THE PRACTICAL SHIPBUILDER

1839

by LAUCHLAN McKAY

THE PRACTICAL SHIP-BUILDER

PUBLISHED IN ORIGINAL FORMAT
WITH SEVEN LARGE FOLDED PLATES

With Biography of Lauchlan McKay, Master-Shipbuilder, &c.

PRIVATELY PRINTED
1940

RICHARD C. McKAY

ONE BROADWAY • • • NEW YORK, N. Y.

THE

PRACTICAL SHIP-BUILDER:

CONTAINING

THE BEST MECHANICAL AND PHILOSOPHICAL PRINCIPLES FOR THE CONSTRUCTION OF DIFFERENT CLASSES OF VESSELS, AND THE PRACTICAL ADAPTATION OF THEIR SEVERAL PARTS, WITH THE RULES CAREFULLY DETAILED.

THE WHOLE BEING PLAINLY AND COMPREHENSIVELY ARRANGED FOR THE INSTRUCTION OF THE INEXPERIENCED

ILLUSTRATED WITH PLATES.

BY L. M'KAY,

PRACTICAL SHIP-BUILDER AND CARPENTER, OF THE UNITED STATES NAVY.

NEW YORK:

PUBLISHED BY COLLINS, KEESE AND CO.,

254 PEARL STREET

AND SOLD BY THE PRINCIPAL BOOKSELLERS IN THE SEAPORTS OF THE UNITED STATES.

1839

CONTENTS.

INDEX.

INDEX.

INTRODUCTION.

In preparing this work, I have had in view the immediate wants of practical ship-builders, and have endeavored to render it plain and intelligible, by using such expressions and giving directions in such terms as are familiar and easily understood. Writing to exhibit learning, by the use of scientific terms, has not been my purpose, but instead, I have endeavored to afford necessary information, in conformity with common practice and without ostentation.

The ship-builder has labored, in the larger portion of our country, under the necessity of working by guess. The publications of other countries have been large and expensive, full of intricacy, scientific rather than practical, and consequently of little use to the uneducated mechanic. Still, without any rules, our mechanics in many parts of the country have been enabled to complete excellent vessels, by their great tact and ingenuity; and undoubtedly, with a moderate share of science, and the aid of correct rules, they will continue to improve in marine architecture, and construct better vessels for the various purposes of trade.

There are certain philosophical principles which govern all works of art; and if practice will often lead ingenuity near to the truth, direct certainty, aided by experience, lessens labor, and ensures a greater degree of perfection. Accurate knowledge is the best copartner of genius; for if much may be accomplished by a strong mind without learning, much more may be done with a rich storehouse. There is now no access in our country to the rules and principles of the construction and building of ships within reach of those whose wealth will not allow them to obtain expensive books, or whose time will not permit them to go through a course of deep and intricate study. My purpose has been to supply this deficiency. In this work the builder is led through his course of instruction as if he were in the ship-yard; with principles to guide him in choosing his model, and with rules for laying out his whole work accurately, and putting it together with certainty and in the most convenient manner.

The form of models should vary much, according to the waters to be navigated, and the object of carrying freight or running with speed. This requires much consideration. The carrying a large freight in proportion to the size of the vessel will more or less impair the speed; and to carry an equally small freight will have the same effect, but for contrary reasons. In overloaded vessels, being immersed more than the natural power of their structure will bear, they labor hard in a sea, and soon become injured from straining. The vessel being immersed deep in the water, the resistance becomes too great for the proportionate power of the sails. In light vessels, with altogether too small cargoes, they are tossed by the sea, become top-heavy, for want of the requisite amount of power to keep them down to a proper waterline and make them steady; the full amount of sail, which under other circumstances would be appropriate, is rendered unsafe to carry; and from want of a proper balance between the weight of the hull and the power of the masts and sails, the vessel in either case loses in speed and security. A true medium should be preserved, and some knowledge of rules and principles is necessary to aid practice in devising the forms, proportions, sizes and models best adapted to different kinds of trade and to different waters.

These remarks, I am aware, contain nothing new, but, because they are so well known, I may rely upon the opinion, that what is here done to supply the deficiency in books will be acceptable and useful. The theoretical part of the book is not extended to minute and learned disquisitions, but it gives established principles with sufficient fulness for a thinking man. The details of modelling, drafting, and laying out in the loft, getting out the timbers and putting them together, are given as one might give directions in the yard, step by step, in the most convenient order for executing the various parts of the work. Yet even in this department much information of a trivial nature might have been added in regard to the management of many parts and the finishing of the whole ship; but to have introduced all this would have swelled the work to an unwieldy and costly size, while to our mechanics the information itself would have been mainly useless. No firmer, better or more highly finished ships have floated than have been built in this country, and general rules only are wanted to aid the practice; while it is certain that our indomitable perseverance, ingenuity and constant practice will come in aid of and improve upon general rules.

When we look at the improvements made by ship-wrights in the United States, and know at the same time that they have been introduced by guess in many instances, we may well be surprised that so little true science and so few methodical rules have been understood; but when again we think of the many failures, of the clumsy, misshapen structures that have been produced, at all times and in all places among us, in the course of these very experimental efforts, it causes regret that enterprise should not have been guided by better knowledge. The schooner is an American invention. The Baltimore clippers, as they are called from their fleetness, astonished and puzzled the British seamen in the last war. The writings of their naval officers are full of expressions of admiration and wonder at the feats of this species of craft upon the ocean. The New York and some other packets, and many of our merchantmen, have long been the admiration of other nations. The English and French have paid just tributes to the neatness, elegance and accurate form and rig of our merchant ships, while Russia and Turkey have adopted them as models. But during the time that improvements have been thus perfected, the ocean has been too often burthened with ill-formed, unsightly, clumsy and dangerous vessels.

There are principles of construction adopted by the French naval architects, which are not in fashion in this country, but which deserve the consideration of our ship-builders. They have a tendency to rake the main breadth from a perpendicular, which they have proved by experiments improves the sailing qualities of the vessel. To understand this, take the centre of the middle waterline, at which point should be the greatest breadth upon that line, take also the centres of all the other waterlines, from stem to stern, and the points of those above the middle waterline will be more forward according to their height, while those below will fall more and more abaft as they descend. A diagonal line will cut all the points, and will represent the line of greatest breadth for the entire hull, which will deviate just so much from a perpendicular line as the stem may rake. Some, however, contend, and with some propriety, that the greatest breadth should be more or less farther forward than the middle of these lines, but preserving the same proportion of rake according to the rule laid down. Taking the distance from the stem, at which the greatest breadth is desired, the rake of the main-breadth line will correspond with the rake of the stem. The philosophy of this form of the model is, that the resistance to be overcome by the vessel is of two kinds: first, it must be met in a horizontal direction by the bows, by which it is forced aside; then there is an upward, or rather an inclined upward force, as the swell of the bows and sides makes an angle to which the fluid always presents a corresponding angle. The hull is therefore propelled easiest when its form is such as to take the most advantage of and ride easiest over the inclined surface of the water.

This process leads naturally to considerable fulness of the lower waterlines, and is opposed to the principle of raking stems, which is so much approved by many builders. A very raking stem rides easily over smooth water, and presents the angle best adapted to overcome the double resistance of a fluid inclined plane; but in pitching in a heavy sea a variety of difficulties are encountered. The weight and burthen of a vessel with raking bows are sustained further aft than in full nose. The centre of gravity is consequently further aft, and when the vessel turns upon that centre the sharp bows pitch quickly upon a sea, which strikes with great force, but presents little lifting power at that point to enable the ship to rise and ride easily upwards upon the sea. After the first shock, and when the stern has settled, the water presents an inclined plane to the bows, and the weight or downward pressure being always perpendicular, the inclined plane of the raking stem, upon the natural inclined plane of the sea, tends to slide backward, according to the true mechanical principle of the wedge. If, on the contrary, the stem be perpendicular, it gains the advantage of buoyancy at that point, which is so desirable, and also divides the water immediately, so as to avoid the heavy stroke of the sea in the first place, and then to be lifted by it handsomely without the natural mechanical tendency to slide backward. The effect of a raking stem is governed by the same principle of inclined planes in riding a sea; it makes little difference in ascending or rising, because then the power and resistance are encountered by the bows and main breadth, but in descending into the trough there is a material difference. If the stern be perpendicular, it sinks directly into the water, and the vessel is deprived of the propelling action of the fluid angle, which may be obtained by a rake. When the stern presents an angle corresponding to that of the water in a considerable degree, the tendency is to slide downwards and forwards, and a power is thus gained to give headway as the bows are about to ascend the next wave. This action of the water, slight as it may at first seem, is an important element in gaining headway in heavy seas, when a portion, if not all, the sails are taken in, and it gives liveliness and ease, in proportion as the vessel is adapted to make every advantage of it.

Having in the body of the book given instructions for building according to the plans most common in this country, it was impossible to go at full into the detailed considerations of these principles; but the builder, who has made himself acquainted with the rules of modelling and drafting, can easily take advantage of these suggestions, and vary his model accordingly, and will be better prepared to study more intricate and scientific books, embracing essays and calculations incompatible with a cheap and practical work.

Many of our ship-masters are fully acquainted with the science of ship building, and understand better even than many ship-builders the operation and action of the wind and water upon different hulls and sails. They procure various information in foreign countries, become possessed of instructive books, and improve the many leisure hours they can command at sea in study and contemplation. Others pay no attention to such subjects, and are satisfied if they can master the rules of navigation. It is apparent, however, that a ship-master ought fully to comprehend the structure of his ship, that he may know where its greatest strength lies; that he may be able to take every advantage of circumstances to sail her in the best possible manner, according to her form, rig, or manner of lading, and above all that, in case of accident or damage, he may be able, in foreign ports and among ignorant men, to direct and superintend the making of repairs in a correct, thorough and economical manner. If it were possible to avoid it, no man should be entrusted with a valuable ship and cargo, who is not thoroughly informed upon these subjects. It is scarcely to be expected that owners and underwriters should be intimate with the details of a ship's structure, but they should possess and have at command the means of estimating the correctness of reports of damage, loss and expenses, in order to ascertain the faithfulness and ability of those employed by them to take charge of an important trust.

For midshipmen and other young officers in the navy, such a work as is here presented, though not devoted to ships of war, will be found useful in giving principles as applicable to them as to merchant ships; and the material part of the construction being similar for both classes, a competent amount of desirable knowledge may be herein obtained, at a cost which is reasonable, and in a form easy for constant reference. Should this effort to improve the art of ship building be approved, we may reasonably expect that copies will be furnished by government for the use of young officers, and especially for the advancement of the naval school in what should be an important branch of their education.

TREATISE ON SHIP BUILDING.

SECTION I.

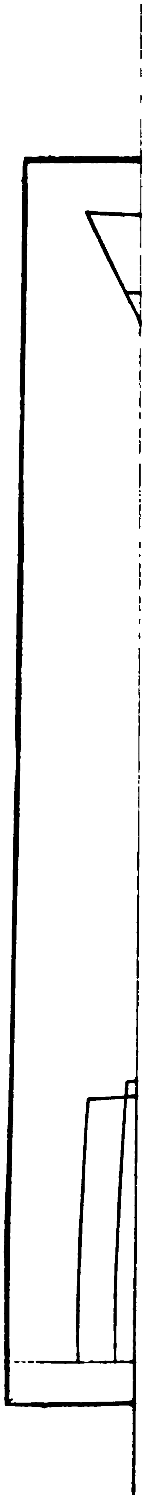
Directions for the making of Models; for transferring the construction to the drafting board; together with the laying down in the loft: and some general observations on the form and sailing qualities of different models.

THE first consideration when constructing a vessel, is that of constructing her on the most proper model to suit the trade for which she is intended, and at the same time to preserve as many of the necessary qualities for other trades as possible, to enable the owner to dispose of her, should the particular trade for which she was constructed prove unprofitable. To construct a vessel so that her natural relative position in the water will be taken when launched,—which she should have when loaded, is another of the first considerations, and one that requires a very considerable mathematical calculation—the outlines only of which I shall mention. There are three great laws on which this science is based, viz., stability, velocity, and buoyancy. The correct arrangement and disposal of these three leading principles will afford ample scope for improvement, and will furnish our future architects with a subject capable of employing their minds and capacities for ages to come.

Naval architects first consider the weight of the guns, rigging, shot, provisions, men, &c., together with the weight of the hull. They are thereby enabled to find how much water is required to be displaced, to be equal to the said weight. They then determine upon the centre of gravity; which may be obtained with a great degree of accuracy. To bring the centre of gravity in the most appropriate point, it is necessary to calculate the weight, height, &c., of the masts, yards, sails, and that portion of the hull which is above the water; as they act upon, and are counterbalanced by, the ballast, cargo, and all that is below the water. The centre of gravity is a well-known point. It is that point, whether it be within or without the body, by which if it was suspended, it would rest immovable in any situation, as if the weight of the whole body were united in that single point. "Hence," says Brindel, "to find the centre of gravity of any body, is to find that point upon which, if the body rested, all the points would be in equilibrium." This, therefore, is applicable to a ship's body. There are many ways to find the *displacement* of the water. I shall mention but one, which is the most simple and easiest comprehended, by which you can easily determine how much weight will be required to load the ship to any waterline. Take the width of every other frame on the loaded waterline, either from your model or from the body plan, on the said line; add the widths so taken together, except the forward and aftermost frame; take one half of each; multiply that sum by the distance between the frames so taken, and the product will be the area of the waterline contained between the foremost and aftermost frames; then find the area of that part abaft the after frame, which forms a *quadrilateral* figure; also the post and rudder; likewise find the area of that part forward of the foremost frame; also the stem and gripe: add these last areas to the one first found, and double the sum will be the area of the surface of the same waterline. Secondly, the areas of the other waterlines may be found in the same manner; then add all the areas together, except the upper and lowermost ones, of which one half only must be taken, and multiply that sum by the distance between the water lines, (they being equal distances from each other.) The product will be the solid contents of the space contained between the lower and loaded waterline. Add the area of the lower waterline to the area of the upper side of the keel; multiply one half that sum by the distance between them; which will give you the solid contents of that part between the lower waterline and the upper side of the keel, supposing them parallel to each other. But if the lower waterline is not parallel, but similar to the Pilot Boat, (Plate 2,) then take the distance between the upper edge of the first waterline and the keel at every other frame, and add them together; divide the sum by the number of frames so taken, and the quotient will be the mean distance by which to multiply the mean area as before. The solid contents of the keel may then be found, which, added to the contents already found, will give the whole number of cubic feet contained in the immersed part of the ship, or that part below the loaded waterline. Allowance must also be made for the thickness of the plank, and added to the above.

By this means it is easy to determine how much a ship or vessel weighs, with sails, rigging, cargo, &c. on board; and if the calculation is properly made, the vessel will come down to that line and no further; and you have simply to multiply the number of cubic feet of water displaced, which is the number of cubic feet already mentioned in the immersed part of the vessel, by the weight of one cubic foot of salt water, which is equal to seventy-four pounds, and the answer will be pounds.

It will not be necessary to lay down the rules for finding the centre of gravity, as they may be found in any work on Geometry. Neither is it necessary to enter into this tedious process for merchant vessels. But you can bring the centre of gravity on a fore and aft or longitudinal direction, near its proper place, by embracing the improvements that I herein strongly recommend; viz.—by filling out and straightening the hollow lines which are usually made concave. Many of our merchant ships, when launched, set three feet by the stern, when they are actually required to be brought on an even keel for our southern trade. It is also a well-known fact, that vessels should be trimmed when loaded, parallel to their draught when launched. When they are altered from that trim, it not only injures the sailing materially, but strains, and eventually hogs the ship; for the process of putting ballast in the forward part of the vessel only serves to lift her aft, from the centre of gravity amidships, or wherever it may be; and as long as the vessel is kept in this position the whole stern will hang down with a strain, equal to its own weight, and must finally hog the vessel. Many fine ships are broken-backed and ruined through a misapprehension of this part of the theory; and none that I have ever heard speak of having their vessels hogged, have attributed the fault to the proper persons; for it has generally been attributed to stowing the cargo, or getting aground, and so forth. But the fact is obvious, that when a vessel gets old or weak, having no bearings aft to sustain that part of the superstructure, she must settle aft;



whereas if she was trimmed to her natural position, there would have been no such tendency.

As vessels are almost universally built from models in the United States, and as it is much the most accurate and preferable method, I shall commence by showing that mode of construction.

