern machinery. The following is a representative equipment in a shop using machine tools:

Rotary shear, hydraulic setting machine, bending rolls, upright drill, pipe filling tanks, band-saw, laying-off table, punch pipe expander and bending machine, hammering machine, gas and oil burners for brazing.

The final operation usually consists in installing the parts on board the ship. This work is frequently done by the regular pipe fitters or plumbers instead of being required of the coppersmith.

REQUIREMENTS FOR WORKERS

Nearly all first-class coppersmiths are developed from helpers. Each skilled man has at least one helper, sometimes two. Experience in any copper-smith shop on work in copper pipe and sheet copper is usually sufficient to enable a man to carry on all the operations required in a ship yard. Silversmiths, sheet metal workers, tinsmiths and workers on certain operations in a boiler factory have had experience of a desirable kind. The principal difficulty lies in making and fitting exceptionally large pipes and in learning to work from templates instead of from blueprints. As a rule the templates are very simple and it does not take long to master their construction and use. Experienced men are started on first-class pay as soon as they can demonstrate their ability.

THE PIPE SHOP

On the ships, this shop installs heating and sanitary systems, bilge and ballast piping, steering gear, windlasses, scuppers, drains, fire extinguishing systems, air ports, turrets, magazines, and ammunition hoists. The plumbers make the joints for most of the copper pipes and install much of the shorter copper piping.

Although plumbing is an important branch of ship work, it is relatively small in comparison with the work done by pipe fitters. There is much more heavy work than in house plumbing and considerably more bending of pipe. Very few factory prepared pieces are used. On account of the corrosive action of sea water, the ship uses a great deal of lead pipe and much sheet lead, as in the floors of shower baths.

A ship yard pipe fitter must know how to bend his pipe, how to use lead ends, wipe joints, and install his work. It is important for him to realize that his work has to be fitted in such a way as to take care of the movement of the ship. Decks and bulkheads must be water-tight, and wherever pipes pass through them, or traverse water-tight compartments of the ship, extreme care must be taken in the installation.

Some of the work done by this department is of a highly specialized character and requires workmen who are thoroughly familiar with the peculiar demands of ship construction. Turrets for battleships are of this character. It may

require as much as a year to install a turret with its track, ammunition hoists, and placements for guns on a large battleship.

In the yard itself, a special gang of twenty to forty men is required to lay and repair all steam, air, gas, and water pipes, and to care for the plumbing in buildings. A few plumbers and steam fitters having good general experience are needed; the rest are unskilled workmen.

TRADES AND OCCUPATIONS IN A TYPICAL PIPE SHOP

A yard employing a total of 8,000 men has about 300 men on this class of work. They are grouped as follows:

Plumbers—14 men employed. Men who have had experience in pipe work on railroad cars have had valuable experience.

Pipe Fitters—50 men employed. Install all galvanized iron pipe. They must bend and joint up pipe. In many ways their work is similar to that of the mechanics who lay electrical conduits on the ships. (See page 31.)

Machinists—60 men employed. These men must have had experience as pipe fitters. As a rule any good floor hand who knows how to lay off and install his work can be used.

Chippers—30 men employed. Use air and hand machines to smooth up pipe and castings in various parts of the work.

Drillers—30 men employed. Air and hand machines.

Pipe Machine Men—4 or 5 employed. Cut and thread pipes in the shop. This work is not highly skilled, and helpers are advanced to these positions.

Helpers—140 to 150 men employed. No previous experience is necessary.

EMPLOYMENT CONDITIONS AND REQUIREMENTS FOR WORKERS IN THE PLUMBING AND PIPE FITTING DEPARTMENT

Only a small portion of the work is done in the shop, nearly all the men being constantly employed on board the ships or about the yard. Employment is steady and the pay is regular, conditions which do not always exist for outside plumbers. Excellent experience will be gained by any man who expects to return later to his former employment, since many parts of the ship work call for a high degree of skill and there is constant change in the nature of the parts to be installed. Every pipe fitter and plumber requires a helper; a man with little or no experience can be used for these tasks. It usually takes from two to three years for a helper to learn the trade.

Men who have had experience in railroad work on car plumbing are especially well fitted for this department. Any plumber who has had experience on sanitary installation or who fully understands pipe and steam fitting can soon advance to a first-class rating. Apprentice courses for this work are well developed and many boys enter the trade in this way.

The general work about the yard, exclusive of that done on the ships, does not differ from that by any plumber or pipe-fitter.

THE ELECTRICAL DEPARTMENT

There are two principal divisions of electrical work in the ship yards:

(1) The installation and repair of motors and electrically operated tools throughout the yard. This division includes the wiring of buildings for power and light and the upkeep of these systems.

(2) The installation of electrical machinery and power and lighting systems on the ships.

The newer steel ships and submarines require a large amount of electrical wiring and electrical machinery. There are lighting and power circuits, electric

search lights, wiring for gasoline motors and generator systems, and a variety of motors. The following is a partial list of motor installations on warships:

Boat cranes.
Deck winch.
Ammunition hoist.
Ventilating fans.
Fresh-water pump.

Steering-gear motors.
Motors for turning turbines.
Turret-turning motors.
Gun-elevating motors.
Anchor windlass.

Storage batteries, wireless outfits, and a few other units are usually installed by the manufacturers.

KINDS OF WORK DONE BY ELECTRICIANS

Yard Repairs ("Trouble Shooters")—These men care for all motors, light and power lines, switch boards, etc., throughout the plant. Nearly all the machinery in the shops is motor driven, the cranes are operated by electricity, and there are numerous power and light lines that may get out of order.

Men who are familiar with machine operation and repairs are selected for these positions. Men are often advanced from the shops who are familiar with the yard. A so-called "trouble shooter" or maintenance man from a locomotive works has the type of experience desired.

Machinists and Armature Winders—Two or three men are employed in each electrical shop to do this work. Most of it consists in repairing electrical appliances from the yard, rewinding damaged motors, and building switch boards, truing up commutators, and other machine work. An occasional second-hand motor is purchased which must be put into good condition.

These men need an all-round electrical experience and must in addition be skilled mechanics, accustomed to the use of ordinary machine-shop tools, such as the lathe, drill, and planer. At least two or three men are always kept in a shop who are familiar with the operation and repair of hand tools.

Installation of Machinery and Wiring on the Ships—As soon as the hull is complete and enough of the inside finishing has been done by the joiner shop, a gang is sent to the ship to do the necessary wiring and installation of electrical machinery. Each gang is furnished with a set of portable benches, the necessary tools, and a certain amount of wire and conduit. All wiring of the ship except around generators, at switchboards, and in wire tunnels, must be enclosed in conduits of enameled steel, enameled brass, or flexible rubber-lined hose. The steel and brass enameled conduits are similar to standard steam, gas, and water pipes.

The electric pipe fitter differs from the plumber in the character of the bends and joints to be made. The conduit layer must make all bends on a very long radius. The steam fitter or plumber very often draws joints together until the ends meet, forming a burr of metal across the connection. Such a broken piece of metal would prevent the entrance of a wire, but would not affect the pipe in carrying water or steam. Steam fitters usually bend pipes while they are hot, while conduit men are expected to bend pipe up to two inches in diameter while it is cold.

Bell Hangers—This term applies to men who install mechanical telegraphs, battery circuit work, and telephones. The work is very similar to that done by telegraph and telephone electricians.

Store Room—The store room is under the control of the Materials Department. About three men act as stock clerks. They check up requisitions for material and keep account of stock.

Oilers—Four to six men may be employed for this work in a large yard. They oil and inspect all motors in the yard, calling a trouble man if necessary. Helpers without previous experience can be trained in one to three weeks.

CONDITIONS OF EMPLOYMENT AND REQUIREMENTS FOR WORKERS

First class electricians are relatively few in number. The modern plan of operation is to place a foreman in charge of a ship or a group of ships. He must be familiar with the installation, construction, and operation of generators, motors, and switchboards and the installation of conduits and wiring.

Under such a man, several gangs of men will be found, each doing its own special kind of work. The gang may be made up of one electrician, four or five helpers, and one or two apprentices. Sometimes two men make a gang; often one man will work alone on a specialty. A gang may specialize on any one of several kinds of work: Installing motors or generators; connecting up motors; interior communication; lighting systems or power circuits.

The yard offers many opportunities to gain an acquaintance with a variety of mechanical work. The electrician touches elbows constantly with painters, steam fitters, machinists, carpenters, and inside finishers. Any man who learns to do electrical work well on a ship is certain of good pay and reasonable promotion in work outside of the yard. Apprentice courses are usually well developed in this department.

Experienced men will find a number of points with which they must become familiar before they can be really efficient on ship yard work. Among them are the requirements of Lloyd's code and the underwriters' code for merchant ships, government specifications for federal work, new methods of installation such as required on water-tight joints, and the connections for complicated telegraph and telephone systems. Experience in house wiring is helpful, but ship work must be done very much more carefully since it is all exposed. Most workmen are expected to do conduit work as well as wiring.

The pay varies according to the skill of the workman and the class of work being done. Helpers are advanced fairly rapidly. In order to become first-class electricians, men must understand how to read blueprints and be capable of laying out and completing a piece of work.

THE JOINER SHOP AND THE LUMBER YARD

In some yards a rough distinction is made between ship carpenters and joiners on the basis of the size of lumber used. Ship carpenters do all work on lumber over 2", both inside and outside the ship. The joiners build and install furniture for state-rooms and store-rooms, do the inside finishing of these rooms and the pilot house, construct decks less than 2" thick, fit up the carpenter's workshop for the ship, build accommodation ladders and all wooden step-ladders or stairways, make spruce and ash gratings for floors, and build doors, refrigerators and equipment for cold storage rooms. This shop also builds tables, desks, chronometer cases, lockers, and seats.

Some work is done for other departments and shops in the ship yard. Much of it is rough jobs, such as building of bins or shelves for storage, which can be done by third-class men.

DIVISIONS OF WORK IN A JOINER SHOP

1. *Drafting Room*—This work requires from one to three first-class joiners and one or more apprentices. Elevations and plans to 1 1/2 inch scale are made from the detail drawings. When the blueprint comes from the hull drafting room, it shows only the location and approximate size of the article to be built. From this blueprint, complete drawings must be prepared for each important article of furniture or piece of work to be installed, so that it will fit the slope of the deck or the side of the ship.

Drawings are not necessary and are not used in practice for all work done by the joiner. On small jobs, the material is laid out from measurements taken directly from the blueprints or specifications.

2. *Mill Work*—Machines used: Planer, mortising machine, tenon machine, variety moulder (shaper), four-sided moulder, band saw, cross cut saw, boring machine, lathe.

In some shops, the joiner is required to mill his own stock, but as a rule special men are employed to run the machines.

3. *Cabinet, Bench, and Ship Work*—These workmen are expected to lay out their material from a blueprint, cut and fit the parts, and install their work in the same manner as any carpenter or cabinet maker.

Pilot houses and cabins represent the largest work done. They may be built complete in the shop and hoisted out of the building onto a flat car with a traveling crane.

4. *Apprentices*—Only a small part of the force is usually recruited in this way.

The period of apprenticeship varies from three to four years according to previous experience and training. Boys from industrial schools are well prepared for this kind of work, if they understand working drawings and have had practice with the essential tools and machines.

5. *Grinding Tools and Repair Work*—It is customary in most shops to keep one man constantly employed at sharpening tools, repairing tools and machines, and filing saws.

6. *Stock Room and Materials*—One man handles all screws, bolts, nails, locks, hinges, etc. From two to six third-class men and helpers are employed to distribute materials and lumber.

7. *Lumber Yard and Drying Kilns*—Very little skilled labor is needed. Men who have had experience in any lumber yard are capable of handling the work. Most of it is done by unskilled laborers. A large quantity of lumber is handled, even in steel ship yard, for the work of the joiners and carpenters.