It is first necessary to determine the length that the vessel is required to measure on deck when built, together with the width and depth. Prepare a drafting board three or four feet long, according to the size of the scale or ship. Draw a line or run a gauge about one inch from the edge of the board, to represent the base line, or top of keel. Take a scale to correspond with the size you want your model; one quarter, or three eighths, or any other scale you may deem suitable, will answer the purpose. Having concluded on the length and the scale, you will now proceed to draw the sheer plan. Draw a line perpendicular to the line representing the upper edge of the keel, which will represent the after side of the stern post. Set your dividers and measure on the base line the length of the ship, which will be to the forward part of the stem when squared up; but you must deduct the size of the stem and stern post, in a fore and aft direction, which will give you the rabbetts of the stem and stern post. Suppose that a ship was required to measure 125 feet; the stem to mould 1 foot 6 inches; and the head of stern post 1 foot 3 inches. Deduct the sum of both, which is 2 ft. 9 in., from 125 ft., leaves 122 ft. 3 in. between the perpendiculars and rabbetts. Square up a line as before, to represent the after side of stem or rabbett, and these two lines will be 122 ft. 3 in. apart on the base line, or at the height of the deck where the ship is to be measured. You will next determine on the height of the main transom, or cross seam, which should be about the depth of the ship's hold, or a little less, as you may fancy, but for a small vessel much higher, and from that determined height project your counter, and upright of stern, according to your wish. You will then find the depth that the model is required to be, by supposing she was required to measure 19 feet when built. Set down in figures, as follows:—

	Feet.	In.
Required depth,	19	0
Thickness of floor and ceiling,	1	2
Height of water-ways,		10
	21	00
Deduct round of beam,		6
Depth required amidships,	20	6

to the under side of plank sheer. Suppose your sheer to be 2 feet; take 22 feet 6 inches in your compasses, and set it up from the base on the fore and aft perpendiculars, and bend a batten fair from thence to the height, 20 ft. 6 in. amidships, which will be the sheer; then draw in your stem, and rake it as your judgment may direct. You will also strike a sheer above, parallel to the sheer last drawn, for the ship's rail. You will now proceed to draw in your waterlines in the sheer plan. Two feet on your scale is about the best thickness for them. Set your dividers to 2 feet; step them up on the forward and after perpendiculars; observe to make dots for each step; take a straight edge and draw a line with a pencil from one dot to the other. Continue to draw in your waterlines, raising one above the other until you come about 1 ft. 6 in. or 2 feet from the top height, amidships; and this 1 ft. 6 in. or 2 ft. will be the thickness of your sheer-pieces in the model. If you cannot make your waterlines come out right by making their thickness 2 feet, you may increase or diminish their thickness, so as not to leave your sheer-pieces any thicker amidships, or you may make your upper waterline out of a thin piece half as thick as the others, and as it is a preferable way to let your upper waterline come as high as the cross seam. In that case it will be termed a cross-seam breadth in the half-breadth plan, and a cross-seam height in the sheer plan. For instance;—suppose a ship's model is required to be 20 ft. 6 in. deep amidships; we will draw 9 waterlines in the sheer plan which will be 18 feet. This, you see, would leave the sheer-piece too thick, and will be about the proper height for the cross seam, and it cannot be altered for the better. Hence we will call it a cross-seam breadth, in the half breadth, or model. The height of the cross seam should always be determined, and is never to be lowered or raised to suit any convenience that the thickness of the lines might seem to call for. It may not be amiss to remark, that a difficulty arises from the cabin windows, which should always be consulted when the vessel is to have a flush deck; if you raise your transom too high, your windows cannot be of the proper size to look well and come under deck. You will see from the following, that the height of the upper edge of the beam amidships is not so much as the height of water-ways, or under part of plank-sheer, by 4 inches; because the round of the beam is but 6 inches, and the height of water-ways 10 inches. If the round of beam was 10 inches, then a straight line extended from the top of the water-ways athwart-ship would intersect the top of the beam, when in its place.

The height of the beam amidships, or in the main hatch from the upper side of keel, is 20 feet 2 inches; add, for instance, 2 feet sheer, which is a straight sheer for a ship of this size, the sum will be 22 feet 2 inches, which will be the distance from the top side of the after beam which fays against the counter timber, to the upper edge of keel, or base line. Deduct 19 feet, which is the height of cross seam, and the remainder will be 3 feet 2 inches; which is the distance from the cross seam to upper edge of beam. You will see from the accompanying draft of a ship, (figure 1,) that the under part of the arch-board is about 1 foot above the cross-seam height: the width of arch-board should be about 1 foot; but as it cants on an angle of from 30 to 40 degrees, its upper edge would not be more than 20 inches from the cross seam, in a perpendicular direction. This leaves but 1 foot 6 inches for cabin windows under deck, in flush-deck vessels, 8 inches of which would be blinded by the depth of beam; 10 inches only would remain for windows. In such a case, you would have to lower your cross seam about 5 or 6 inches, which would give the windows on the angle of the upright of stern about 20 inches. One of the greatest advantages derived from a poop or break in the quarter-deck is, that of having a high transom; whereas if the ship is flush decked and straight in the sheer, you cannot get it as high as it should be, to make a vessel easy in a sea-way. If you have a poop, or high quarter-deck, you need not consult your cabin windows on your model, as you will be sure to have room enough.

The sheer plan being now completed on your draft board, you may proceed to draw the shape of your midship frame or dead flat; having determined on the dead rise of floor, and the width she is required to be when built, deducting the thickness of waist, or bends, as the vessel may be finished. Suppose a ship required to measure 27 feet, and the thickness of waist 4 inches, and the top sides to tumble home 2 inches at the height for measurement, which is frequently termed side swell. I shall not presume to say which is the most proper term, as my object is to make the terms familiar to all. It matters not which side you make the model for. You can proceed to draw it on your draft-board or parchment, by drawing a straight horizontal line, to represent the top of the keel, from which you will raise a perpendicular line to represent the centre of the ship, as though a line was extended plumb from the centre of the beam to the centre of the keel, which is called a middle line. You will take half of the width, 27 feet, which is 13 feet 6 in.; deduct the thickness of the waist, which will be about 4 in., that will leave the moulded breadth 13 feet 2 in., and she may tumble home at the measured height about 2 in., which should be added to 13 feet 2 in., making 13 feet 4 in.; and with that width in your dividers, set off on the base line representing top of keel, making a dot, and raise the other perpendicular, which will be parallel to the middle line. You will next draw a line to represent the side of keel, which will be half the thickness of it from the middle line, and parallel to it, and is called a side line. We will next consult the length of floor, which in a flat ship may be as two thirds of the extreme width, which will be 18 feet; take the half of it, 9 feet, in your compasses, and set off from the middle line on the base line, and make a dot. Square up a line about an inch, and then take your dead rise, 10 inches, set up on the line last drawn for your floor head, and draw a straight line from the dead rise, just set up, to where the side line intersects the base, which will be the dead rise or bottom of floor. You will then form your bilge or side, as your fancy may direct, observing to continue the second futtock easy from the floor head, until you meet the line representing the width of the ship, about the middle of the wales. Then take from the sheer plan the height of under side of planksheer amidships, or at he mark ⊕, and set it up, from the base line in the body plan, on the middle and half-breadth lines, and draw a horizontal line from one to the other, to represent the under side of planksheer. Then take three feet in your compasses, and set it up above the line last drawn, and draw a line as before, to represent the height of rail; then take the space in your compasses that you intend the ship to tumble home, on the plank-sheer height, and placing one leg on the line representing the width of ship, extend the other leg in towards the middle line and on the one representing the under side of plank-sheer, and make a dot, which will be the outside of the timber at the plank-sheer height; draw a line down from it to intersect the half-breadth line about 5 feet below, which will leave a small space in the ship's side, exactly plumb; this line will curve gradually, and you will extend it up fair in the same direction nearly until it meets the rail height. Having done this, you will have the shape of the ship's side, and floor, and you will then proceed to draw in the waterlines, parallel with the base line. The spaces are to be the same as they are in the sheer plan. Having done this, the body plan is complete. You will number the lines 1, 2, 3, 4, beginning at the first line, or the one nearest to the base, and then prepare your boards—pine and Spanish cedar are the best, the colors being contrasted, and the stuff soft, and easy to work—if you make them all pine you cannot see the form of the lines. Be very careful to face your stuff, and it requires the greatest pains to get the stuff out, of the same thickness as it is drawn in the sheer and body plans. When you have it all of a thickness, joint and square one edge; number them 1, 2, 3, 4, &c., putting the narrowest and shortest in the bottom, and commence your numbers also from the bottom, to correspond with the same heights in the body plan; you will then take the widths from the waterlines levelled out in the body plan, and transfer them to their corresponding numbers on the pieces of boards; gauge and plane the boards parallel from end to end. Proceed in this way with all the waterlines and sheer-pieces; you can then obtain their length from their corresponding height in the sheer plan; and can then fasten the whole together with screws or keys, observing to keep them square from the bottom upwards as you secure them. The better plan is to put them in a bench screw, observing to square and keep all the edges out of wind before you tighten the screw. This being done, bore three or four holes through the whole, and treenail them together. Then face the midship part of the model, observing carefully to square it; for if it is not exactly square and out of wind, it may be liable to great error, and very difficult to lay down. Next plane off the outside edges from one to the other, which will form the side of the ship, at ⊕, from the first waterline to the rail. Be careful not to plane too heavy, or you will make the ship too narrow. You should leave your stuff all about one eighth wider, to guard against this evil tendency. You can then get your dead rise by setting a bevel with the stock on the side line of the keel, as in the body plan, and the tongue running in the direction of the floor of the dead flat. You will then apply the stock to the midship part of the model, and plane until you get it to its proper first waterline, and plane until you get it to its proper bevel. Then mark the length of the floor on it, and round it gradually from that, to the edge of the first waterline. Having done this, you will have the shape of the midship frame, which should be two or three feet abaft one third of the length of the ship from the forward perpendicular, or rabbett of stem. A ship being 114 feet, as in plate 1, I have placed the dead flat 42 feet from forward; and after you have concluded on its station, make a mark across the model to designate it.

In a full ship there should be three or four of these frames alike, all of which I would place abaft the dead flat; you will then form your stem and stern as you have it on the draft-board. Set a gauge the thickness of the plank less than one half the thickness of the keel, and run it along the bottom, and up to the stem and stern-post, to form a rabbett. You now have the length, breadth, and depth of your ship, together with the shape of the side and bottom; and from this block you have to form the vessel, without any other correct rule or guide but your own judgment.

You will next conclude on the length of your transom; which should be, according to the prevailing fashion, about four fifths of the width of the ship; 22 feet for 27 feet beam will be about the proper width; one half of which you will set off from the edge of the model, or centre of stern-post, and bring the stern to that width, which will remain the same on the knuckle or end of main transom. Then tumble in your quarter as much as you may deem proper. The horn-timber or fashion-piece (plate 1, figure 3,) will give you the idea. You may then proceed to your width forward, which should be a very little less abreast the windlass than amidships. Form your deck-harpin full on the luff, with a short but easy turn, and let your rail-harpin be much fuller; so that the forward part of the rail will be nearly athwart-ships. The breadth on the rail should be nearly as wide on the luff as amidships, and the luff carried much further forward than that of the deck or wale-harpin. Having formed the top sides of the ship, you will now commence the bottom by gradually increasing your dead rise forward and aft of the dead flat, and making your waterlines easy and fair until you approach the extremities, where they will come nearly to a mitre, as they meet the gauge mark which was run for the inside of the rabbett. You will readily perceive the necessity of cutting to the inside of the rabbett, when you reflect that the outside of the plank must come flush with the outside of the stern-post, and stem; and on the same principle fore and aft the keel. You will also observe to make the frames come fair moulding-ways, or up and down the side of the model; and also be careful to make the section lines easy and fair. The utility of them I think necessary more fully to show. For example, divide your cross-seam breadth or transom on your model into four equal parts, which will give three settings off betwixt the centre of the transom or cross-seam and the quarter or end of the transom. If you will pin a thin batten to either of those settings off, and let the other end extend forward towards the floor of the dead flat on the bottom, keeping its forward end as far from the midships as the after end, or parallel with the keel, and straight on its edge from end to end, you will then see that the bend comes on the flat side of the batten. If this bend should be unfair, you must endeavor to ease it as much as your waterlines will admit without making them too hollow, or the ship too sharp. You will see that the sharper the ship is aft, the straighter will be the sections, and the more hollow the waterlines. If this batten is on the spot nearest the centre of the stern-post, it will be called the first section; and you will number from that towards the end of the transom. You will also perceive that the batten will have to bend much more on the first than on the second or third section. When your bottom is in its proper shape, and a batten is bent on the third section as above described, it will be seen that the after end of the batten, or all the part within 10 feet forward of the cross seam, will come straight, and it will often have a tendency to come hollow, which you should guard against, and keep the after end of your third section nearly straight. Let the after end of the third section batten run abaft the cross seam, and it will be found to fay against the counter; so that you can have no better guide than to cant or rake your counter accordingly; and if you have a patent rudder your counter should be 26 inches on this rake to the knuckle, from which you will rake the upright of the stern. Observe not to cut your waterlines too hollow for the sake of straightening your first section. I admit that the straighter the first section is, the more easy the water would seem to pass in the direction of that line; but you will also see that the water closes in with quite as much force in a horizontal direction as it does in a fore and aft direction; and as I have explained in the theory of sailing qualities the evil tendency of a hollow or concave line, it will not again be necessary to warn you any further against it. It may be worthy of remark that there are a number of ships now building, without the smallest concave line in any part of the bottom. In the ship (plate 1,) it may be seen that the first section comes very round or full, and I have no doubt but such vessels will sail equally as well as sharper ones, and they will carry a much greater cargo.

The action of the Water on the Rudder.—Many practical men, both mechanics and captains, as well as merchants, object to have the lower waterlines full, on the ground that the ship will not steer well; but this I believe to be a mistake. I contend that the water acts with a much greater force upon the rudder half way up the stern-post than it does on the lower brace; and the proofs are plain. Suppose you put the helm half way to starboard or port, as in figure 8, plate 5. You will admit that the water closes in upon the ship before it reaches the rudder, or at least a portion of it; hence it passes along the side, closing in on a horizontal direction, or parallel to the surface, and on a right angle to the ship's course, leaving the ship as though she was lying at anchor in a strong current. Let the line A B represent the ship's course, and C the rudder half way to starboard or port; let the line marked S E represent the side of the keel or ship's side, and the line D E the first or second waterline, or direction of the water as it passes the ship. F represents the fourth waterline, or course of the water round that part of the ship. It must be admitted that the water passes the ship, or that they pass each other, in the direction of the lines marked D E and F E, or on a fuller or sharper line as the ship may be built. It must now be plain to every unprejudiced man, that the water will act with much greater force as it passes from F to E than it does from D to E; for, in the first case, it strikes the rudder on a right angle, consequently it acts with full force, and will be but little impediment to the ship's headway; whereas in the latter case it strikes the rudder in an oblique angle, and passes by without acting with any material force, and is a greater impediment to the ship's headway than in the former case. This may be proved by considering the action of the water on the opposite side of the rudder; the course of the water being the same on both sides of the ship until it meets the rudder. You will see in the same figure, on the side opposite to the line marked F E, a line marked H, which represents the water's course, as above described. You will also perceive that it strikes the rudder obliquely, and serves to impel the ship ahead, or at least to counteract any tendency to impede in the line F E. Next observe the course of the water on the line marked K, until it reaches the after part of the stern post, when it has to fill up the vacancy made by the rudder. To do this, it has to change its course on a right angle at W, in which case the water, thus suddenly changing its course, cannot fill up the space as quick or as forcibly as it would on the line H.

Therefore I propose and recommend the straight waterline, as it must be evident to all that the water will pass by with more ease on the line G, than it can by running in the hollow one marked K. Nearly all persons will say that almost all the bad steering vessels they have known were full aft. This I will admit to be the case; but they were not full where they should be. The worst steering vessels are generally wide and flat, with heavy buttocks; and of all impediments to fast sailing, such a form of construction is the greatest. If you were to observe such a vessel under way, with a very light breeze, and in company with another vessel of a proper model, you could perceive little or no difference in their respective speed; but as the breeze freshens, the latter will gradually draw ahead. I conceive it to be for this reason, viz.: when the full vessel is moving very slow, the water passes along so gradually that it has time to change its course without boiling or roaring, as it thereby is enabled to fill the space in due time, notwithstanding the difficulties already enumerated, and with which it has to contend; but when the vessel is going rapidly ahead, you will see a confusion in the water, which is caused by its having to change its course on a right angle to the vessel's course, and the distance being so short from the buttock to the stern post, it cannot form a regular stream, owing to its being interrupted by the water boiling up from under the bottom, in the direction of a section line, or fore and aft.