QUALIFICATIONS TO ENTER THE TRADE AND SPECIAL FEATURES OF THE WORK

Since conditions on the ship are rarely the same for any two rooms, and since they differ widely between different ships, the work of the joining shop is highly specialized. There is a great deal of bevel work due to fitting to the slope of the side of the ship, the camber of the deck, or allowing for machinery, ports, and ventilators. Some of the work is built on a special platform, arranged to conform to the curved surface of the deck.

Ordinary carpenters are not used to this kind of work and it takes some time to become fully accustomed to it. Almost any good mechanic familiar with wood-working tools can break in, but house carpenters, inside finishers, and mill hands make the best joiners. A first-class man is expected to be able to make out a bill of the necessary material from the blueprint, lay out and saw the parts, assemble and finish complete. Speed is an important factor in the amount of pay.

Only a few helpers or handy men are employed in the shops. On the ships, a first-class man may be assisted by several second-class workmen.

RIGGERS

The term "rigger" is applied in a variety of ways in the different yards. It may mean the man who follows a crane on the ground in order to attach ropes or chains to articles to be lifted and to direct the crane operator. One yard rigger works alone or with from one to ten helpers, depending upon the size of the machinery or material to be transported.

Another common use of the word "rigger" is to denote the men who make in the rigging loft and install on the ship all the standing and running rigging and shrouds, sails, awnings, and cargo handling equipment. An indoor rigger on

this class of work splices and fits manilla and steel cables and sews canvas coverings. On the ships, riggers install the equipment of rigging, hawsers, guys, chain and rope tackles and mooring lines.

In addition to their regular duties, the riggers' helpers are frequently called upon to assist other workmen on such jobs as launching, clearing away for the keel blocks, unloading cars, or clearing the ships of debris.

REQUIREMENTS FOR WORKERS

No apprentices are employed in these trades. Workmen are developed from helpers. Riggers in the loft need no special education and only the leading man needs to know how to read blueprints. The men must know how to cut, fit, and splice wire and manilla cables and ropes. The best man for the rigging loft is a sailor. Cable splicers or tent and awning makers have had valuable experience.

To be a rigger or hitcher on outside work a man needs no special education, but should have good health and strength and be able and willing to work out of doors. He must have judgment in estimating weights and making hitches and ability to size up a piece and determine the best method of hoisting. Sureness and care are needed in hitching so as not to cause injury to himself or other workmen.

Structural iron men, bridge erectors, house movers, and outside riggers are the best material for a rigger on hoisting work. A rigger's helper on outside work, if he has good judgment, can learn to do ordinary hoisting in three to six weeks; large heavy jobs require more experience.

PAINTING AND CEMENT WORK

Under conditions as they existed some years ago, it was customary for the painter in the ship yards to be called upon to do every class of work, no matter how skilled a workman he might be. As the work is arranged at the present time, helpers, beginners, and third-class workmen are placed on those parts requiring little or no skill. As they learn the requirements of the trade and become acquainted with the practice in the yard, they are advanced to better positions.

GRADES OF WORK DONE BY SHIP YARD PAINTERS

First Class—The work as it comes from the joiner's shop must be finished before it is sent to the ship. In many respects this work resembles that of the first-class house finisher, sign painter, or piano finisher. Much of it calls for skill of a high order. It consists of applying enamel, varnish, and better qualities of paint. Among the articles turned out are drawing boards, bulletin boards, various articles of furniture, the inside finishings of pilot houses, and other articles enumerated under the head of joiner shop.

Interior decorating, especially on commercial ships, is a division of this work calling for special training and skillful workmanship.

Second Class—The entire structure of a steel ship, except the parts noted below which are covered with cement, receives a priming coat of red lead. The under water portion of the hull is covered with anti-fouling and anti-corrosive paint, and the other parts with special weather paints. Steel decks, bulkheads, and other parts to be ceiled or covered with wood receive at least two coats of red lead. Areas finished in white or spar color have at least two coats of color in addition to the red lead. A special division of this work is done by the steeple jacks, who must paint the masts and other parts of the superstructure. The transports and certain other ships are painted in camouflage, work which requires some artistic ability and special training.

Third Class—The holds and the bottoms of the ships, except the parts to be cemented, are painted over with a heavy red lead mixture. Pitch mixture, tar, and asphalt are used to plug seams and openings.



Painters at Work

Painting on the outside of the hull or upon smoke stacks is done upon stagings or swinging seats. Painters are also needed for interior painting, varnishing, and decorating.



Electricians Installing a Search Light

The Electrical Department repairs the yard motors and lighting and power lines, and installs electrical machinery and power and lighting systems on the ships.

CEMENT LAYERS

In the water courses, or bottoms of the ships, it is necessary to fill in all pockets and crevices about brackets and frames and the joints between plates so that water can flow freely. The entire bottom of the ship, and of many of the tanks is covered with a layer of Portland cement from an inch to an inch and one-half deep. This is omitted only in the oil compartments of oil tankers.

In some yards, this work is done by the laboring or rigging gang under the direction of the Hull Engineering Department.

PAINT MIXERS

In some large yards, the shop mixes and grinds all its paint and white lead. Four or five men are employed at this kind of work. One leading man who is acquainted with the trade is necessary; the others are all green men who are trained in the shop.

CONDITIONS OF EMPLOYMENT AND REQUIREMENTS FOR WORKERS

When a man enters the yard, if he has had little or no experience, he is put on third-class work, either painting in the hold or applying the first coat to decks or stringers. He is then advanced to painting the outside of the ship; to engine room work; then to joiner work; and finally to hard wood finishing.

The painter in the yard finds that if he can accustom himself to the changed conditions he has many distinct advantages. In common with the other ship yard trades his pay is regular; there is no changing about from job to job; if he shows himself to be reliable and industrious his position and pay are permanent and are safely guaranteed. The house painter frequently waits for long periods for his pay, and may be out of work for days at a time on account of inclement weather. On the ships, bad weather does not influence his work to any appreciable extent because it is always possible to find inside work that can be done on unpleasant days.

Men who have done house finishing, sign painting, piano finishing, or any sort of painting connected with structural steel work find employment in the ship yards.

PURCHASE AND STORAGE OF MATERIALS AND YARD MAINTENANCE

In order to give an idea of the extent of this work, a description is given of the way in which it is carried on in a yard employing a total of about 10,000 men.

PURCHASING DEPARTMENT

The head of this department and his four or five assistants purchase all the supplies and material for the yard. About 26 clerks and 14 stenographers are occupied on routine work of the kind required in any large office. Familiarity with the terms used in ship building or experience in any kind of shipyard work are valuable assets, but are not required of clerks and stenographers in this department.

WAREHOUSE DEPARTMENT

The employees in this department are classified as follows in the yard in question: 1 chief clerk; 2 stenographers; 2 shippers; 1 pricing clerk; 4 stock clerks; 5 receivers and checkers; 6 warehouse clerks; 2 supervisors of the sale of scrap; 3 truck drivers; 4 spare part men; 25 laborers to handle material.

Freight checkers, stock room clerks, tool room clerks, and baggage men are well adapted to the better classes of this work. It is difficult to secure efficient workmen. Unskilled workmen are hired to handle material.

BRICK MASONS

Throughout the yard there are power house boilers connected with the shops, and in the foundry and steel mill there are special furnaces. All of these require constant repair and attention from the masons in this department. It is also the duty of these masons to lay the fire brick for the boilers in all the ships. On the destroyers, every brick is bolted in place and a special fire clay, almost like cement, is used as mortar. Occasional repair jobs require the laying of red brick or pressed brick, but nearly all the work deals with fire brick laid in special clay.

Men are needed who understand fire box and boiler work. It is frequently necessary to do repair work, or to install boiler foundations under very trying conditions. The heat is often intense and the quarters are frequently cramped. On this account, young, active men are desirable. At present, the department is running short handed because the right men cannot be found.

A number of unskilled workmen are used as helpers. Their work is similar to that done by mason's helpers on outside work.

BUILDING DOCKS AND DRIVING PILES

Two pile drivers are in constant operation, one for land work, the other one a floating pile driver. This work includes building docks and driving piles for the launching ways. An engineer and several dock builders are required for each gang. Men who have had experience as bridge carpenters, or on dock or trestle work, or any kind of heavy, rough wooden structures are desirable as employees. The work is entirely different from that of house carpenters, and men with experience of this sort are not, as a rule, encouraged to undertake it.

CONCRETE WORK

Much of this is repair work. A few men are constantly employed on foundations for machinery, concrete floors, sidewalks, steps, etc. A few carpenters are needed to build forms. This class of work presents no peculiar or unusual difficulties to men who have done similar work outside of the yards.

CARPENTERS

Aside from the carpenters mentioned in the paragraph above, and in addition to the men employed as joiners and as ship carpenters, a force of 25 to 30 men is needed for work such as the following:

Constructing boxes for, and boxing up, machinery and patterns; building houses over boilers; repairing and laying tar paper on buildings; inside and outside repair work of all kinds on buildings and fences; making benches, racks and bins for storehouses; boxing pipe lines. House carpenters or concrete form men are familiar with this type of work.

RAILROAD MAINTENANCE

The yard in question maintains a total of 10 miles of standard guage track beside a short street railway and a considerable amount of narrow guage track running into the shops. There are 87 frogs and switches, 10 cross overs, 2 trestles, and several bridges to be kept in shape. About twenty men are constantly at work. Section hands, or men experienced in street or road work are well adapted to fill these places. Foremen or gang leaders should have railroad experience with section gangs. Crane operators, engineers, firemen and switchmen are occasionally needed.

MISCELLANEOUS WORK REQUIRING UNSKILLED LABOR

Pick and shovel men lay pipe lines, clear away for foundations and keel blocks, handle snow, and assist in keeping the railway tracks clear. There are numerous pipe lines for compressed air, steam, water, and gas to be laid and repaired.

This department unloads from the cars and distributes all coal, coke, charcoal, fuel oil, tin, lead, zinc, copper, aluminum, and lumber. It helps to unload cars for the Receiving Department.

About 100 acres of the yard and all the ships must be kept clear of rubbish and scrap. A gang of 14 bolt pickers gather up the bolts that need to be rethreaded or fixed over in order to be used. Ten teamsters and as many more helpers are needed to haul materials, scrap, and lumber. Twenty men are needed to clear away the rubbish from the docks alone. The ships must be cleaned inside and outside. Steel turnings, odds and ends of steel and lumber are picked up and sorted to sell. Many barrels of bolts, washers, rivets, nuts, and bits of iron are collected and sorted every day.

PIPE COVERING

Steam pipes, hot and cold water pipes, boilers, feed water heaters, and evaporators are covered with magnesia, asbestos, or hair felt pipe covering. Cement is used for irregular shapes. Canvas is usually sewed on over the first covering.

First-class workmen are developed from helpers. In six weeks a green man can learn the most important parts of the trade, but it takes from one and one-half to two years to become fully proficient on all classes of work. Plasterers, stucco workers, cement workers, and brick layers are the best material for pipe coverers outside of journeymen pipe coverers employed on similar work in factories and heating and power plants. The ability to use a trowel is their asset.

CIVIL ENGINEERS

One or more gangs of men are always needed in a yard to run grade lines for keel blocks, set shaft lines, make out yard maps of progress, and run lines for new buildings. A few transit men, levelers, rodmen, and draftsmen are required for this work.

POWER PLANT

The production of power, heat, and light for the plant requires one or more power stations in each yard. Each of the larger shops has its own heating and power plant. A typical list of workmen for a power house consists of the following: 1 chief engineer; 5 engineers; 5 oilers; 3 water tenders; 6 firemen, 7 coal passers; 1 repair machinist; 2 cleaners; 1 helper; 1 office boy. The work does not differ from that done by similar workmen in any power plant.

MARINE ENGINEERS

A considerable number of men are required to install and test the engines on board the ships. They are generally classed as outside machinists, but it is essential that they be accustomed to the repair and operation of the standard types of marine engines in addition to being experienced assembling machinists.

Many of the yards have several tug boats which must be provided with full crews, including engineers.