It is then very evident, that as far under water as the buttock extends, the water can have no material force on the rudder, and in many vessels the evil of hollow waterlines is prevalent in the extreme. In Eastern vessels, more especially, this fashion prevails; and in such cases it is usually said, the run is short, consequently we have to make it sharp, to make the vessel steer easy; and we, like our forefathers, conclude to make the vessel sharp from the keel one half or two thirds up the stern post, taking it for granted, that the rudder would do little or no good from that to the surface of the water; whereas if they had filled out the run, so as to bring the lower waterlines less hollow, and eased the buttocks, the ship would steer well. The line N shows a waterline of a vessel having a short but sharp run, and it may be seen that the water comes in contact with the side of the run before it gets to the rudder, and then becomes dead, or branches off on the line O. The line L shows the line of the water, and its course round the vessel at a loaded line; and when she is in a heavy sea with two or three streaks heel, the whole buttock is buried under water, which must necessarily cause confusion in the water, to avoid which, without altering the model, you would have to change nature itself.

I should not have gone so fully into this explanation, had I not been convinced of its vast importance to a correct knowledge of the science of ship building.

I shall now beg leave to refer this part to your own consideration, and proceed to finishing the model. Having got your model fair, without suddens or lumps, you may sand-paper it smooth, and square up your dead-flat in its proper place, as before described, from the base to rail, and mark every piece on that line with an O crossed thus, ⊕; and then set off your joint of frames forward and aft. It is fashionable at the Eastward to put in a set of single timbers betwixt the fore and after body; this they do because they fear the ship would be too weak without it, as two navel timbers must come together. If you choose to continue this practice, you must leave space enough between your dead-flat and No. 1 to admit of this single tier of timbers; but this practice has been abandoned long since in nearly all parts of this country, and is entirely unnecessary. The quickest and best method of laying off the frames and getting the widths, is to take your model apart, lay the pieces on your draft board, and scribe round them with a pencil. To do this, however, you should first lay the model on the draft board before you take it to pieces, keeping the face, or bottom of the first waterline, to the edge of your draft board, and mark out your stem and stern, and before you move it, mark on the edge of your draft board where your dead-flat is on the model; then lay the model off, and square up your dead-flat, last marked on the draft board, and square it down on the edge of the board, and mark it "dead-flat," the same as the model. Then when your model is taken to pieces, take the lines and lay them on the draft board, observing to put both dead-flat marks together, and keeping the edge of the water-lines fair with the edge of the draft board. Having marked round them, you will mark them each, 1, 2, 3, or 4, as the case may be, until you get all your lines. Then put your model together, and proceed to lay off the joint of every fourth frame on the edge of the draft board, and square them across the lines of the half breadth and up to the rail of the sheer plan. Then number or name your frames from the dead-flat by marking them in the fore body with letters as in the alphabet, by inserting every fourth one, as D, H; and mark the after body with figures, as 4, 8, 12, &c. It will be necessary to lay out all the frames, forward and aft, but every fourth frame amid-ships will be sufficient to take your dimensions from. Having done this, you have your draft board ready for the loft. You must take your width from your sheer-pieces, for you cannot scribe round them, as they are crooked and will not lay flat on your draft board. You can now take the dimensions of any of the frames, and on any of the lines, keeping one leg of your dividers on the edges of your draft board, and extending the other to the required line, which will be the half breadth of the ship on that frame, at the height of that waterline in the body plan, whichever it may be, and by transferring that space or width between the legs of your dividers, to the scale that your model was made from, you will easily ascertain the number of feet and inches to be laid down in the loft, the theory of which I will explain in Section II.

SECTION II.

Instructions for laying down a Vessel in the Mould Loft.

You will require a loft as long as the after body of the vessel, and as wide as she is required to be deep, from the top of the knight-heads to the top of the keel. The floors should be smooth and fair, for if there are hills and hollows it will be more diffcult to get your lines correct; and if it is rough or dirty, it will be difficult to see your marks or follow your lines. Yet in many of the country towns where I have been laying down and making moulds, a loft of this description is not to be had, and I have often been compelled to clear out a sail or rigging loft, and even then have been so pinched for room that I have been compelled to lay the after body divided in two parts.

First prepare five or six battens as long as possible. Some of them should be sixty or seventy feet; and if you cannot get them so long you must scarf them together. When running in your fore and aft line on the floor, these battens need not be fastened together. They should be about one inch by three fourths, without knots and straight grained; be careful to get them out fair, and of an exact size, from end to end. Have as many as 75 or 100, from 15 to 30 feet long, for running in the sweeps or frames in the body plan, and other uses in the loft, and as a great many of them will break in the loft, your supplies when done will be but small. Many workmen have battens enough to run in all the sweeps or frames of the after body, without taking any of them up before they are all proved. If you can get a clear pine board five eighths of an inch thick, set a split gauge to about three eighths, and cut them off, jointing the board every one you cut off. If the board is one inch thick you will have to split them the other way. Then plane them off, sweep out your loft, and proceed to get a base line on the floor, to represent the top of the keel in the sheer plan, and the middle line in the half-breadth plan. You can get this by stretching a line from one end of the loft to the other; a six eighths cord, or mackerel line, is better than a chalk line, as you can haul it much tighter and straighter. This line should be close to the side of the loft; then mark on the floor where the line touches, and take strips of board, plane one edge straight, and nail them to the floor, letting the straight edge come to the line or marks on the floor, and the other edge will be in towards the side of the loft. When you have done this from end to end, your base line is prepared. Remember that this is always a base line in the sheer plan, and a middle line in the half-breadth plan. Raise a perpendicular at either end of the loft, and from that set off your spaces for frames as on your draft-board, after they are applied to your scale, and square them up parallel with the perpendicular and square from the base—the best way to do this is to take a long batten, lay it down on the base line, and mark the joints of the frames on it the same as you have on the floor; and carry up your batten on the perpendicular, and parallel with the base; then mark on the floor wherever the marks for the joints are on the batten, and strike them in from that to the base, with a chalk line; and number them the same as on your draft-board, commencing at the dead-flat in one end of the loft, and letting your numbers increase as you go aft, as ⊕, 4, 8, 12, &c., until you come to the forward side of the stern post. Then get its proper rake, and set up on it, square from the base, the height of cross-seam, and square down a line from that to the base, which will be an after perpendicular. If your loft is too short, your better way is to set off your frames from your after perpendicular, placing it as near to the end of the loft as you can; and if you wish to make your midship counter-timber mould, you must leave room enough aft to project it. Then strike up as many frames as the loft will admit, leaving the remainder, as many as there may be from that to the dead-flat, to be comprised in the fore body, or laid down in a third midship body, which is much more work, yet if you are careful you may be enabled to get it nearly correct.

You can run in your sheer by taking it from your sheer plan on the draft-board, and transferring the height to a scale, and from thence to its corresponding frame on the floor. You will prepare a ten foot batten, and mark feet and inches on it for that purpose. It is for that use that the battens or straight edges are nailed on the base or middle line; for you can run your ten foot batten down against the base with more speed than you otherwise could.

After you have set up your deck sheer on every fourth frame, making marks or driving a nail at every setting off, you may take one of your large battens and fix it to those spots by driving nails on both sides, and let the forward end of the batten extend 10 or 12 feet forward of the rabbett; and if it is not fair, you may regulate it by raising one or lowering the other, as the case may require. You can then mark around the batten on the floor with red chalk or a large pencil The forward end of the batten, from the foremost square frame to its forward end, must be marked with white chalk; when this is done, you have the sheer on the floor the same as it is on the model. But this sheer will not answer; it must be raised forward, otherwise the sheer will appear to droop when the ship is built. This will readily be seen when you reflect that the distance from the stem to the stern is much less than it is to measure along the side and around the luff of the bow to the stem. The true principle is, to give each foot of the wale the same rise or sheer, both around the luff and amidships. To do this properly, you will take the length of the top-breadth line in the half-breadth, by marking the square frame on the batten, when you are running in its form in the half-breadth. When it is marked, you can take up the batten and carry it up to its corresponding height in the sheer plan, by placing the mark on the batten to the square frame which was marked in the half-breadth. Let the end extend forward on the line for the midship-sheer, as it was taken from the model, and mark on the sheer line at the end of the batten; and the distance from the rabbett to the said mark, as from A to B, figure 1, will be the difference in the length of the sheer when measured alongside as aforesaid.

You will then draw a horizontal or level line from B to the rabbett, as the dotted line from B to A, and the sheer will be raised from the foremost square frame to A, and marked in to intersect the midship sheer, which will be the proper sheer. To get the sheer of the rail and wale to a nicety, you can pursue the same course; but on ordinary occasions you can set them up and down from the deck sheer, by raising the rail sheer more than the deck, and the wale a little less than the deck, differing from each other according as the vessel may be built full, or flaring on the rail, or sharp.

Then set up on every fourth frame from the line last drawn the distance required for the rail height, and make it fair with a batten as before, and mark it "rail."

Set down from the deck the height of the upper edge of the upper wale, which should be about three feet amidships for a 400 ton ship with a bright waist, and about 31 inches aft. Fasten your batten down 3 feet from the top height amidships and 31 inches aft, and diminish gradually from the top height, and fair from one end to the other; mark it as before, and it will be the wale height. Then project your counter, and upright of the stern, as it is on your model or draft-board.

You may then strike in the horizontal waterlines as they are on the sheer draft, figure 1. You need not strike the lines fore and aft, as they are on the draft-board; 10 feet forward of the after perpendicular will be sufficient, as they are only required for ending the half-breadth waterlines. Next strike up the after side of the rabbett, which will be the thickness of the bottom plank abaft the forward edge of the stern post, and parallel to it, as the line A B in figure 5. I have constructed figure 16. on a large scale, to show the ending of the line, and to make it plain I shall not confine myself closely to a scale, but merely show the principle. The sheer plan being completed, proceed to lay down the body plan. If you have room in your loft, the best way would be to lay it down as in figure 3, 7 or 11, in the most convenient place, and make the base of the sheer the base of the body; but if you are crowded for room you will be compelled to lay each body down by itself, like figure 12, making the base line of the sheer plan the middle line of the body plan, and many prefer it to the mode as in figure 3; but as both are precisely the same in principle, I shall lay down the fore and after body as in figure 3. Let A B represent the base line, and E a perpendicular or middle line of the body plan, and N the side line of the after, and M the side line of the fore body. The lines A D and *b h* represent the main breadth of the ship, which you take from your draft-board on the dead-flat, being the widest part of the ship. You will then draw the line R square from the base, to represent the length of the floor, and set off on that line the dead rise, whatever it may be. It is taken by applying a square across the model, and measure down from the tongue of the square to the mark on the model, showing its length; set it up from base A B on the line R, as from R to ⊕. Set a pair of dividers to the thickness of the plank; place one leg on the line M, or side line below the base, and sweep towards E or the middle line, or from a quarter of a circle by the same sweep, and nail it on the circle, and all the sweeps will end on the back of the sweep. Draw a straight line from ⊕ to the back of the arch, which will be the floor of the dead-flat. Strike in your waterlines at equal spaces as they are on the draft-board, or in figure 3. Run in the dead-flat by taking the widths from your draft-board, and transferring them to their respective lines in the body plan. When you are laying down the after body, it is best to nail a batten on the left side of the middle line E, keeping its edge on the line, and place it on the other side when you are laying down the fore body. Having taken all your widths on your waterlines on dead-flat, and transferred them to their respective heights, get the top and rail height from the sheer plan, by extending a batten from the base to the top or rail height, as from O to P in figure 1. You will then transfer the batten from A to D, as in figure 3, and level out a line at D towards the middle line. This you must always do on every fourth frame, and it is always exact and wants no altering. Take the dimension from your model on the top breadth and rail on the dead flat, and set it off as a waterline on the line D, the height last levelled out at D, and drive a nail; bend a batten from the floor heads, keeping it to the widths set off on the waterline, top and rail breadths, and if they do not give a fair curve, you must regulate them as the case may require, and proceed to prove your first waterline, by taking the width from the first waterline in the body plan, and transferring that width to the half-breadth plan on the floor, as from ⊕ to W, in figure 16. Then take from your draft-board the widths of your first waterline on their respective frames, and set them off from the middle line in the half-breadth plan on the floor and on their corresponding frames, and proceed to find the end of the line. The line O F represents the middle line for the half-breadth, and the base for the sheer plan; the line S V the side line, or half the thickness of the keel; the one parallel to it, marked *w n*, is the first waterline in the sheer plan. To end this line properly, you will observe where it intersects the aft edge of the rabbett of the stern post, as the line *w n* at *n*; square it down to the side line from *n* to *v*, then take your dividers and set them to the thickness of the bottom plank, and set one leg on the intersection of the lines, as S V and V N, and let the other leg extend forward. You will then describe an arch with the forward leg, sweeping in toward the middle line, and on the back of this arch will be the ending of your first waterline. All the waterlines aft may be ended in the same way, but not in the same place, except the stern post is exactly plumb; hence you have to go through the same process for every line. Now secure your batten on the main breadth or dead-flat, and on the arch for the ending; these spots are correct and must not be altered. Then bring your batten to the settings off on the frames, and regulate it fair by making it fuller or sharper as the case may require, and mark round the batten on the floor, with white chalk, and mark it 1st W. You can then run in the fourth waterline in the same way. Run in a couple of frames at equal distances betwixt $\oplus$ and aft, then run in the waterline by taking the widths from all the frames that are in the body plan, and transferring them to the half-breadth on the floor, and taking your remaining widths from your draft-board as before. You next get in two or three frames, by first taking your width from the floor, and transferring from the half-breadth plan to their corresponding heights in the body, namely, 1st, 4th and 7th; then take the width from the draft-board, on whatever frame you have not taken the width from the floor, and transfer it to its proper height in the body plan; having thus taken your widths on your 2d, 3d, 5th, 6th, 8th, and top breadth, observing to take the height of that frame from the sheer, as in the dead-flat, you can sweep in the frame; taking care to keep your batten to the spots taken from the floor on the 1st, 4th and 7th waterlines. If either of them look decidedly too full or slack to agree with all the spots taken from the model, refer to that line on the half-breadth on the floor, and see if you can alter it by making it fuller or sharper, as the frame may require, without making it unfair: if you cannot, you must alter the other widths to suit it. If the widths taken from the draft-board do not give a fair curve, you must fill the batten out or haul it in, so as to let it suit the greatest number of spots or widths, and never allow your batten to be shifted from the spots or widths taken from the floor, unless they look entirely too full or slack, as before mentioned.

Having got your batten regulated to all the spots, you can then fill out the floor as much as you may deem proper, to correspond to the frame on the model; mark around your battens with white chalk, and where they come sharp, let the heels intersect the side line and run down to the circle at the base, so as to give a fair curve. You now have five or six frames in your body plan, and you can now run in the top breadths and rail, by taking the widths from the heights levelled out in the body plan, and transferring the widths of the half-breadths on the floor to the corresponding frames. They will end on the side counter timber, as Q R, figure 5, which has to be squared down to the side line of the half-breadth, and the width taken from the model and transferred on the spots so squared down. Next take your width from your model and apply it as before, and regulate your batten, and mark it with red chalk, and run in three or four frames that come the nearest aft, and run all your waterlines, by taking the widths from the draft-board and body plan as before directed: also run in your wale by taking its heights from the sheer plan in the same manner as you have taken the top height; take the widths at the several heights on each frame, and transfer them to their corresponding frames in the half-breadths, and regulate and mark them, as before. Now run in your wale and top height in the body plan, by bending a thin batten to all the heights taken from the sheer for that purpose. If the sheer is fair, and the heights are taken from it and set up on their respective frames, a batten bent to the several spots or nails drove in the floor, to show the height, it will form a fair curve, as G H I, figure 3. After you have bent this batten fair, you will scratch it in. This should be done very correctly, for when the several frames cross those three lines G H I, your mould has to be marked on them, and as it is fair or unfair, so will your ship be in a greater or less degree, according as you work from your moulds.

You may proceed to prove your frames by running in three sections, the nature of which I have described in the directions for making the model. You can put all trust and confidence in these lines if they cross the frames at a right angle. To get your sections, you will divide your cross-seam off in as many equal parts as you mean to have sections; you can have as many of them as you deem proper, but three is sufficient.