COUNTERS, RATE SETTERS, AND CLERICAL POSITIONS COUNTING

In the hull department, men and boys are employed to keep account of the amount of work done by riveting gangs, chippers, calkers, bolters, reamers, and other piece workers.

A good counter should have a high school education, but this is not absolutely necessary. The work is largely of a routine nature, and while some clerical training is helpful, it is not insisted upon as a rule. The most difficult part of the task is to learn the parts of the ship and the different classes of work so as to be able to pick out the right rate from the price list. The blanks to be filled out are not complicated, but a great many are needed every day.

Not only is it easy for a counter who is not tactful or courteous to cause dissatisfaction, but carelessness may easily result in considerable loss to the company. The counter must write a legible hand and must be accurate in the simple processes of arithmetic.

Strong, active persons are required since there is a great deal of climbing and walking to do.

RATE SETTING

A continuous record is kept in each shop of the price paid for all tasks and of the time required to complete them. From these records, and from his knowledge of conditions, the rate setter places a valuation upon any given piece of work.

Nearly all rate setters have had some shop experience. This does not need to be on actual machine work. A man may become accustomed to the work of the shop as a clerk or time keeper, or in many other ways.

The shop clerk punches each man's card when he begins and when he stops work on each task, and assists the rate setter and foreman in various ways. Only ordinary clerical experience is required.

CLERICAL POSITIONS

The main offices of every ship yard employ a number of bookkeepers, clerks, stenographers, and messengers. The time keeping, cost accounting, purchasing, and employment and service departments are examples of offices requiring a considerable number of such persons. Some of the larger shops have one or more clerks and stenographers. It has been customary to employ men for most of these positions, but there is no reason why a large amount of the work cannot be done by capable women.

Graduates of the commercial department of a good high school are fully qualified for the majority of these positions. A few persons having more extended experience are occasionally needed.

The organization of a typical time-keeping office is given as an illustration of this kind of work.

TIME-KEEPING OFFICE

Time-keepers (outside)	10 men
Pay roll clerks	20 men and boys
Index clerk	1 man
Deduction clerks	3 men
Force Report	1 man
Stenographer	1 girl
Printing shop	2 men and 1 boy
Addressograph	1 man and 2 boys
Liberty Bond Sale	2 girls
Annual Wage Report	4 girls

The principal machines in use with which a prospective employee should be familiar are adding machines and the comptometer. Familiarity with machines is not so essential as accuracy in use of figures and ability to do neat, accurate work.

THE BUILDING OF WOODEN SHIPS

Compared with other industrial enterprises the wooden ship yard employs fewer persons, and the materials entering into wooden shipbuilding construc-

Building Wooden Ships



Schooner in the framing stage, showing the laying of the keelson.



Courtesy of International Marine Engineering.

Shipwrights shaping timbers with the adz.



tion are simpler and much less in number than might be expected. For the same reasons office forces are smaller and there are fewer departments. A manager may be both purchasing agent and paymaster, or in a slightly larger plant there will be an assistant manager who will act as paymaster, purchasing agent, and general clerk. The number of stenographers and clerks varies with the size of the office, but the administrative end of a wooden ship building plant is always relatively small. The purchasing agent, where there is one, needs to be familiar with the cost and quality of ship building materials. The paymaster obviously does not need to have ship building experience. There are no special requirements for clerks and stenographers, although they are likely to be more valuable if they have had some acquaintance with this particular business.

The workers in a wooden ship yard who have to do with actual construction are indicated in the following list:

1. Draftsmen.
2. The master workman, or ship carpenter.
3. Ship carpenters.
4. Hewers, liners, plankers, and bevelers.
5. Ship joiners.
6. Calkers.
7. Blacksmiths.
8. Painters.
9. Ship Riggers.
10. Millmen.
11. Teamsters and lumpers.
12. Yard riggers.

THE DRAFTSMAN

The draftsman and his assistants must be trained in drafting for the construction of wooden vessels. Drafting deals with the lines for the frame especially, but usually provides the boss carpenter with a drawing of the midship section. The draftsman also directs the making of the molds for the frames. All work in connection with the mold loft is highly expert and requires years of experience.

THE MASTER WORKMAN

The most important factor in the construction of a wooden ship is the boss carpenter or master workman. He is personally responsible for the proper performance of all work. He is an expert in every sense of the word, and personally supervises the laying out of the molds, the placing of the keel, the setting of the stem and stern post, and the work of the liners and bevelers. More than any other one man, he is responsible for good workmanship in the making of a vessel. He needs not only skill but years of experience in the construction of wooden vessels.

The tool house in which are stored the general supplies and the tools not in use, is under the charge of the boss carpenter and the gang foreman. In most wooden shipyards there is no necessity for a special man to take charge of the tool house.

THE SHIP CARPENTERS

The boss carpenter takes the timber which has been sided in the mill and molds out the sections of frames, which are built on the framing stage by the ship carpenters. This can be done by intelligent laborers under the supervision of experienced foremen. After the frames are built they are set in place and fastened. Intelligent laborers can be taught fastening, although it is necessary for them to work under an experienced foreman. The stage on which the frames are built is usually constructed by experienced stage builders. These

stage builders do all of the stage building, keeping it up about the vessel as it develops toward completion, and also erecting more or less staging on the interior of the ship.

The inside wood-work of the hull is performed in the main by ship carpenters. As a general thing these have been apprenticed to the work at an early age and have acquired a skill which an intelligent workman can have only after years of experience. The ship carpenter must continually use good judgment in the cutting of the timber that he is working upon. Everything must be made to fit as he goes along. Outside of the general lines and dimensions, it is impossible to stipulate just how the workman shall prepare each stick. Nothing is machine made, nothing is stamped out for him as in steel. Wood swells, shrinks, and twists, and when using large timbers no two are just the same in dimension or quality. A ship cannot be well made unless the workmen are intelligent enough to carefully work out and join every piece which is put up. Some general carpenters can be made over into ship carpenters, especially if they are accustomed to heavy tools. This is best brought about by assigning such men as apprentices to work along with an experienced ship carpenter.