You will strike those lines in the body plan with a chalk line, observing to keep them parallel with the side line, and perpendicular to the base; number them as before directed in making the model, commencing at the one nearest the middle line, as in figure 3, (where the 1st section is distinguished by figure 1, 2d by figure 2, and 3d by figure 3,) and run them in the sheer plan, by taking from the body plan, as follows:—

Commence with your first section; take the height from the base line of the body plan to the ⊕, or as in figure 3, from where the line marked 1 crosses the base line at 1 to ⊕. Transfer that height to ⊕ in the sheer plan, by setting it up from the base, as from ⊕ to S, in figure 1. Drive a nail at that spot thus set up, or at S, and that is not to be shifted, because the dead-flat is a fixture, and all the other frames must conform to it. Next get the heights from its intersection with the frames, 12, 20, 28, 32, by taking them all on a batten at one time, and set them up on their corresponding frames in the sheer, as before. This line, like all the other sections, will end in the cross-seam, or at O in the sheer plan, figure 1, except the transom has a spring, or rise, like a floor timber; in which case you can take the height from the base of the body plan to the height of the cross-seam, as from 3 to 7, figure 3, on the third section, and set it up from the base of the sheer, parallel to the after perpendicular, and it will be found to come above the cross-seam O, which will be the ending of the line; but this is seldom the case. Then bend your batten to all the spots and make it fair, at the same time observing that it gives a fair curve to the frame in the body plan, and run in the other sections in the same way. Next consult your dead-flat to find the most proper place to form the joints of the timbers; and after you have done this, lay battens on each spot on ⊕, letting the other ends run up to the middle line. Regulate the ends of the batten that are on the middle line, so as to bring each one as square across the frames as you can, observing at the same time to cut off all the frames to the best advantage, for it is evident that in most vessels the third futtocks come straighter as you approach the extremities, and the top timbers become more crooked: for that reason shorten your top timbers as you go forward and aft from ⊕ by raising the diagonal on the middle line as much as the case may require, and drive a nail at the intersection of the batten with the middle line. Then strike a line from the spots on the dead-flat to the nails in the middle line for a large ship; strike one diagonal from the centre of the arm of the floor timber to the middle line, for a bevel spot; next transfer all the diagonals to the fore body plan, by measuring the width and heights on the base and main breadth, and applying the widths and heights on the opposite side, and mark them 1, 2, 3, 4, &c., commencing at the one at the floor-heads. (See figure 11.) The 2d, 3d and 4th will be sufficient to run in the half-breadth, commencing with the first, by placing a batten against the middle line of the body plan, in the direction of the diagonal, and marking the intersections of the frames on the batten, and transferring them to the half-breadth plan on their corresponding frames, or against a nail at C, figure 11, and bring its edge to the diagonal line; then mark the intersection of this line with the frames on the batten, and mark each frame by its name on the batten, and transfer the widths to the half-breadth plan, by placing the end of the batten that was against the nail to the middle line of the half-breadth, (or by taking the distance from C to ⊕, figure 11, and transferring it from ⊕ to 1, figure 10.) Carry your batten aft and set off all the other widths on their corresponding frames; drive a nail at each setting off, to designate the width, then end the line by taking the height from the body plan, to where the diagonal crosses the inside of the rabbett in the body plan, as frame A to the diagonal line at E in figure 11. You will then take the height and apply it to the sheer plan, finding how far that height, when applied parallel with the after perpendicular, and from the base, will come upon the rabbett of the stern post, and square it down to the half-breadth plan, or take the height from A to E, figure 11, and apply it from the base of the sheer, as from A to E, figure 9; and square it down to the middle line in the half-breadth plan, as from E, figure 9, to 27, figure 10. Next take the distance from the middle line to the inside of the rabbett, near the side line of body plan, in the direction of the diagonal, as from C to E, and set that distance off square from the middle line of the half-breadth on the spot last squared down, and that will be the ending. You will observe that it often comes nearly outside of the rabbett, which is proper. Then pin your batten to the settings off, and make it fair, marking it with red chalk, or something that will contrast with the waterlines, or it will be difficult to distinguish them from each other. In this way you can get in all the diagonals, except those that cross above the cross-seam; and they may be ended by taking the distance in the direction of the diagonal, from the middle line of the body plan to where the diagonal intersects the cross-seam, and setting it off from the middle line of the half-breadth, on the after perpendicular or cross-seam breadth.

You can now get your bearding line by measuring the distance from the intersection of the frame with the side line of the body plan to the base; set them up on their corresponding frames in the sheer plan, and drive nails at each of the spots; bend a batten, and scratch or chalk around it. You can have another guide by observing where the waterlines in the half-breadth intersect the side line, and square them up to their corresponding heights in the sheer plan. To make it more easily understood, see figure 10. Place one end of a batten against the base, near A, figure 11; bring its edge to the side line; mark the intersection of the frame 37, with the side line on it, and name the mark on the batten from the name of the frame, 27, from which the height was taken; transfer your batten to the sheer plan, (figure 10,) by placing the end of the batten that was at A, to the base of the sheer at 27, and on the frame which is perpendicular to 27; drive a nail in the floor where you find the spot marked 27 on you batten; shift your batten forward to the next frame, and do likewise, until you get forward to where they do not rise at all, or where they end on the circle as dead-flat.

Method 2d.—Measure the distance from where the 3d waterline crosses the side line to the after perpendicular, as in figure 6, from 4 to 3; square it up to the sheer plan by setting the same distance forward of the perpendicular on the third waterline, as from 4 to 3 in figure 5; do likewise to all the waterlines, and bend a batten fair to agree with the greatest number of spots; if it will not come fair, you must consult the frame in the body plan, and you can lower or raise on the side line, and at the same time give a fair curve to the heels of the frames.

After you have made the frames and battens both fair, you will then scratch or pencil in the bearding line, and get the true ending of all the frames, by measuring up from the base of the sheer plan to where the bearding line crosses the several frames, and set them up from the base of the body plan on the side line. Having got all your lines fair on the half-breadth and sheer, you can run in all your frames, by taking a batten and commencing at the 1st frame in the half-breadth abaft ⊕; and on whatever diagonal or section you commence, follow it clear aft, taking the height or width of every frame on that line, and transfer it to the body plan as heretofore directed. If you are on a diagonal on the half-breadth, you will place the end of the batten that was against the middle line of the half-breadth, against the middle line of the body, as against C, figure 11; drive a nail at each frame so marked on your batten; and when you are on a section in the sheer plan, turn the end of the batten that was against the base of the sheer against the base of the body, and drive your nails as before.

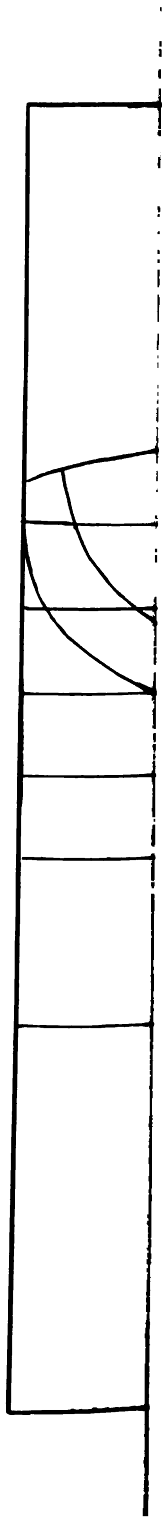
After you have taken all your widths on your diagonal and all your heights on your section, get your widths from the floor, and your wale, top and rail breadths. If you wish to be very particular with your sheer, you will have to take the heights from the sheer plan on every frame, and place one end of the batten, that the height is on, against the base of the body plan; the end of the batten that was against the middle line when you took your widths will be placed against the middle line in the body plan. Observe when you set off your width to keep your batten level from the height, and the batten with the heights on will be kept perpendicular. Let the marks for the widths come to those for the heights of the same frame, and they will be found to cross. Drive a nail at their intersection, and mark the name of the frame close to the nail. Proceed in the same way to get the top height and rail; but on ordinary occasions you need not take the heights on more than every fourth frame, and set your widths off where they cross the wale in the body plan, at J H I, figure 3. Having got all your widths, and a nail at every setting off, bend your batten from one nail to the other, carefully observing to place it to its proper nail, for if your figures are not made very small it will be difficult to distinguish which is the proper one. The best way is to mark around each nail, and mark the frame inside of the circle. Having bent your batten and made it fair between each waterline or section, you can pencil it in, and so proceed until you have marked in the whole, except those that come aft, which should be rubbed out and cants put in their places.

Cants and Riband Lines.—Five cants will be sufficient for this ship, (plate I.) To ascertain their proper form, first consult the cant of the fashion-piece. If the ship is full, it need not cant so much as though she were sharp. You are not to understand by canting a fashion-piece, that its middle part is carried forward, and both ends kept aft, as has always been done in the Eastern States, for in such a method you have to guess at the forms of the transoms; but the proper way is to bring the heel as far forward as the model and size of the ship may require, and swing the head aft; at the same time the cant stands plumb, and swings upon the same principle as a door upon its hinges.

I will cant the fashion-piece of this ship, Plate I., 2 feet 6 in.; that is, so that the heel is 2 ft. 6 in. forward of the head—the line marked *m n* in figure 3, or body plan, is the height of the main transom, from which the width is taken to the square fashion-piece or end of transom on the upper edge; and the width so taken from the middle line of the body plan, is set off from the middle line of the half-breadth plan, on the after perpendicular, representing the after edge of the main transom. Then draw in its size in a fore and aft direction, forward of the after perpendicular. The width is taken from the body plan as aforesaid, from *m* to *n*, and transferred as from N to M, figure 2, which will be its width in the half-breadth plan. Let the fashion-piece cut off the forward corner of the main transom by drawing your cant line about four inches from the forward side, then set off your cant on the middle line, and as far forward as you intend to cant it, and draw a line from one to the other, as from M to 6, figure 2. Your fashion-piece being thus drawn, you can divide the space from the after frame, on the top breadth, to the fashion-piece, into as many equal parts as you have cants, and drive a nail in each division; then divide the space on the middle line for the heels into the same number of equal parts, and strike lines from one division to the other, which will be the joints of the cants. Proceed to get the forms of them by running horizontal riband lines on the half-breadth. When drawing on paper, it is most proper to draw a separate cant plan, to keep the lines from being confused. You can do this by drawing it exactly the same as the body plan; but it is not necessary to do so on the floor, as the body plan is the proper place. To get the form of the diagonal riband lines, take the space square from the middle line in the body plan, to where the diagonal crosses each of the square frames, and set them off on their corresponding frames in the half-breadth plan. The ending will be the same as a diagonal, except that the distance taken from the middle line to the inner edge of the rabbett in the body plan is taken square, instead of in the direction of the diagonal, until they come above the cross-seam; and in that case take the distance square from the middle line of the body plan, to where it intersects the cross-seam, instead of taking on the angle; make your batten fair and mark it with red chalk.

To show the method in a more plain and simple way, take the width square from the middle line, as aforesaid, to where the frame 20 crosses the diagonal, as from 20 to 1, at the middle line, figure 11; apply that width to the half-breadth on the frame 20, as from 20 to 1, figure 10, and drive a nail at 1. You will then return to the body plan; follow up the same diagonal, and take the width on frame 22, as from 22 to the middle line above 1, figure 11, transferring it to 22 in the half-breadth, as from 22 to 3; and proceed in the same way until you get the widths from as many frames as you wish; but two or three forward of the cants will be sufficient to make your lines fair. They will end where the spots squared down for the diagonal cross the rabbett, as aforesaid. Mark and name each according to the diagonal it was taken from; if taken from the first, it will be the first horizontal riband line; then commence on another diagonal and do likewise, until you have got as many as you have diagonals in the body plan. These lines will be found to come much fuller aft than the waterlines; and it is because they do not lie level, but run in nearly the direction of a streak of plank at the height of the bilge or 2d futtock heads. You can now rub out your square frames, that come in contact with the cants, so that you will be less liable to mistake the lines, the cants being struck up in the half-breadth, to substitute the square frames. You can now get the form of the fashion-piece, which I shall commence with, as it has the greatest cant, and will show the principle plainer than the rest. Take the width square from the middle line of the half-breadth to where the horizontal line crosses the fashion-piece, and set it off from the middle line of the body plan, from where the width intersects the diagonal, that corresponds to the riband line, and level out a line from the diagonal. You will then take the width in the direction of the fashion-piece, or cant, from the middle line, as before, setting it off from the middle line of the body, on the line last levelled out, and it will be found to come outside of the diagonal. Drive a nail at the width so taken, which will be the proper width for the fashion-piece on that diagonal. Take widths on all the riband lines, and apply them in the same way. When the heads of the cants and fashion-pieces come above the diagonals, you will observe where they intersect the waterlines, wale, top, and rail breadths; and squaring them up to their corresponding heights in the sheer plan, bend a batten to all the spots, and it will show an athwartship's appearance of the fashion-piece, or cant, in the sheer plan. You can then take the heights from the base line of the sheer plan to where the athwartship's appearance of the cant crosses the wale, top breadth and rail, and set them up from the base line on the body plan, and level out a line at each height. Then take the widths from the middle line of the body plan, in the direction of the cant, to where it crosses the wale, top breadth, and rail, and set them off square from the middle line of the body plan on the line last levelled out, driving a nail where the heights intersect the width; which will not only give the widths, but the heights of the sheer on the cants, when it swings forward to its place; for it is evident that no cant is in its proper place when on the floor, because when it is taken off, on the cant, and set off square from the middle line of the body plan, it is much wider than when it is canted, but when it is swung round to its proper place, on the harpin, it will lose that additional width. You may easily find the width of any cant on the harpin, by measuring square from thence to the middle line of the half-breadth, and set it off square from the middle line of the body plan on the line levelled out for its height. Get the ending of your cant, or fashion-piece, by observing where it crosses the side line of the half-breadth; square it up to the bearding line in the sheer plan; take the height from the spot squared up on the bearding line to the base of the sheer plan; transfer it to the body plan by setting it up from the base on the side line, and level out a line at that height, which will be the height of the cant or fashion-piece. Then take the distance from the middle line to the side line in the direction of the cant; set it off from the middle line of the body plan on the line set up, and it will be found to come outside of the side line, which will be the proper ending of any cant or fashion-piece; bend a batten from thence to the several others, observing to make it fair between the nails, and pencil it in. If you wish to be very accurate, you can try it by the waterlines, and if they agree with each other, you may rely on its correctness.

Take the width in the direction of the cant where it crosses the waterline in the half-breadth, and set them off on their corresponding heights or waterline in the body plan. This last method alone will answer well for the fore body, as I shall hereafter show; but in the after



body it is not so correct as riband lines, because the waterlines are more liable to error, owing to their crossing the timber in an oblique angle. You can proceed in this way to run in all your after cants, as there is no difference in the method between the fashion-piece and the other cants. To make the method of getting them from riband lines more easily understood, I will refer you to figure 13, which is the cant plan for the after body. To get the width or station of the fashion-piece on the third diagonal riband line, take the width square from the middle line of the half-breadth, as from A to B, (figure 10,) and set it off on the third diagonal in the cant plan, by running it up on the diagonal until it strikes the middle line, as from 1 to 2; you will then take the cant of it in direction of the fashion-piece, as from 26 to B, and apply it from 1 to 2 in the cant plan, and as far as the width is found to come outside of 2 it will be the spot for the cant. You will get all the widths on the diagonal in the same way. To get the height on the wale, top height, and rail, you will observe, as before directed, where the thwartship view of the cant crosses each of the sheer heights, and take them on a batten. It will be the better way to take all the heights at one time, which will save travelling in the loft. Again: to get the widths and heights of the cants on the top-height, take the height from the base of the sheer or from A to B, (figure 9.) Set it up square, from the base of the cant plan, to A, and level out a line at A; then take the width in the direction of the cant, as from 26 to T, (figure 10,) and apply it square from the middle line of the cant plan, as from M to A; drive a nail at A, and you will have the proper width and height of the fashion-piece at the underside of the plank-sheer. If your fashion-piece is laid down in the same body with the square frames, it is often found to come in contact with the heads; and it is proper it should. If it has the ordinary cant the reasons are obvious. Again: to end the cant, or fashion-piece, square up from where they intersect the side line to the bearding line, as from 4 on the side line of the half-breadth, (figure 10,) to 5 on the bearding line, (figure 9;) then take the height square from the base to the figure 5, as from 6 to 5, (in figure 7,) and set that height up square from the base of the cant plan on the side line, as from E to G, and level out a line; then take the distance from the intersection of the afterside of the fashion-piece with the side line, in the direction of the cant, to the middle line, and set it off from the middle line of the cant plan on the line last levelled out at *g*, and that will be the ending; all the cants will end in the same way.