HEWERS, LINERS, PLANKERS, AND BEVELERS

Among the yard workmen there must be hewers and bevelers. These men must be very skillful with the broad axe and the adz. To do this work satisfactorily requires both skill and experience. The work could be done by lumbermen who have been in the habit of using such tools or by men from farms on which there has been considerable homemade construction of farm buildings.

The beveler bevels all plankings and ceiling and is responsible for their fitting tightly, stick to stick.

After the frame is up it is worked over by the dubber, or hewer, who smooths the timbers with an adz so that the planking will fit properly. After the dubbing process the planking begins. The plankers work in squads of three or four. Their work is closely watched and frequently tested by liners who see that the work is in right alignment. Liners and bevelers stand next to the boss carpenter in importance and responsibility. The work is quite difficult and requires years of training. Plankers also are expert workmen, though some in each gang may not be skilled men.

THE SHIP JOINER.

The inside paneling for the cabins is all constructed in the joiner shop. It involves the highest grade of workmanship. The panels are built to measure and finished in the loft, and are then taken into the ship and set in place. Doors, windows, stair-rails, etc., are all made in the joiner's shop. Ability to run a lathe is necessary.

Cabinet workers and house carpenters may learn joiner-shop work. House carpenters do not always adapt themselves easily to ship work. They are likely to feel that their previous knowledge of carpentry is sufficient, and do not realize that ship joinery and ship carpentry are quite different in the grade of workmanship required. Another great obstacle is that while house carpentry is nearly all estimated on a flat surface, nearly everything in the construction of a ship is on a bevel. Hence, the ordinary carpenter finds himself at a loss to make his measurements and joints.

After calking has been completed, a gang of joiners planes the inside and outside of the ship to produce smooth surfaces in every part.

CALKING

After the outside planking is on, the squarer wears it down to some degree of smoothness, using an adz for this purpose. Following the squarer is the calker

Building Wooden Ships



Ship planked just above the water line, showing the ribs of the upper part and the cross pieces of steel used for reinforcement.



At the left, ship ready for launching; at the right, ship fully framed, ready for planking.

who fills in all seams with cotton, oakum, and pitch. While calking requires considerable skill and judgment, an intelligent workman with a reasonable amount of supervision can learn to perform all ordinary parts of the work in a few weeks.

THE BLACKSMITH

One of the most important workers in the shipyard is the blacksmith. He needs to be unusually expert and a skilled worker in iron, as practically all of the iron work which enters into the vessel is manufactured in the local blacksmith shop. About 125 tons of iron enter into the construction of a 3,500-ton vessel. The blacksmith makes rings, bolts, diagonal strappings, drift bolts, turnbuckles, belt straps, and many other parts too numerous to mention. His helpers should be more skilled than the average blacksmith; preferably they should have machine-shop training.

THE PAINTERS

Painters follow the calker and the joiner. They put on priming coats and do plain work on the hull, masts, and spars. In the paint shop some parts of the joiner work are painted and varnished before being installed in the ship. This work, and the finer finishing on the ships, call for expert painters and varnishers.

SHIP RIGGERS

In the rigging loft all cables are cut to the right length, fitted, and covered. Then gangs of riggers install the ropes and cables upon the ship. For the most part, the riggers should be men who know the work. It is not easy for a common laborer to take up the occupation. As in the steel shipyard, sailors and builders of yachts and small boats make the best riggers.

MILL MEN

A very important adjunct to the yard is the lumber mill. The head mill man should be experienced not only as a mill man, but in working out ships' timber. The mill men must be able to run circular saws, bevel band saws, and planers. The helpers may be men who have had experience in heavy lumber mills.

TEAMSTERS AND LUMPERS

In most yards the heavy hauling is done by teams. Any man accustomed to driving work horses can act as teamster. Working with the teamsters are men who are accustomed to handling lumber, hauling it and piling it. This work may be performed by men who have had experience in handling lumber, whether in mill yards or in lumber districts. Men who have worked on farms can do this work. There are also a few common laborers, sometimes called lumpers. Any strong, healthy man can do the work of the lumper.

The stable is in charge of the head teamster. In most of the large yards now under construction there is little or no teaming, steam derricks and electric cranes, and in some cases traction engines, taking the place of teams.

YARD RIGGERS

There should be in the yard crew a few men who are capable of handling fall and tackle and derricks. These men are called yard riggers. Men who have been in the habit of using tackle and derricks, with other similar lines of work, are capable of doing the same work in a shipyard.

THE ENGINEER

Wooden yards have stationary engines in the saw mills which any engineer accustomed to this kind of work can run. Yards are now using pneumatic tools

to a considerable extent. The engineer who runs the compressed-air plant does not need to be especially skilled. Any man who has had experience in running a stationary engine is competent, with a little instruction, to do this work.

WORKING AND LIVING CONDITIONS IN THE SHIP YARDS

All of the yards are striving to make good provisions for the comfort of their employees. Conditions are on the whole, considering the national emergency, fairly satisfactory, and in many of the yards they are excellent. As rapidly as unfavorable conditions are brought to their attention, the managers of the yards and the Emergency Fleet Corporation are striving to improve them.

WHAT THE EMPLOYMENT AND SERVICE DEPARTMENT MEANS TO WORKMEN

Many of the yards maintain a special department whose duty it is to select workmen from those who apply and to provide for their later training, promotion, and welfare. Responsibility for the safety and health of workmen within the plant as well as the housing and living conditions of the vicinity may be included in the work of this department.

The workman who applies for employment is assigned to a position upon the basis of his previous experience and training, and his general ability and fitness for the work. If it is not possible to place him to the best advantage at once, a transfer to some other department may be arranged later. Through the records in the employment office, promotions and transfers can be fairly and quickly dealt with. In many cases, its records are appealed to when a recommendation for discharge is made. If a man's record is on the whole meritorious, and he is being discharged because of inability to do the work and not because of misconduct, he may be given a trial in some other division of the yard.

The following are typical examples of what is being accomplished by Service Departments in the ship yards to make both living and working conditions attractive.