Transoms.—You will first draw in your main transom in the body plan, (as in figure 3,) by drawing three fourths of its depth above the cross-seam, and one fourth below it; strike them out horizontal in the after body or cant plan, until they intersect the cant. You will continue to draw them in one below the other, at equal thicknesses, according as you mean to side them. Leave a space betwixt each as you strike them in, in the body or cant plan. For a ship of 500 tons, the transoms should be sided about 10 inches, and a space between them of about 3 inches. After you get in as many as the form of the ship will admit, you can represent your inner post in the sheer plan, by setting its size forward of the stern post, about 2½ inches forward of the bearding line, and then your transoms will all throat 2½ inches. Its upper end should come up as far as the cross-seam, and its size about 2½ inches, and the lower side of the main transom would then be cut out to admit the upper end of the inner post. Set off its size at the lower end, as large as you see fit, and from that to the lower transom. You can get the size that it is required to be sided, by squaring down from where it intersects any of the waterlines in the sheer-plan to the corresponding line in the half-breadth, and measure in from that spot to the middle line, and that will be its size, from the centre, at that height; and you can get its bevellings in the same way, by keeping the stock of your bevel square from the middle line, and letting the tongue reach forward in the direction of the waterline; but on ordinary occasions it may be sided the same as the stern post, on the forward side to the inner edge of the rabbett, except you cannot conveniently get your transoms as crooked as they are required to be, or wood enough on the heel or after part. In that case you can leave the inner post large enough to make up the deficiency; but this must not be done at random, or you will get some of your transoms either too far forward or aft, which will materially alter the whole shape. Suppose, for instance, you wish to favor the seat of your lower transom 5 inches, and the second 2 inches; in that case you will set that distance forward of the bearding line at the lower and second transom, and diminish from one to the other. When you are making the mould for your transoms, make them precisely the same as though that was not the case, and you can then take from the sheer plan the distance on each transom from the bearding line to the line drawn forward of it, to favor the transoms. Then set up the distance on their respective transom moulds, and mould the transom as far down on the seat as that mark on the mould. You will then see that your transom is much wider on the seat than the stern post is, which must be made up by leaving your inner post wider, and placing your transom on it, by a middle line on the inner post, as well as on the transom; or when your stern frame is all made, you can fay a three cornered piece against the seats of the transom and the inner post, letting it extend aft to the bearding line. Neither of these methods interferes with laying them down, other than when you are making your moulds as aforesaid; but when vessels are full, like most of the freighting ships, and the fashion-pieces cant but little, you can get nearly all the transoms out of straight timber, as I have frequently done. Let us proceed to lay them down, without favoring them as aforesaid.

Get the form of the transoms by levelling them out in the body plan as already directed, only let them extend outside of the cant, and cross three of the square frames; then take the widths from where any of the transoms in the body plan cross the square frames, and transfer them to their corresponding frames in the half-breadth. You may do this on four or five frames for each transom; bend a batten to these spots; get the ending of the line by taking the height of the required transom from the base of the body plan, and transfer it square from the base of the sheer plan on the bearding line, and square it down to the side line; you will then have the ending of the transom, wherever it may be. You can then make the line fair and pencil it down, and it will be the form of the upper or lower edge of the transom, whichever it was taken from, in the body plan; but in this case only one arm of the transom would be represented. The best method is to lay them down by sections or buttock lines in the sheer plan.

You will level out your transoms in the sheer plan, the precise height that they are in the body plan; let your transom line in the sheer plan extend 8 or 10 feet forward of the stern post; having done this, you will now get their form by drawing a transom plan (like figure 4) in the most convenient part of the loft; draw the after part of the main transom to correspond to the after perpendicular; next raise a perpendicular to represent the centre of the transom, and set off, on both sides of it, the side of the stern post or transom; then take from the middle line of the body plan the widths to each of the sections, and set them off from the middle line of the transom plan, striking them up square from the back of the main transom; then take the width of the main transom from the body or half-breadth plan, and set it off from the middle line of the transom plan, and square up a line at each end, to represent the end of the main transom. You will then take from the half-breadth plan, at the end of the transom, the distance from the after perpendicular, or after side of the transom, to the line drawn for the cant of the fashion-piece. Set it up on the transom plan, from the line drawn from the back of the transom, and on the line representing the end of it; drive a nail, and take from the middle line of the half-breadth plan, the cant of the fashion-piece, from the after perpendicular to the fashion-piece, or as from 4 to 6, in figure 2, and set it off on the side line of transom plan from the back of main transom, as from 4 to 6, figure 4; draw a straight line from that to the nail driven for the fashion-piece at the end of the transom, as from 6 to 9 in the transom plan, figure 4; on that line all your transoms will cut off square from the upper or lower sides. Having thus got your transom plan completed on both sides of the middle line, you can then get their form. Commence with the upper edge of the 2d transom, take the space from the after perpendicular in the sheer plan, and on the upper edge of the 2d transom, to the bearding line, and set it off from the corresponding perpendicular on the plan of the transom, driving a nail in the side lines; take the distance from the after perpendicular in the sheer plan, as before, to where the upper edge of the 2d transom crosses the section line, as from D to B, figure 1; transfer the width to its corresponding section in the transom plan on both sides of the middle line, as from A to B, figure 4; take the width from the sheer plan, as before, on the 2d section, as from D to E, and transfer it from the corresponding perpendicular in the transom plan on its corresponding section, as from D to E, figure 4. Then bend a batten to the spots so set off; scribe it until it meets the line drawn for the cant of the fashion-piece at E, and it will be the shape of the upper side of your 2d transom. If you wish to be more particular, you can have two other proofs. First, take the widths square from the intersections of the several waterlines and wale with the after side of the fashion-piece to the middle line of the half-breadth plan, and set them off from the middle line of the body plan on their corresponding waterlines and wale height; bend a batten to form a fair curve through the several spots, and it will represent the width of the fashion-piece when swung to its proper place; this is called a square fashion-piece. (See figure 3.) The dotted line outside of the fashion-piece is the form of the forward side, from which the bevel of the fashion-piece is taken; the line inside of the fashion-piece is the square fashion-piece, which shows the termination or width of all the transoms. You can take the width from the side line on the upper or lower edge of any of the transoms to the middle line, and transfer it from the middle line of the transom plan, square to where the width may meet the cant of the fashion-piece; and if the said width so taken agrees with the dead rise or spring of the transom, that is, if they both intersect the cant of the fashion-piece in the same place, you may rely upon their being correct.

For further proof, take the distance from the after perpendicular in the sheer plan to the thwartships view of the fashion-piece, on the upper or lower edge of any of the transoms, and transfer the width to the transom plan, from where the corresponding transom crosses the cant of the fashion-piece to the after side of the main transom, or line corresponding to the after perpendicular. If the work is correct, the width so applied will agree with the former, and if otherwise, it will not.

To make the subject more familiar, I will refer the anxious learner to the following figures. To get the length of the transom in the body or cant plan, or the shape of the square fashion-piece, which is the same, take the width square from where the fashion-piece intersects the several waterlines and wale to the middle line of the half-breadth plan, as from 3 to 8 in figure 2, for the 8th waterline, and transfer it from the middle line of the body plan on the 8th waterline, as from 8 to 9, figure 3. Proceed in the same way with all the waterlines and wale, and bend a batten to the spots and mark round it with white chalk. To get a proof for the upper edge of the 6th transom, take the width from the square fashion-piece to the middle line, as from 6 to 6, figure 3, and transfer it from the middle line of the transom plan, as from *n* to *m*, figure 4. For further proof take the distance from the after perpendicular to the thwartships view of the fashion-piece in the sheer plan, as from 6 to 6, figure 1, and transfer it to the corresponding perpendicular, and from the corresponding transom in the transom plan, as from *o* to *m*, figure 4; and if the width from 6 to 6, figure 1, be the same as the width from *o* to *m*, figure 4, you may rely that the transom and fashion-piece are correct.

You will then lay down the lower edge of the 2d transom, and so proceed until you have the upper and lower edge of all the transoms in the transom plan. The bevellings will be taken by measuring the distance from the upper to the lower edge on the floor, as from 1 to 1, figure 4, which distance will be applied from a square across a bevel-board, on the same principle that you get them from the square body. Your transoms being completed, you can get the bevelling of your cants.

To get the bevelling of the cants by riband lines.—To do this, you have to lay down the forward side of each cant and fashion-piece. To arrive at a greater degree of accuracy, you should lay down the edges both forward and aft of the joint; but on ordinary occasions it will only be necessary to lay down one edge and reverse the bevelling for the opposite side of the joint. You will first determine on the siding of your cants and fashion-piece; set them up from the joints on the half-breadth plan, parallel to the joint. Commence the bevellings with the fashion-piece, as it has more cant than any in the after body, and will be more easily understood. Set off forward of the line drawn for the cant of the fashion-piece the size you intend to side it, which may be as large as the cants. Then square a line from where the after side of the fashion-piece in the half-breadth plan intersects the middle line, to the forward side, as from 6 to 5, figure 2. Then take the distance square from the middle line to where the line drawn for the forward side of the fashion-piece crosses the diagonal riband lines, and set the width so taken, square from the middle line of the body plan, to where the widths may happen to intersect the several diagonals, levelling out a line from each diagonal, as in laying down the joints of the cants. Then take the distance from the spot squared, from the intersection of the joint, on the after edge, as from 5, figure 2, in the direction of the forward edge of the fashion-piece to where it crosses the several diagonals R L, and set them off square from the middle line on their corresponding diagonals on the spots levelled out, and drive a nail at each width. Then get the ending by squaring up the intersection of the forward edge of the fashion-piece with the side line in the half-breadth plan, to the bearding line in the sheer plan; then take the distance from the spot so squared up to the bearding line to the base line in the sheer plan, and set it up from the base line of the body plan, and level out a line; then take the distance from the side line of the half-breadth plan to the square in direction of the forward edge of the fashion-piece, and transfer it from the middle line of the body plan on the spot last levelled out for the height, and that will be the proper ending of the forward edge of the fashion-piece.

You can get the spots on the wale, top height, and rail, by observing where the forward edge of the fashion-piece crosses each of the lines in the half breadth, and square them up to their corresponding heights in the sheer plan. Take the heights from the base of the sheer to the spots so squared up, and set them off from the base line of the body plan, and level out a line at each height; then take the widths from the square drawn from the after side of the fashion-piece as before, to the forward side in the direction of the cant, or as from 5, in figure 2, to where the forward edge of the fashion-piece crosses each of the lines on the half-breadth, and set them off from the middle line of the body plan on the spots last levelled out, for the height; you can bend your batten fair to all the spots, and mark it with white chalk. You will have to go through the same operation for each cant.

To get the height of the deadwood and throats of the floor.—Take the depths of the throats of the floor at dead-flat, and set it up on the middle line of the body plan; strike a horizontal line; then take the same height, and set it off square from the floor timbers to the side line in the body, and mark a spot at each height; you can then take the heights from the base line of the body plan to the spots set off from every 4th or 5th frame, and transfer them to their corresponding frames in the sheer plan; a batten bent to the spots in the sheer plan will show the height required for the deadwood, forward and aft. For example, suppose the lines marked 4 4 and 3 3 to be the size of the timber; draw from the frame P and frame 16 to the side line in figure 7; then take the height from the base of the body plan to where the lines marked 4 4, 3 3 intersect the side line to the base, as from 3 and 4; transfer that height from the base of the sheer plan on frame 16, and do likewise with every 4th or 5th frame, drawing the line from one to the other as aforesaid.

Next determine on the seats of your floor forward and aft. It is obvious that the line last drawn in the sheer plan rises forward and aft, in a greater or less proportion, as the vessel may be full or sharp, forward and aft; and it is also plain, that the floor timbers need not be any deeper in the throats forward or aft than they are amidships, for it is on the midships floor timber that the dead weight of the cargo concentrates, and as the seats of the floor timber may be cut out, and the deadwood or top of the keel may be let into them, it would not only keep the keel from twisting out, but it would give additional strength, in a fore and aft direction, owing to the deadwood, or keel, being so much deeper; and it seldom weakens the floor timbers to throat them on the under side, for the sharp ones, or those which throat the deepest, are generally got out of roots or limbs of trees, and have but little strength on the bretch, but are generally strongest directly under the kelson. Although I have represented the upper edge of the keel for the upper edge of the rabbett, I am far from approving of the plan, and shall hereafter show the nature of a cutting down line, that builders in the different section can choose whichever they think best; but I should not do justice to my own judgment did I not utterly condemn the precedent. I could wish that it may be overcome by the rising generation, which will be the only way in which it is likely to be effected.

In nearly all the Eastern ships, the floor timbers are simply laid on the keel, without any jog to support the keel, and it is supported by the butts alone; the seats of the floor timbers are all in a straight line, and the after ones butt against the stern knee and deadwood, which leaves a weak place in the keel, at the after floor timber; whereas if the keel was got out sweeping on the upper edge, as is always the case in this city, the weakness would not be felt as on the old plan; for when the ship is straining heavy on the ground, the after part of the keel cannot hog or spring, because the deadwood, being piled up and bolted through, prevents it, and that part of the ship is stronger than any other, on a fore and aft direction. This must necessarily be so, for you must have the proper height of the deadwood, in order to have a support and fastening for the heels of the cants.

Another very important requisite, often neglected, is that of tenoning or boxing the cants two and a half or three inches in the forward and after deadwood. The only ground on which that method is opposed is, that it weakens the deadwoods; but the individual so arguing need only consult his own judgment to be shown that the deadwoods are much stronger, in a longitudinal direction, than the keel and kelson amidships, and that the keel and kelson actually require more strength amidships than at the extremities. I merely make this remark to impress on the mind of the learner or young mechanic more fully, that the true philosophy of building is, to have every part of the ship equal in strength, according to the several functions that the different parts have to perform, and I know of no greater improvement than the one above mentioned. One of the latest improvements in the construction of naval ships was made by Mr. Pook, a most scientific naval architect, now stationed at Portsmouth, N. H. It is that of throating the floor timber for a vessel of 500 tons, building at Charlestown, about five inches on the keel amidships, and setting the stem and stern post each five or six inches nearer the centre of the ship than formerly; consequently the rabbett of the stem cuts nearly in the middle of it, or half way from the after to the forward part, and the stern post in the same way, as well as the rabbett of the keel. This improvement may be considered one of the best that I have ever seen. It is evident that the keel, stem, and stern post would all beat off flush with the planks before they could possibly be started from their location at the garboard or hooden ends.

To get the cutting down of the floor timbers, you will set down the depth of the throat on the forward and after floor timbers from the line drawn from the upper edge, and gradually diminish a line from that spot to the throat of the midship floor timber, and the line so drawn will be the upper edge of the keel or deadwood, from the forward to the after floor timber.

The after body being completed, you will commence with the forward body.

You can now rub out your lines with a damp cloth, and strike up the joints of the frames in the same place. If they are rubbed out or made dull, you can then rub out your figures which designate the several frames in the after body, and commence from the dead-flat to name the frame in the forward body, and raise a perpendicular to the forward side of the rabbett of the stem; then strike in your waterline, and get your sheer as in the after body; you will run in the stem by taking its rake from the forward perpendicular on the waterline on your draft-board, and applying it to the scale and setting it off on the corresponding waterlines on the floor. The raise of the stem from the base should be taken from the joints of the frames on the draft-board, and transferred as before; bend a batten and sweep it in; run in the rabbett by setting off the thickness of the plank forward of it. Then commence with the first waterline in the fore body, by taking the widths from three or four frames from the after body, and transferring the widths so taken abaft the ⊕ on corresponding frame, struck up for that purpose in the half-breadth plan, and keep your batten to the spots so set off. In getting the widths of all the lines amidships, you must strictly adhere to this method, as it answers the same purpose as lapping the lines or bending a batten across so many frames when the ship is built; consequently it may prevent any sudden which might occur if you did not let your lines lap. Get the width of your frame from the draft-board or model, as in the after body, and end the lines on the same principle, thus: Having set off the side line, half the thickness of the keel from the middle line, square down from where the first waterline crosses the forward side of the rabbett of the stem to the side line; set your compasses to the thickness of the plank, setting one leg aft of the spot last squared down, and with the after leg sweep in toward the middle line, and the line will end on the back of this arch. Make your batten fair, by keeping both ends stationary, and proceed in the same way with all the rest, by getting in some of the frames as before directed in the after body. Then get in all your forward frames, in order to get a fair bow, and you can do this as soon as you get in the half of your waterlines and top breadth.

To get the ending of the sweeps or frames which rise on the stem, measure up from the base of the sheer plan to where they cross the forward edge of the rabbett of the stem, and set off that height square from the base of the body plan on the side line; take the thickness of the plank in your compasses, and set one leg on the spot so set up, and with the other leg sweep in toward the middle line, on the back of the arch. The sweep or frame will end in the same way. You will get the ending of all the frames that rise on the stem, and then get the forward bearding line in the same manner as the after one, by measuring where the several frames intersect the side line of the body plan, and set them up on their corresponding frames in the sheer plan, which should be done as soon as your forward frames are regulated by waterlines. It will be best to prove the frames in the fore body with diagonal lines, and it may be well to run one section along the floor-heads of a flat vessel, but on ordinary occasions diagonals come squarer across the timber, and it is obvious that the nearer your lines are square with the timbers, the greater dependence you may place on them; for, when the lines cut the timbers very obliquely, you might fill the line out, or haul it in, two or three inches, and it would not alter the timber one half inch; consequently, it is difficult to tell whether the timber is right or not. By such a line your diagonals forward will end the same as they do on the stern post. If you wish to run in forward sections, you will take the widths that they are from the middle line of the body plan, and set them up square from the middle line of the half-breadth plan; strike them in parallel to the middle line; observe where the several sections in the half-breadth plan intersect the wale or top breadth, whichever you may deem fit to end them on; take the distance square from the forward perpendicular to their several intersections, and square it up to the wale or top height in the sheer plan, and that will be the ending of the several sections in the fore body.

After you have completed this line, you can then run in all the frames by taking one line at a time in the half-breadth, and transferring it to its corresponding line in the body plan, marking it, as directed in the after body. You will not pencil the forward frames in the body plan, but mark round your battens with white chalk, because they are to be substituted by cants, and will be diffcult to rub out if otherwise marked. If your waterlines do not give a fair frame, you must alter them so as to agree with the frames in the body plan. After being satisfied that the line in the half breadth gives a fair bow, you can rub out the square frames in the body and half-breadth plan that are to be substituted by cants. Then determine on your forward square frame, and also determine on your knight-heads and hause-pieces, and set off from the apron on the top breadth the widths you mean to side each of them, and mark where they terminate on the top breadth, which will be the forward side of the foremost cant; then set off from the spot where the hause-piece terminates the size you mean to side this timber, and that will be the joint of the foremost cant, and divide the distance between that and the square frame into as many spaces as it may require frames to fill up between them. Then get the ending, or cant of the foremost cant, by setting off on the rabbett of the stem on the sheer plan the spot where you wish your knight-head to stop, and make a mark on the after edge of the rabbett, and square it down to the side line of the half-breadth plan; then set off square from it on the side line the siding of the timber as it is on the top breadth, and strike a straight line, which will be the joint of the forward cant. Now divide the distance between the joint and the square frame in as many equal spaces as there are on the top breadth, and strike lines from the spot on the top breadth to the corresponding divisions on the side line of the half breadth, and you will have the joints of all your forward cants; then mark them with letters of the alphabet, commencing at the after one, and proceed to get their shapes.

Cants laid down by waterlines.—This method is exactly as good for the forward cants as horizontal riband lines. If you have the waterlines fair it is but little trouble, compared with the riband lines, and I have never known it to fail of success if strictly followed. I therefore recommend it for the forward cants as perfectly simple; consequently, an error would be more easily discovered, and corrected in less than half the time, that it could be if you had to correct the riband line. The method was briefly explained in the cants of the after body, but for fear that it may not be sufficient, I will here more fully explain the principle.

Observe where the joints of the forward cants cross the waterlines, top and rail breadth, and square them up to their corresponding heights in the sheer plan, and make a mark at each spot so squared up; take the heights from the base of the sheer, and set them off from the base of the body plan, and level out lines at each height. Then take the widths from the middle line in the direction of the cants to where it crosses each of the waterlines, wale, top and rail breadth, and set the widths off on their corresponding waterlines, and on the wale, top, and rail, on the spots last levelled out for their height, as heretofore directed in laying them down by riband lines.

You will proceed in this way with all the forward cants. It will not be necessary to show a thwartship appearance on the floor for any except the forward edge of the forward cant, unless the heels are placed close together, and you have to snipe one timber of wedging; in that case you will have to show a thwartship view, to know how much and how far up you have to taper or diminish on a thwartship direction. The thwartship view of the fore edge of the foremost cant shows the ending of the knight-heads and hause-pieces, and they are all cut to fay against it. To get the stations of all the cants on the deadwoods, you have only to square up from where the joints cross the side line in the half-breadth plan, to the bearding line in the sheer plan, and do this for every cant. Mark each line so squared up on your deadwood mould, and if you do not make one you can take the height of the bearding line from the base on each line, and mark it with figures on each cant, or box-frame mould, and mark a batten on the floor showing their station, which will be applied to a line struck forward, and on a line with the upper edge of the rabbett of the keel. When the ship is raised and the several cants are struck up to the bearding line, then take the heights that are marked on the heels of each of the cant moulds, and set them up from the line struck on the side of the stem, representing the upper edge of the rabbett, and on that spot the joint of each cant will end. Then get the fore and aft bevel for the heels, as directed in laying down the after body. It is an excellent plan to tenon the heels of one of the timbers of each cant and frame, that has no floor timber, 2½ inches in the deadwood. You can do this by leaving your 1st futtock 2½ inches longer than the 2d, or 2½ inches inside the side line marked on the mould. Cut the mortise square from the base line, and as deep as the heel of the frame may allow, to make the tenon square on the upper part; and the lower part of the mortise, or boxing, you will cut in the direction of the bearding line, and square on all parts from the side of the deadwoods. The deadwoods are to be the same thickness as the keel. The apron may be as wide as you please from the head down to the forward side of the foremost cant, where it must be the same thickness as the keel.

Knight-Heads.—The knight-heads and hause-pieces compose the forward part of the bow, to which the bowsprit is confined, and through which the hause-pipes are fitted, to receive the chain or hemp cables. To get the shape of these peculiar pieces of timber, you must stand their sides directly fore and aft, which is the plan most generally preferred, and best adapted to full vessels, to get their forms. First represent them in the half-breadth plan by setting from the middle line in the half breadth one half the siding of the apron, which will be the fore side of the knight-head. If it fays close to it, then set off square from the same line the size you mean to side it, drawing a line parallel to the middle line as before, letting it end against the line drawn for the forward side of the foremost cant, against which all the hause-pieces and knight-heads will end in the half-breadth plan. You can then draw in the same way the siding size of all your hause-pieces. Observe where the line drawn for the knight-heads and hause-pieces in the half breadth crosses the upper waterline, wale, top breadth, and rail, square them up to their corresponding heights in the sheer plan, and draw a line to pass through all the spots set up from their respective lines in the half-breadth plan, letting the end of each line be against the thwartship view of the fore side of the foremost cant, and square up a line at the intersection, and in that direction all the hause-pieces will cut off. As all the pieces are calculated to come close together when they are in their proper places, the mould that moulds the after side of the knight-head will mould the forward side of the forward, or 1st hause-piece, and the one that moulds the forward side of the 2d will mould the after side of the 1st one. To get the bevelling, you will prepare a bevel board, the size that you side your timber; take from the sheer plan on the rail, top breadth, waterline, &c., the distance from one edge of each hause-piece and knight-head to the other, and set it off from a square struck in the bevel board; draw a line from the square on the opposite side of the board to the spot so set off from a square, and that angle will be the bevel of the knight-head, or hause-piece, at the height it was taken from in the sheer plan. To get the bevels of the heels to make them fay against the foremost cant, apply the stock of a bevel against the middle line of the half breadth, letting the tongue extend in the direction of the foremost cant; and apply the stock of the bevel to the side of the knight-head or hause-piece which comes nearest the stem; let the tongue extend across the after side, and cut from the bevel to the perpendicular mark transferred from the mould. Their forms and bevels may all be obtained by two other methods; either by canting them in the direction of the foremost cant, or by diminishing the heels, by siding them large on the rail and small against the foremost cant. To get their forms, when diminished, proceed as follows. Having determined upon their siding size on the rail, also on the lower ends, you have only to strike them in the half-breadth plan as large as you want them on the rail, as well as the required size on the cant; square up their intersections with the waterlines, wale, top breadth, &c., and bend a batten to show the thwartship view, as before directed. Then proceed to get their form in the body plan, by measuring square from the middle line to where they cross the several lines in the half breadth; transfer the widths so taken from the middle line of the body plan on their corresponding heights. Take the height in the sheer to where the thwartship view of the hause-pieces crosses the forward cant; set it up on the forward cant in the body plan, and bend a batten to the several spots, which will give their proper form, to which the moulds are to be made. Get the sheer and bevel mark, to be marked on the moulds, by measuring the distance from the base of the sheer to where the several thwartship views cross the diagonals, wale, rail, &c., and set them up from the base of the body, on their corresponding hause-pieces and knight-heads.

To get the bevels to fay against the foremost cant, you have only to square a line parallel to the side line, from where the line of their forms intersects the line set up for the heel against the foremost cant. To get the bevels, to fay them on a thwartships direction, you will take the angles which the foremost cant makes with the side lines on each hause-piece, by laying the stock of a bevel on the knight-heads and letting the tongue extend in the direction of the cant in the half breadth, and apply it as from the side of the knight-head which fays against the apron and on the after side of it; let the tongue extend across it, and cut the bevel out of wind with the perpendicular mark transferred from the mould. To get the bevels on the wale, top height, &c., in this plan, you must lay down the bevelling edge of each one, by setting off any size parallel from the moulding edge, and transferring it to the body plan as before.

Harpins.—Harpins are artificial pieces of timber that are made from a model in order to get the form of the bow. They are usually hewn to the form and bevel of the bow, scarfed together, and fastened to the foremost square frames and the sides of knight-heads. In heavy ships there should be one made to the wale, top height, and rail forward, and one to the cross-seam or waterline aft, as it is quite as difficult to get the form of the stern without them as the bow.

To get the forms nearly correct, you have simply to make them to your wale, and rail breadths on the floor, by fitting the inside of the mould to the lines like that of the stem, and all the cants; and also one or more of the square frames are to be marked on them, and transferred from that to the harpins. The bevel of them may be got by laying down the form of the lower side in the half breadth. You can do this by taking the thickness you intend to side them in your compasses, and set it down from the sheer in the body plan; take the widths from the marks so set down on the frames to the middle line of the body plan, and transfer it to its corresponding frame in the half breadth; get the widths from all the frames in the same way, and bend a batten to each spot or width, and it will represent the bevelling edge of the harpin.

Then get a bevelling board, of the siding width of the harpin, and take the distance from the moulding edge to the bevelling edge, and apply it from a square on your bevel board, and you will have the true bevel; but as they are artificial, and the upper edge is calculated to fay to the ship's side, it will be well to give them a little more bevel than they might seem to require. In that case there will be no difficulty arising from the frame bringing up on the lower edge of the harpin.

On ordinary occasions it will answer to get the bevels from the body plan, without reference to the half breadth, which is a saving of time, and to do so you will strike a horizontal line at the height of the required harpin. Let the stock of your bevel lie on the line, and the tongue extend down the frame, which will be the bevel nearly correct; and as you may increase the bevels it will be found to answer the same purpose for small vessels. If your harpins are not made to a level line, as a waterline, they will be shorter when in their place than they are required to be. Moreover, when you drop the after ends it brings the cants abaft their proper station; consequently, the ship will be fuller than she should be. The same defect is manifest, but in a small degree, when you make the harpins to the wale, or deck-breadth line; but as it is so trivial, it will not make any material error in a common ship. But if a strict degree of accuracy is required you will pursue the following instructions: Suppose you wish to make a harpin to the fourth diagonal, which is the same as the aforesaid principle. You will first run your diagonal in the sheer plan by taking the height, square from the base of the body plan, to where the diagonals cross the square frames; set them up from the base of the sheer on their corresponding frames; bend a batten to the several spots—make it fair—*mark* it in, and it will represent a level view of the harpin, or a diagonal in the sheer plan as in figure 9. Observe where the *thwartship* view of the cants crosses the diagonal in the sheer plan, square them down to the diagonal or harpin in the half-breadth plan, which will give the stations of the cants on the harpins.

Again; to get the line for the harpin mould, observe where the line squared down crosses the diagonal, and level out a line abaft of it, as the line marked A and B, figure 10; then place the end of a batten against the after side of the rabbett of the stem in the sheer plan; bend the batten in the direction of the diagonal, and mark the intersection of the cants with the diagonal; keep the end of the batten in that position, and carry up the after end level or parallel with the base, and square the marks on the batten down to the lines levelled out from the diagonals in the half breadth. Where they cross each other will be the spots to make the harpin mould; and also the station of the cant to be marked on the mould.

SECTION III.

Construction of a Ship on parchment.

You will first conclude on your length, width, and depth, and form your sheer and body plan in the same manner as before stated in directions for making models. Having drawn the sheer plan and struck up every fourth frame on it, together with the form of the midship frame, you will consult your judgment for the form of your fashion-piece or horn timber. First take the height of the cross seam from the sheer plan, and set it up on the body plan; then level out a horizontal line and determine on the length of the main transom; set half its length off from the middle line of the body plan, and on the line levelled out for the cross seam; raise a perpendicular which will represent the extreme half breadth of the horn timber. You may tumble it home as much as your fancy may direct, and it should be about plumb at the height of the upper whale or upper side of the main transom, and commence to cant under to the cross seam, with a short but easy turn. The half breadth being prepared, as in plate II, you can draw in the top breadth by taking the top height from the sheer plan on the midship frame and after perpendicular, setting them up from the base of the body plan on the ⊕ and horn timber, levelling out a line at each height; take the width from the intersection of the mark levelled out with the horn timber and ⊕; set them off from the middle line of the half-breadth plan on the ⊕ and after perpendicular; pin a batten to the two spots, and find where it ended forward, by squaring its height down from the sheer plan to the side line of the half breadth, ending inside of the rabbett as directed for laying down in the loft; pin the forward end of the batten to the circle and fill it out in the luff to suit your fancy, and make it fair to the ⊕, which is to be wider than any other part; and to have the line diminished easy and fair from the luff aft. Having got this line to suit, pencil it in and draw two frames in the body plan, one for the fore and one for the after body. Consult the form of the ship where they are to be placed;—I would place them about two thirds of the length of the bodies from amidships; take their width on the plank sheer from the line last drawn in the half breadth, and set them off from the middle line of the body plan. After the frames are formed to suit your judgment, run in your third waterline by taking the widths from the middle line of the body plan, and transferring it to the middle line of the half breadth, on the corresponding frames, ending the lines as heretofore directed; make it fair, and if either of the after frames is too full or too lean, you must fill the line out, or haul it in, as the case may require.

Then run in another after frame, abaft the one already drawn, by taking the width from the third waterline and top breadth in the half-breadth plan to the middle line, transferring the widths to the body plan as before, and run in your frame. It will be a more preferable method to run in the after sections in the sheer plan, by taking the heights from the base of the body, as in directions for the loft. After you have regulated your sections you can run in some more frames in the body plan, and run in the waterlines to prove the frames. If your draft is large it will be best to lay down the after body by itself. Having made your water and section lines to agree with the frames, you can prove them by diagonals. Let the frames in the body plan extend up to the rail height, and take the height of the rail from the sheer plan, and set them up on their respective frames in the body plan. Level out lines, and take the widths square from the middle line of the body to the intersection of the several frames with the heights levelled out, and set them off on their corresponding frames in the half breadth; fit your batten to correspond to the spots, if they are fair, if not, they must be regulated, as the case may require, so as to give a fair line and curve to the heads of each of the frames. Then run in the wale, by taking its height from the sheer; level out lines in the body; take the widths and transfer them to the half breadth; then regulate the line as before. Having proved all the lines in your after body, you can run in a frame close forward by taking the width from the plank sheer breadth, and transfer it to the body; take the height that it raises on the stem, and transfer it to the body; run it nearly straight from head to heel; and then run in your fifth or second waterlines by taking the widths from the frames in the body plan and transferring them to the half breadth, and ending the lines as before. Let them extend two or more frames abaft the ⊕, and observe to make the lines fair from all the successive lines in the after body. Strike up all the frames that form the bows of the ship, either as cants or square frames, and run them in the body plan by adding a frame or two to the body plan every time you run in a waterline, and so continue until you run in all your waterlines, wale, top breadth and rail, and every fourth frame, and prove them by diagonals. Having proved all your lines, you can run in all your frames, either by sections or diagonals, taking a narrow strip of paper, and placing one end against the middle line of the half breadth for diagonals, and the base of the sheer plan for sections, marking the intersections of all the lines with the frame, and transferring the strip to the corresponding lines in the body plan. All your lines and sweeps may be made of thin mahogany veneer, as a substitute for spring elliptics, which are to be fitted fair to the several spots, and filed or sand-papered smooth.

All the lines are to be pencilled in, and in every respect finished, before they are run in with ink. Your sheer and body plan, and ⊕, may be run in with ink before you commence the half breadth; likewise all the bases, side lines, joints of frames, perpendiculars, and all other lines that are to remain permanent, such as rabbetts, cross-seam, horizontal waterlines, &c.; if they are merely pencilled in, they will be extinguished by India rubber, as you are altering the frames or half-breadth lines.

The neatest and most correct way is to make a mould to every line and frame, when you pencil them in or when they are in their proper shape; and the same mould will answer to draw them in with ink, by filing a small champer on the lower edge to keep the ink from spreading on the paper.

It will be necessary to strike your sections in the half-breadth plan, by setting them the same distance from the middle line as they are from the middle line of the body plan, and run them fore and aft with ink. You will then observe where the sections in the sheer plan cross the horizontal waterlines, and square them down to their corresponding sections in the half breadth, and that spot so squared down will be the spot where the corresponding waterlines in the half breadth will cross the section; and if they agree you may rely on the correctness of the waterlines and sections; if not, you will discover the error by consulting the frame and both lines, and see which can be altered. For example, suppose the third waterline of the forward body, figure 2, to be correct, and observe where it crosses the third section at 3, and square it up to the third waterline, as to 3 in figure 1, the third section will cross the waterline at 3, as it does in the same figure. I could easily add to these instructions, by describing the ending of all the lines running in the cants, and a multiplicity of other useless instruction, but as they are all briefly explained in the previous sections, it would only be a repetition, and my object here is to show the parts that differ from those instructions. All the instruction that is omitted in this section will be found in the former, and will apply to the parchment with the same propriety as to the draft-board or the loft.