HOUSING AND REAL ESTATE

In several yards, two or three persons are constantly employed in searching out rooms or houses for rent and boarding places for employees. A list is kept of such places so that new men can be advised of suitable opportunities. Excessive rates are prevented by cooperation with the real estate dealers and the local Boards of Trade.

Many of the yards are building cottages and dormitories to accommodate their employees.

ATHLETICS AND OTHER FORMS OF RECREATION

One company has given \$25,000 for a club house and the improvement of six acres of land. Among the features are a baseball diamond, a soccer field, and a running track. On the first floor of the club house are six bowling alleys, two pool tables, a dance hall, lounging and reading room, shower baths, locker rooms, coat rooms, a kitchen, and canteen; on the second floor are located a ladies' rest room, a shooting gallery, the drill room for the guard, and a suite of rooms for the caretaker.

Dances and whist parties, smoke talks, indoor track meets, popular entertainments, boxing matches, and banquets are among the attractions to be found every week at the club house.

The members keep up a band of 35 pieces. A machinist in the plant is director. Beside giving concerts three times per week inside the plant, the band gives numerous public concerts and frequently represents the company on parades.

Launching the Ship



Launching Ways. In launching, the upper part of the ways slides upon the lower, carrying the ship into the water.



Ship just launched, with flags flying; launching ways showing at the right.

A glee club of forty members hires a professional leader to assist the director, who is elected by the club.

In some yards, rifle companies have been formed, composed entirely of employees and subject to call in case of emergency. They drill regularly and have a complete equipment of uniforms, rifles, and side arms.

SUGGESTION COMMITTEES

New designs for tools or machines, suggestions for better methods of doing work, provisions for safeguarding the health and safety of employees, are constantly being received and investigated. Suitable rewards are usually made for all suggestions adopted.

MEDICAL ATTENDANCE AND FIRST AID

No matter how much care is exercised, some accidents are certain to occur in any large establishment employing thousands of persons. Nearly all the yards make provision for taking care of all minor injuries.

Some yards maintain a first-aid station, in charge of a competent physician, in the center of the plant. By this means, considerable time is saved in handling small injuries, and assistance can be given to any serious case in a very short time.

The hospital in one yard occupies part of a well-equipped welfare building. It has a waiting room, emergency-treatment room, and a larger room fully equipped to perform even a major operation. Several physicians and nurses are in constant attendance. Free medical advice and treatment for any illness contracted while at work is given to all employees. Several groups of men have been trained under one of the physicians in giving first aid. The company keeps a record of the standing of the men in these classes and recognizes their willingness to cooperate by undertaking this study.

SAFETY WORK AND ACCIDENT PREVENTION

The staff for this work in a typical yard consists of the General Manager, two Staff Associates, and the Chief Surgeon.

There is a regular secretary who is responsible for all safety work, who acts as secretary to this committee, and also to a committee of workmen. Four subcommittees are selected from the employees, each having a chairman and secretary. The purpose of these organizations is to study the causes of injury, to provide means of preventing accidents, and to give out information concerning safety appliances and better methods. The subcommittees are distributed about the yard in such a way as to cover the most important portions of the work. In case an accident occurs within the territory of a member of any of these committees, he makes an informal investigation and renders a report to the committee at its next meeting.

THE SHIPYARD APPRENTICE SYSTEM

Many of the trades in a shipyard have characteristics peculiar to shipbuilding. For this reason it has always been the practice to give considerable attention to the training of boys rather than to depend upon the outside supply of skilled workmen. In fact, in certain trades, such as those of hull draftsmen, mold loftsmen, layer-outs, shipwrights, and shipfitters, it was absolutely necessary for shipyards to train their own workmen.

An apprentice supervisor is usually appointed whose functions are to take care of new boys, and to devote himself to the best interests of the apprentices during their terms. He sees that the efforts of instructors, leading-men, and foremen are applied to the best advantage, to the end that capable young workmen of good character are produced.

Provisions are usually made so that the apprentices have the best possible opportunity to learn the trade, that is, to work with a first-class workman rather than a helper, and to attempt a variety of work rather than to stay at one operation continuously.

Systems of pay vary slightly, but it is a common practice to make an annual increase of a few cents in the hourly rate. This is sometimes done semi-annually.

After a period of probation, generally six months, an apprentice contract which sets forth the terms of apprenticeship is signed by the apprentice and the concern. In order to encourage the apprentice to complete his term, a bonus and a diploma are generally offered for satisfactory service.

Evening classes are sometimes conducted for the special benefit of apprentices and time credit is given for attendance.

SPECIAL TRAINING FOR WORKMEN

It was understood from the outset that it would be impossible to get trained men in sufficient numbers to carry on the greatly expanded work of the old yards and to man the new plants. Men from other trades must be trained for the emergency needs of the nation.

In order to meet the demand for capable instructors in the yards, a special training center has been established by the Emergency Fleet Corporation at Newport News, Va. Experienced workmen are sent from yards all over the United States to be taught how to teach their trades to others. After a few weeks of intensive drill, they return to their respective yards to take up the task of emergency training of fresh recruits from allied trades in the work in which they are expert.

This training school for workmen-teachers has the whole shipyard for its laboratories and class rooms. Its instructors are chosen from successful teachers of shipyard apprentices and from specialists in industrial training. The staff is now organizing courses and developing plans which will make it possible to continue the Newport News center indefinitely and will also furnish material for establishing centers in other parts of the country as the need arises.

The man who seeks employment in the shipyards can be assured of the best of instruction. He will be helped to gain in speed and skill, and will be allowed to advance as rapidly as his ability will allow.