To construct the sterns on parchment.—You will draw a base to correspond to the garboard seam of the counter; raise a perpendicular from the centre of the base; take the half of the length of the transom, or the extreme width of the horn timber, from the middle line of the body plan, and transfer it from the middle line of the stern, and rise a perpendicular from the base. Take the height of the wale, plank sheer and rail, and set hem up from the base on the perpendiculars, and draw horizontal lines parallel to the base, and take the widths square from the middle line of the half-breadth plan to the widths of the wale top breadth and rail on the after ends, and cut them off from the middle line of the stern plan on their several heights, and form a curve to pass from the several widths to the cross-seam. Take the width of the counter on its rake, and set it up from the base on the middle line of the stern, and on the perpendiculars; take the round or spring of the archboard in your compasses, and set it down from the spots last set up on the side line, and it will be the height of the archboard on its ends. The round of the archboard should show the same as the round of the beam, and it is necessary that it should have more sweep than the beam; if not, it would show less when canted; and to get the round that is required to show the same as the beam, you will strike two parallel lines, and let the distance between them be the same as the round of the beam, and take the cant of your archboard by applying the stock of a bevel fore and aft on the sheer plank, and let the tongue extend in the direction of the archboard. Transfer the stock of the bevel to the lower parallel line; let the tongue cross the upper line, and take the width between the two lines in the direction of the cant or bevel mark, and that width will be the arch or round of your archboard or tafferel rail. Take that width in your compasses, and draw a semicircle from a straight line and bisect it in the centre, by squaring from the spot where the leg of your compasses stood in the base to the arch, and divide the half of the semicircle in four equal parts; take a less space in your compasses, and divide the base of the quarter circle in four equal parts, as in figure 14, and draw lines from one division to the other. Strike a straight line from the upper edge of the archboard on each end, and set off the centre on the line, and divide the ends in four equal parts on the line, and apply the stock of your bevel on the base of the arch or circle, and let the tongue extend in the direction of the line showing the first division, or the one nearest the centre, and apply it in the same direction on the line, showing the first setting off from the center on the archboard, and scribe in the direction of the tongue. Proceed in this way until you have taken the other two, and take the height from the base of the arch in the direction of the several lines; set them up from the straight lines on the archboard, in the direction of the several bevel marks, and bend a batten to pass through all the heights, and make it fair to the end. The same method applies to making the beam mould, which will be found to be simpler than the old plan of working from a square. After you have formed your archboard on the upper edge, you will bring it to a parallel width, and apply the lower edge to the spot set up for it on the centre and ends. You can then set up the height of your cabin windows, which vary in size according to the fashion prevalent in different sections of the country; but if you have room under decks, they should be deeper than they are wide, so as to show square—for if they are made square, they will show much wider than deep, owing to the rake of the stern. If you are cramped for room, you may even make them wider than deep, but they will be most sightly to be twenty-four inches by twenty-two, or in that proportion. The number of windows is regulated by fancy. Some ships have four, some five, and some six; but for a common-size ship, two on each side and one in the centre is sufficient. They look as well, and even better than six, although the centre one gives but little light to the cabin, on account of its being shaded by the rudder. The pilasters between the windows should be all of a width; and the upper end should gradually tumble home towards the centre as you approach the ends of the archboard or quarters. They may be from ten to twelve inches in width, according to the size and number of the windows, and in proportion to the width of the stern. Then form the fashion-piece by setting its size from the counter timber, and adding the thickness of the waist and wales at the lower edge of the archboard, and let the curve conform to the shape of the quarter. You can then set up the height of your tafferel rail amidships, sweeping it fair to the height of the rail in the side counter timbers; and form your tafferel to suit your fashion; it will rest on the upper edge of the archboard. The better way is to keep it inside of the fashion or quarter-piece; in that case, the tafferel will often escape injury, which would otherwise occur, when loosing the quarter-pieces while lying in dock. When constructed in this way, it is called a raking view. You can draw a perpendicular view by levelling a line out abaft the cross-seam in the sheer plank, and taking all the heights perpendicular, and applying them the same as for the raking view.

SECTION IV.

Taking the bevels of the square body; also the bevels of the cants; and making the moulds.

Taking the bevels of the square body.—Having got the form of all your timbers comprising the frame of the ship, you will proceed to get their bevels from the floor, commencing with the square body. Make a skeleton frame out of strips of board, by placing two of them one inch nearer together than the spaces of the joints of the frames; set off one inch on the edge of the left hand board, and square a spot from the one to the other, fastening the end of a batten with a gimlet on the intersection of the square, with the inch set off on the left hand strip. Then swing the right hand end of the batten at your pleasure, and the square mark across the battens will answer for the dead-flat, or any frame that has no bevel. Prepare your bevel board at any width you see proper, but seven inches will be sufficient, and lay the bevel board betwixt the two strips, and under the straight edge, keeping it close or parallel to either of the battens. Next take the bevels from the body plan square with the timber, at the intersection of each diagonal, by measuring the distance that the one frame is within the other, and set that distance from the square mark on the right hand strip or batten, moving the right hand end of your straight edge to the distance set off from the square on the inner edge of the board; mark your bevel board, and it is the standing bevel of the frame that it was taken to; if it was taken as from the dead-flat to 1, it will be the bevel of 1. The better way is to have two persons engaged in taking the bevels, in which case one will take the distance with a rule, telling the other, and he will set it off from the square, and mark and number it on the bevel board. You will commence with the first diagonal, and take all the bevelling on it, and designate it on your bevel board. Some prefer to commence with the forward and aftermost square frame, and take the under bevel; but either way will answer.

Your bevel board being of a parallel width, you can reverse your bevellings by applying your bevels on the opposite sides of the board. You will have a separate bevel board for the forward and after body.

Taking the bevelling of the cants.—Prepare your bevel board the siding width of your cants, and place one leg of your compasses on the line that is levelled out for the width on the diagonals; open them until you can sweep the nearest part of the line drawn for the after side of the joint, and transfer that width from a square across your bevel board; draw a line from the square mark on the opposite side, and the angle will be the bevel.

Proceed in this way with the wale, top breadth, &c., and they may be reversed to get the under bevellings. The bevel to fay the cant against the deadwood is got by placing the stock of a bevel in the direction of the cant in the half breadth, and the tongue in the direction of the middle line.

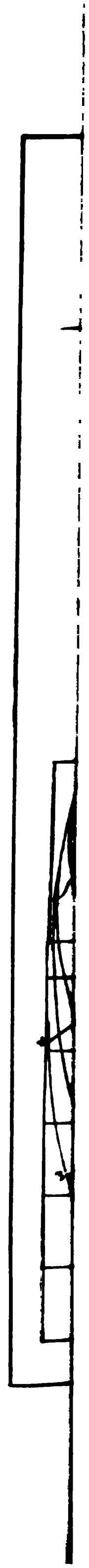
Making Moulds.—Having obtained the form of all the timber comprising the frame of the ship, and also their bevels, you may proceed to make your mould by making one to the height of the after deadwood.

You will first make a straight batten, and nail it on the floor at the base, letting it extend from the forward side of the inner post to the after square frame; fit a mould to the deadwood line, letting it end as before; tack it on the floor and nail straight battens from one to the other, at the stations of the after square frame and cants. Observe to keep the strips that show their stations square from the base, on the spots squared up to the bearding line for their endings. You can then fit a mould to the bearding line, and nail it on the outside of the battens.

Mark one or more square frames on your mould, to know how to place it to the deadwood when the ship is raised. Make a mould to your inner post as it is drawn in the sheer plan, marking the bearding line, and the upper edge of all your transoms on it. Then make your forward deadwood mould in the same way. But on ordinary occasions both those moulds may be dispensed with by marking on the mould the heights that the cants are from the base, and taking their stations with a batten as heretofore directed. Next make your stem mould, by letting its width extend forward of the line drawn for the after side of the rabbett, or stem. Mark the waterline, wale, top height and rail on it, also a square frame and base line, to set it by on the keel. Make it in two or more pieces, as you may deem fit, or intend to have your stem: if you make it in one you must brace it strong to prevent its springing; if it is made in two, you must make a midship piece of sufficient length to procure its true form when they are all nailed together for framing the stem.

You can then make your harpin mould to the wale, top breadth, or rail, in the half-breadth plan. The wale and rail will be sufficient to get the form of the bow, and show the station of the cant. Mark all the cants, and one or more square frames on both the harpins to hang them by. You can make them in three pieces. It will not be necessary to make moulds to the waterlines to regulate the frames or cants by; but you should bend a batten to a diagonal on the half-breadth plan, and mark the joints of the square frames on it. To get the station of the cant on the batten, you will square from where the joint of the cant crosses the riband line to the diagonal, marking it on the batten the same as it is on the floor, and transfer the stations of the frames and cants from the batten to a riband, to bend to the bottom of the ship, and on the diagonal mark on the frames. Then make the knight-head and hause-piece mould, which ends against the forward side of the foremost cant and perpendicular from, the base, where they intersect the forward side of the forward cant. and mark the diagonal wale, top height and rail on each mould; and also make your counter timber mould, observing to keep the toe up far enough from the fore end aft line drawn for the cross-seam, to admit of the counter plank, without lowering the outer edge of the plank. If it was projected from the cross-seam, the thickness of the counter plank on the angle of the counter would bring the cross-seam lower than it is calculated on the draft.

Many of the fashionable ships have two knuckles to the counter timbers, in order to prevent the archboard from turning sudden from the counter. You can project them on the latter plan by canting the archboard as much under from the upright of the stern as you see fit, and make your mould straight from the upper edge of the archboard to the upper end. Commence with the



moulds of the square body, by making the first futtock mould for ⊕ to fay against the middle and base lines, and if the floors are let over the keel by throating them, you will set up the same distance parallel from the base, and cut out square from the side line to the said height. The upper end of the said mould will terminate at the second diagonal, or the one next above the floor heads; the next will be the second futtock, which extends from the first diagonal or floor head to the third diagonal; and then your third futtock, which extends from the second diagonal line to the plank sheer, or to the wale, if a half timber is required, and on every second frame the half timber will be substituted by a stanchion. The top timber extends from the third diagonal to the plank sheer.

It will be well to let the end of your moulds extend a few inches above and below the diagonal, and mark the diagonal on the moulds; for you may often find when moulding, one timber, that would work a few inches longer, which will favor the one that is to meet it.

Next get the moulding size of the timber at each diagonal by marking the intersections of all the diagonals, top height, side line, &c., on the batten that you bend to make the mould, and strike a straight line on the most convenient part of the floor; apply your batten on that line, and transfer from it to the line on the floor, all the joints and ends of the timbers. Then set off square from the extreme end or mark that designates the side line of the floor timber, and the under side of the plank sheer, the size that you intend to have the throat of the floor timbers, and the upper end of the top timber, which should not be over one half the size at the throat. Strike a straight line from one mark so set off to the other, and it will be a diminishing line; then measure from one line to the other at the settings off for the heads of the timbers, which is to be transferred to the moulds which are tacked on the floor; bend a batten to pass through each of the spots so set off on the joints, and mark round it; the moulds taken to that width will give the size of the scantling. Mark the diagonals across the mould, and also the height of the wale, plank sheer, side line, &c.; number the moulds by marking the name of the frame on each one, designating the different marks. The diagonals may be marked 1st, 2d, &c., the wale W, the plank sheer and rail P and R; and those marks are to be carefully made, and also transferred to the timbers when moulding, as on them are placed the bevels to hew the timber by. Proceed in the same way with all the moulds in the square body.

It is not necessary on ordinary occasions to make the moulds to the size of the scantling. Let your boards be well seasoned, and you can rip them out about four inches wide. Fit them to the sweeps or frames, marking the size that each timber is required to be on each diagonal, which will be transferred to the timber when moulding, and your mould can be hauled in to the size so set off, and drawn up or down to agree with three or more of the spots.

You may now proceed to make your floor mould. The simplest and most expedient methods I have ever seen, are those used in the ship-yards in Massachusetts. It is simply two pieces of board nailed or screwed together, on a right angle. To make this mould, you will plane up a board the width of the keel, and eight or ten inches longer than the dead rise of your sharpest floor timber; this board is placed over the middle line of the body plan, and both edges against the side lines, and the lower end on the base line. Then prepare a board seven or eight inches wide, and as long as your midship floor timber; place it square across the board on the middle line, and at the height of the intersection of the sharpest floor timber with the diagonal; halve them into each other and screw them together. Should it be necessary to transport them, they may be separated without any inconvenience.

Having made the moulds, you can mark the dead rise and width of the floor-timber heads on it, by hauling it down to where the first diagonal crosses each of the frames. Mark the intersection of the diagonals on the cross-piece or arm, and mark at the same time the intersection of the perpendicular piece with the base line, which will be the dead-rise, and the length of one arm of the floor; haul it down as before, and mark and number them until you get them all in the fore body. Transfer the widths to the opposite arm, marking them the same. Turn your mould over, and proceed in the same manner with the floor timbers of the after body.

The floor-timber mould is often made in a skeleton form by fitting the inside of a board to the ⊕ below the base, letting it extend the length of the floor timber. Tack it to the floor, and place a batten three inches wide on the middle line, on which you can mark the depth of the throats of the floor, by taking them from the sheer plan, and setting them up on the base of the body plan, marking the proper height upon the floor timber.

You can then get two strips of like dimensions, and place them on the side line by letting their width extend toward the middle line; then place another strip from the mould that fays against the dead-flat, and let it extend in the direction of the first diagonal, and of a sufficient length to reach the intersection of the diagonal with the sharpest floor timber.

Place a horizontal batten from one diagonal batten to the other across the middle line; fit and fasten them all together, bracing them as you see fit; and if any of the floor timbers rise above the base, mark the height across the side-line battens. This you will do by scratching up on the diagonal piece all the intersections of the frames with the diagonal or batten, and transfer those of the after body to the opposite diagonal. Turn your mould over and do likewise with the fore body. The preferable way is to make the pieces that correspond to the side line half the width of the keel, and their edges will come close together, so that by putting two or more hinges on it, you can fold it up, and it is less liable to mechanical violence, and is also much more convenient for use. You can make your transom mould in the same way, by fitting a straight batten to represent the back of the main transom; also one to represent the cant of the fashion-piece, and a couple of battens one half the width of the stern post on the side lines, on which will be marked the bearding line, or seat of the transoms, as they are squared across the side lines. Then place a batten to each section, as they are in figure 4, plate I. Then fasten each side separate, and mark the intersection of all the upper and lower edges of all the transoms on the cant of the fashion-piece, and on the section battens you will mark the upper edges on one side, and the lower edges on the other; when it will be understood that each corresponding figure or mark having the most dead-rise is the lower edge of that transom. You can either put hinges on the side-line pieces, or you can observe that they both fay close together, and you may lay them on the transoms in the same way when moulding. It will not be necessary to make batten moulds to all the transoms, except you wish to be very accurate, and in such case you will make them to one side, from the side line to the line of the fashion-piece; get the bevels of the seats, by taking the distance that the lower side comes within the upper, and apply a square across the back, pricking it off from the square on the opposite side, which will be the spot to place the mould, on the lower edge; and you can get the bevel of the part of the main transom that comes below the cross-seam, by applying the stock of the bevel horizontal in the sheer plan, and let the tongue extend in the direction of the several section or buttock lines, and mark it on the transom mould, and near its corresponding section, and they are to be applied from the under side of the transom to the several section marks on it.

The cant moulds may be made in the same way, only they do not end against the side line, but cut parallel to the middle line, and as far from it as the ending of the heel may be, as the foremost cant, figure 3, or in the cant plan. Also observe to mark the bevel spot on them, from the horizontal line which shows the width of the cant on the diagonal, as on the line *n o* in the cant plan. Mark the upper edge of all your transoms on the fashion-piece mould, to set it by on the transoms.

SECTION V.

Upon Building.

THE builder should first impress upon his own mind the great responsibility that rests upon him; he should consider the consequences that may follow if his duty is not discharged with fidelity; and should always bear in mind that, although he may for a while deceive the eyes of the world, as well as his employers, by hiding any defects in the construction that may have been occasioned by ignorance of his profession, or a want of proper faith and fidelity to his employers, yet these defects must eventually be brought to light; and it may be at a time when they may occasion the loss of much property and many lives. It should always be remembered, that the whole strength or strongest part of a vessel is only equal to her weakest part, and to give any part of the ship a superiority of strength more than a just equality, is only to add weakness to the feebler parts; hence, equality may be the basis of your calculation when consulting strength. There can be no better rule for fastening all your work together than the one already mentioned. You can consult your own judgment to ascertain which is the strongest, the wood or the fastenings, and if the latter they should be reduced, or the former, should be increased, until you can safely conclude that if any part of the structure were required to resist more force than its strength would admit, one would be as likely to yield to the superior force as the other. By drawing your conclusions from these premises, you can never be at a loss.