A LIST OF OFFICES OF THE UNITED STATES EMPLOYMENT SERVICE

The National Department of Labor is establishing employment exchanges in all large cities. It is their intention to have a director in every State who will enroll those who are ready to serve in any kind of industrial work connected with the war. Those who are qualified for work in the shipyards will be called to the places where they are most needed. The following list gives the addresses of the more important offices through which your application for employment in the shipyards will be received:

ZONE	HEADQUARTERS	NAME AND TITLE OF OFFICER IN CHARGE	SUB-BRANCHES
Maine	Portland Custom House	Timothy Elliott Insp. in Charge of Employment	
N. H. Vt. Mass.	Boston 53 Canal St.	H. A. Stevens Director	New Bedford
R. I.	Providence 222 Federal Bldg.	Joseph A. McKosker Clerk and Officer in charge	
Conn.	Bridgeport	J. Albert Gelineau Clerk	
N. Y.	New York 22 East 22d St.	P. A. Donahue Director of Employment	Buffalo (Room 8, Federal Bldg.) Syracuse
N. J.	Newark 9 Franklin St.	Thomas J. Burns Inspector and Officer in charge	Jersey City Orange
Pa.	Philadelphia 132 S. Third St.	Henry A. Gehringer Examiner in charge	Pittsburgh (Berger Bldg.)
Pa.	Erie (Federal-State)	Philip J. Barber Special Agent	
Pa.	Harrisburg (Federal-State)	Jacob Lightner Special Agent	
Pa.	New Castle (Federal-State)	James M. Clark Special Agent	
Pa.	New Kensington (Federal-State)	A. M. Frederick Special Agent	
Pa.	Scranton (Federal-State)	Joseph M. Stephenson Special Agent	
Pa.	Williamsport (Federal-State)	L. J. Fisk Special Agent	
Pa.	York (Federal-State)	W. B. Barnes Special Agent	
Del.	Wilmington Old Federal Bldg.	A. G. Benkhart Director	

ZONE	HEADQUARTERS	NAME AND TITLE OF OFFICER IN CHARGE	SUB-BRANCHES
Md.	Baltimore 2 North Eutaw St.	Thomas M. Barr Inspector	
D. C.	Washington 1410 Pennsylvania Ave.	E. M. Kline Acting Director	
Va.	Norfolk City Hall	F. A. McCarthy Examiner in Charge	
W. Va.			
N. C.			
S. C.	Charleston Custom House	Helen Steeger Clerk	
Ga.	Atlanta State House	W. V. Howard Director	
Ga.	Savannah Custom House	Anzi D. Carroll Clerk and Officer in Charge	
Fla.	Jacksonville Federal Bldg.	Gideon B. Travis Director	Miami Key West Pensacola Tampa
Ala.	Mobile Federal Bldg.	Henry C. Brownlow Insp. in Charge of Employment	
Miss.	Gulfport P. O. Bldg.	Hunter M. Course Examiner in Charge	
La.	New Orleans City Hall	H. A. M. Jacobson Examiner in Charge	
Tenn.	Memphis P. O. Bldg.	Joseph T. Ware Inspector in Charge	
Ark.	Little Rock 27 P. O. Bldg.	Robert B. Keating Inspector in Charge	
Ohio	Cleveland P. O. Bldg.	S. W. Mason Examiner in Charge	
Ky.			
Ind.	Indianapolis 319 Federal Bldg. Women & Girls' Div.	John S. Sherman Clerk and Officer in Charge	
Ill.	Chicago 845 South Wabash Ave.	James G. Boor Examiner and Temporary Of- ficer in Charge	Milwaukee, Wis. (809 Manufac- turer's Home Bldg.)
Mich.	Detroit Old P. O. Bldg.	Bert E. Barnes Examiner in Charge	Sault. Ste. Marie
Minn.	Minneapolis Federal Bldg.	Rutland D. Beard Examiner in Charge	
N. D.			

ZONE	HEADQUARTERS	NAME AND TITLE OF OFFICER IN CHARGE	SUB-BRANCHES
S. D.			
Mo. (Eastern District)	St. Louis 19 N. Eighth St.	W. R. King Clerk and Temporary Officer in Charge	
(Western District)	Kansas City 804 Grand Ave.	W. W. Brown Examiner in Charge	Des Moines, Iowa (1116 Capitol Avenue)
Nebr.	Omaha County Court House	M. A. Coykendall Examiner in Charge	Lincoln
Kans.			
Okla.			
Texas (Southern District)	Galveston Am. Nat. Ins. Co. Bldg.	(Appointment pending)	Houston Brownsville Laredo Eagle Pass San Antonio San Angelo
(Western District)	El Paso	Perry P. Young Insp. in Charge of Employment	Del Rio
(Northern District)	Fort Worth	Wm. H. Robb Examiner in Charge	Big Spring Amarillo
N. Mex.	Santa Fe 261 San Francisco St.	Karl W. Greene Acting Director of Employment	Albuquerque Tucumcari Deming
Colo.	Denver 355 Federal Bldg.	Walter J. Matthews Clerk and Temporary Officer in Charge	
Utah	Salt Lake City Federal Bldg.	D. Arthur Plumly Acting Director of Employment	
Wyo.	Cheyenne	J. E. Durham Examiner and Officer in Charge	
Mont.	Helena Power Bldg.	Chas. K. Andrews Acting Director of Employment	
Idaho	Moscow	Wm. J. McConnell Insp. in Charge of Employment	
Wash.	Seattle First Ave. & Union St.	Harry White District Director	Spokane Walla Walla Tacoma Aberdeen Everett Bellingham North Yakima Friday Harbor Nooksack Lynden Custer Port Townsend Port Angeles

ZONE	HEADQUARTERS	NAME AND TITLE OF OFFICER IN CHARGE	SUB-BRANCHES
Oreg.	Portland 247 Davis St.	W. F. Smith Examiner in Charge	Astoria
Cal. (Northern District)	San Francisco Claus Spreckels Bldg.	William T. Boyce Director	Fresno Eureka Monterey
Cal. (Southern District)	Los Angeles P. O. Bldg.	Emil J. Bernatche Clerk and Temporary Officer in Charge	Santa Ana Santa Barbara San Luis Obispo Bakersfield San Bernardino Calexico Indio
Cal.	Sacramento	Lester M. Young Examiner and Temporary Of- ficer in Charge	
Cal.	San Diego P. O. Bldg.	Henry Y. Hackett Inspector	
Nev.	Reno	Neil McGee Examiner in Charge	
Ariz.	Phoenix 14 Wall St.	Frank Brown Special Agent and Temporary Officer in Charge	Tucson Douglas Naco Nogales Phoenix Yuma