The keel may be composed of three or more pieces scarfed together; and if pieces of a sufficient depth are not to be obtained conveniently, it may be made in two depths, which is the most desirable method, as the weakness occasioned by the scarfs will be felt in a much smaller degree. After one tier is scarfed together, prepare it to receive the other by making it fair and smooth, and lay the other pieces over, observing to shift the scarfs, so as not to bring them over the others. After they are all fayed to each other, bolt them slightly, previously observing to leave as much wood above a straight line forward and after as the timber will admit. Strike a straight line on the side fore and aft, and as far from the upper side as the upper edge of the rabbett amidships may be.

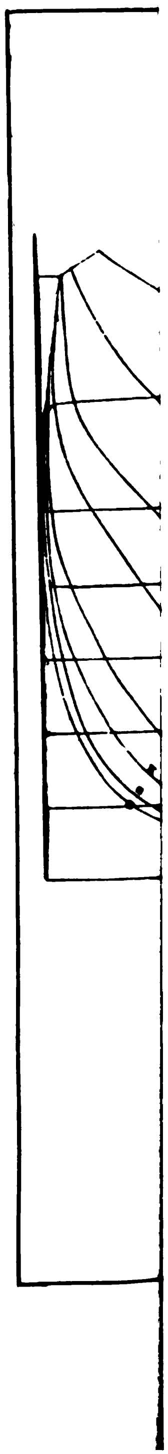
After the line is complete on one side of the keel, you will leave as much wood above the line on the forward and after floor timber as may be required, and take the same depth out of the floor timbers, whatever it might be. Then bring the top of the keel fair, and plane it to receive the floor timbers, and cut the scarf for the stem copper, and put a shoe forward and aft; each piece may be about ten feet long. When this is done, place it on blocks laid for that purpose, about six feet apart; the blocks must be laid solid and flat together, and fastened with a riband nail or a spike to each other. The keel is placed on these blocks, on a descent from six eighths of an inch to an inch and one eighth to the foot. It must be made straight on its side, and may sag a little amidships. After it is in a proper position, you can drive tree-nails or spike cleets on each side of it on every block. You can now lay out the joints of the frames accurately, by commencing from the dead-flat. Square them all across the keel, and number them as they are in the loft; the floor timbers are sided, and those in the after body moulded on the forward side, and those in the forward body on the after side. Mould them by placing the floor-timber mould on them and marking the dead-rise and side line, and seat on it, and take the first futtock mould of the corresponding frame, and mould the floor timber by it, by placing the side line and seat of the first futtock to that of the floor timber, and bring the surmark on the futtock to agree with that on the end of the floor timber; mark round the mould, hew it out, cut the throats, or seats and limbers, and saw off the ends. You may now proceed to lay them across the keel, commencing with the ⊕. After you have laid it across and driven it down, you will draw a line from one diagonal or surmark on the arm to the other, and horn it square across the keel. Place a shore under each arm at one foot inside from the end. and bring it to a level, either by looking it out of winding with the water, or by placing a square in the direction of the line, and hanging a plumb in the direction of the tongue. Drive or slack a wedge under the shores as the case may require. After you have got it to a level and square across the keel, you can brace it by spiking a spall from the arm to the keel on an angle, and put a riband nail in the heads and heels of the shores and bolt it. Let the line remain on the dead-flat to look the other floor timbers out of winding by. Lay across several of the floor timbers. Continue the after body by placing the forward side of No. 1 to the mark for the joints, or half as much abaft it as the futtock and floor timbers are to be apart. Draw a line from one surmark to the other and fasten it, and let one man see when it is out of winding and the other attend to the shores. Square it from the keel to the line, to see whether it stands square, for if the seat is not cut exact it may cant forward or aft; if so, you can drive a spike under either side, until it comes square. You can horn it from the dead-flat, and if it does not fay to the keel, you can run a saw under it, or prick it down by taking the distance in your compasses, that the side of the floor timber is above the upper edge of the rabbett, and scribe it on the floor timber from the top of the keel; cant the floor timber and cut from one mark to the other; cant it up and horn it; nail a cleet up on each side of the keel, and drive a couple of riband nails through the cleets in the floor timber and keel to support it, until the kelson bolts are drove which are to pass through it. You will proceed in the same way with all the rest, observing to horn level. Shore and bolt every other one. After you have fayed and secured them all, run your floor riband, which should be fair and about four by five inches square, more or less, according to the size of the vessel; bring its upper edge to the surmarks on the floor-timber heads; put a riband nail in each; fit a shore under every second floor timber, and nail it to the riband.

Then commence with the frames. The first and second futtock should be sided the same thickness as the floor timbers, and the third and fourth futtock and top timber should each be smaller. They are then moulded, and the bevel spots being marked on them, they are hewn to the bevel. After you are ready for framing, lay the mould on each piece of timber and mark the diagonal or surmark on the timber; saw them in and cut the joints parallel to the diagonal. If any timber does not work to the diagonal, you will leave the one that butts as much above or below the diagonal as the other falls short; but if your timber moulds well, you can cut all the joints exactly at the diagonal, except that enough may be left on each end to fay the two butts together, in case the saw should run. After you have sawed off the ends of the timber, you can cut the limbers and seats in the first futtock, and commence laying down the frames. The ground should be levelled on both sides of the keel, fore and aft, and if so, the method of framing the half frame together is much the quickest. Let each frame be laid down where it belongs, or as near its station on the keel as possible, and commence with the midship frame, by laying the first and third futtock on some pieces of four-inch plank, by letting one piece come under each joint; butt them together, and carry the heel of the third futtock one way or the other, until they both conform to the second futtock mould. Follow on with the fourth futtock or half timber, and regulate it by the fourth futtock or top-timber mould. If either of them wants raising to bring the moulded edges level, you must fit pieces of pine and drive them under. When you get the whole three to agree with your moulds, you can run a cross-cut saw between the butts and fay them close. If you wish to be more precise, saw the ends of your mould off, and butt and nail them together; regulate the frame by it; drive dogs in the butts to keep them together, and lay on the second futtock and top timber and stanchion. If you frame it, bring the surmarks together, and place a three and a half inch pine plank between the tiers; put a screw or clamp across the first and second futtocks, and confine them close and solid. Butt the fourth futtock or top timber against it, and do likewise. Dog the butts together, and follow on with the stanchion on every other frame, and secure and bolt them together by driving a bolt through each butt. Proceed in the same way with the frame abaft, and when it is done take your plank from under it, and place it close to the other half frame, and the outside of the bilge of the ⊕ will lie close to the inside of the bilge of the one last made, and so on with all the frames in the after body. Having thus prepared the after body, you can cant them up, ready for raising, by placing the first futtock, or navel timber, on the floor-timber riband, in the room where it belongs, and let the bilge lie on the ground. Lay a block or place a temporary shore under the top timber, to keep it from springing before it is raised. After this is done forward and aft, the body of the ship or vessel is ready for raising; but previous to making the frames, the stern frame should be made and raised, and the after deadwoods completed.

To make the stern frame, first side your stern post, and hew it square on the forward side, and beard and bring the after side to its proper thickness, and its length should be about two feet more than the height of the cross-seam. Get out the main transom straight on all sides, and deeper or larger in a perpendicular direction than it is fore and aft. The after side may be hewn to a bevel, so as to fay against the stern post when its upper side lies horizontal or fore and aft. If the stern post stood plumb, the transom would hew square and lie horizontal; hence it is evident that the more the stern post rakes the more the transom would bevel. To get its bevel below the cross-seam, lay the stock of a bevel fore and aft in the sheer plan, and let the tongue extend in the direction of the several sections where they cross the main transom, and reverse it, if it was taken as an under bevel, and strike a straight line on the after side of the main transom, and as far up from the lower edge as the transom is below the cross-seam; apply the bevel from the under side at each respective section marked on the transom, and hew it to the several bevels; apply the back of the transom mould to the back of the main transom, or as far back as will bring it square with the cross-seam, if the transom bevels. Bring the centre of the transom mould to the centre of the transom, and scribe on the forward edge of the mould which represents the cant or fashion-piece. Scribe the ends, which will give the length of the transom, and hew the forward side square to receive the fashion-piece; cant it down on its after side, and take the fashion-piece mould and place the line which shows the height of the lower edge of the main transom to its lower edge, and in the same direction on the edge of it; run it out until it meets the line or scribe across the end, showing its length; mould the end of the transom and hew it with the bevel of the fashion-piece on that height. Side all the other transoms as they are in the loft or draft, and mould the upper edge by laying the mould on and scribing the side lines and marking the dead-rise from each of the battens and seat, and bend a batten to pass through each spot, or make batten moulds in the loft for that purpose. Mark the cant of the fashion-piece on it, and square over the seat and ends to the opposite side, and turn it over and place the same marks or risings that you mould it from to the spots squared over. Mould the lower edge by transferring the risings for the lower edge from the mould to the transom. Scribe the cant as before, and sweep it with a batten, or mould it as before, and hew from one edge to the other. Proceed in the same way with all the transoms, by applying the fashion-piece mould to cut all the ends.

Having moulded all your transoms, you can side and mould your inner post. The after side may be lined to the thickness of the inside of the rabbett; and mark the bearding line on it and the heights of all the transoms. Fay it to the forward side of the stern post, and bolt it on with three or more bolts. Measure the distance from the bearding line to the forward edge of the inner post at the height of the transoms, and transfer it to its corresponding transom and cut the breeching. You may cut it all out of the transom, or a part out of each, which is preferable. After you have cut the seats of all the transoms, you can lay them across the stern post, and horn the main transom square across, and lay it level; and lay the side of the stern post plumb, and fay it to the transom by cutting a jog in the lower edge to receive the inner post. Then place it in its proper position, and stay and bolt it. Proceed in the same way with all the rest. After they are all fastened, lay on the fashion-piece and prick it down on the ends of the transom by taking off some from the ends of the transoms that may come a little above the others. After this is done you can lay the fashion-piece on, observing to keep it to its proper place on each of the transoms, and bolt it in every transom. Square off the back of the transom and fashion-piece if it is required to make them all agree with each other. Instead of scarfing the fashion-piece so as to bolt on one or more transoms, you can leave three of the transoms that come nearest the butt or scarf about six inches shorter, by cutting them off at the after edge of the piece representing the cant of the fashion-piece on the transom mould, and side a piece the same size as the mould, which should be the same size as the fashion-piece is intended to side. Hew it by the bevel of that part of the fashion-piece, by reversing the bevel. After the transoms are in their place, you can fit the piece in, and its upper or forward side will come flush with the forward part or ends of the transoms. Butt the fashion-piece on the centre of this piece, and bolt through both butts, and also the piece in the transom under the butt. This last method is a saving of timber; for the transoms which cut off shorter are easier obtained, and it requires less and straighter timber to butt than to scarf the fashion-pieces. The horn-timber may be bolted on the fashion-piece, and butted on the end of the transom; or the fashion-piece may run up singly, and a knee may be moulded with the fashion-piece mould, and fayed and bolted on the top of the transom.

After the ship is raised, you can cut off the lower ends of the stern and inner posts, observing to get its true bevel either from the loft or inner post mould, and cut the posts as much shorter than the mould as the base line is below the upper edge of the keel. Cut a small tenon fore and aft on the inner post, and one athwartships, near the forward part of the stern post. Having completed the stem frame, you can raise it; which should be done before you put the floor timbers across the keel. It is raised with shears and a tackle sufficiently large to take its whole weight. After it is raised high enough to enter the tenons, you can belay the fall, and haul in or slack the fore and aft guys until it is right for entering; lower it down, and put two strong shores abaft, keeping their upper ends secured below the main transom on the stern post with a large cleet, and stand the heels abaft, at a sufficient distance from a line with the keel to afford a bracing position. You will also put a large shore under the ends of the main transom, and wedge up under either shore until you bring the stern post plumb. Horn the main transom with a long batten, and from a centre mark on the keel. If it is not square across the keel, you can set a shore abaft, on either arm of the main transom, and wedge it forward, observing at the same time to keep the stern post plumb. After this is done, fay your stern knee and deadwoods, all of which should be sided the same size of the keel, and filled up as high as the deadwood line, on the loft or mould. If you cannot get a stern knee suitable, fill in all with straight timber, which is equally as good, but is more costly, on account of fastening. Put two or more bolts in each piece as you fay them. After they are all fayed, put in some of the longest bolts, and leave the others to be driven through the keelson and rider. The stem may be composed of two or more pieces sided straight and moulded rough, when the mould may be nailed together, and the several pieces may be neatly scarfed together with hook scarfs. When the scarfs are drawn together with a screw or a chain and wedges, you can lay the stem mould on, and see if they are nearly correct; if so, you can put a couple of bolts in each scarf, and take the screws or chains off and lay on the stem mould. If it is full on any of the scarfs, mould and trim it off, and then transfer the base and forward square frame from the mould to the heel of the stem, and cut the scarf to conform to that on the keel, which can be done quickest by striking the base line of the keel on the upper edge of the mould which the scarf was cut by, and mark the forward square frame on the mould. Transfer the mould from the keel to the stem, by placing the base and square frame marks on the mould to their corresponding marks on the stem. Scribe around the lower edge of the mould, and cut the scarf square and out of winding. Set the forward edge of the rabbett as far from the after side as it may be from the top of the keel amidships, and bend a batten fair and regular, and scratch it in. You can now put some more bolts in the scarfs and cant the forward side up and beard it. Strike a centre line on the forward side, and strike a diminished line on a plank by setting off half the size that the heel is required to be on the end of the plank, and measuring the length of the stem; and mark spots upon it five or six feet apart, transferring the length and spots to the plank. Find the size of the upper end of the stem, which is but little less than the siding size, and set half of it off on the plank; and on the spot showing the length of the stem, strike a line from one to the other; take the widths from each of the spots, and set them off on their corresponding spots on the stem; line fair from one spot to the other, and beard it straight from the forward edge of the rabbett to the line on the forward edge. Plane it smooth, and the apron may be sided four inches wider than the stem; but as it is difficult to get a stick suitable, it is best to side it in two widths, and join them together on the middle of the stem. When you have them in two widths, they may be wider, but not exceeding the size of the bowsprit in width; and the width must be the same as they are laid down in the loft. The apron is moulded with the stem mould, and fays to the after side of the stem; the scarfs or butts of the apron must not come over the scarfs of the stem. The upper piece should extend from the head of the stem down below the forward cant, and should be fayed and bolted. To do this, you will reverse the stem from its position for bearding, by placing the after side uppermost, until the apron is fayed and bolted. Care should be taken to keep the sides of it direct, fore and aft, while faying it; for a small cant would make a material error in the knight-heads. After it is bolted, cast the stem down on its side and mould the knight-heads on the forward edge, and mark the end of the mould on it. If the mould is not made to the size of the knight-heads, range the heel mark up until it comes to the moulding thickness on the after side of the knight-head; take the bevel from the bevel board which fays your foremost cant against the deadwood, and apply the stock of the bevel on the forward side of the knight-head; let the tongue extend across it from where the heel mark terminates on the after side, and scribe by the tongue of your bevel; and cut the end out of winding with the heel mark on the side that fays to the apron. It will then fay to the forward side of the foremost cant. You can trace the line as it was moulded, and bevel it on the several waterlines and wale, top height and rail, by looking the several spots out of wind, on the forward side, or the side next the apron; square over the spots to the opposite edge, and lay a square across your bevel board, and find how much it bevels within a square on the several spots; set it on from the spots squared over, and mould it with your first hause-piece mould, or sweep it with a batten, and hew it from one side to the other, which is more expedient than hewing it by applying the bevel to each spot. If you wish to get the hause-piece out before the ship is raised, you can do so by proceeding in the same way, but it is unnecessary when drafted with their sides fore and aft, for it requires more wood to bevel them than it would if they canted with the bows of the vessel. The knight-heads being complete, you can fay them to the apron, unless they were drafted to have planks between them and the apron; if so, you will place the necessary pieces on the apron and lay the knight-head on them, and carry it up or down until the surmarks agree. Then take a piece of board about 18 inches long and as wide as the bottom plank is thick; make one end square, and bevel the other end across its width on an angle of 45 degrees, or as much more as you please. Lay the short edge of the said batten or mould across the knight-head, and let the sharp corner run down to the stem. Observe if it strikes it forward of the scratch, showing the forward edge of the rabbett; if so, you will knock it aft until the sharp corner comes to the rabbett. After you have regulated it on both ends, you can put chains around them and wedge them taut; observing, at the same time, to keep the sides fore and aft. Then put in bolts enough to hold it fast, observing to keep them clear of the hause-holes, and



trim out the rabbett by fitting the square end of your batten or mould to the side of the stem. When the edge is on the knight-head, you can chisel down spots and fit the mould every two feet; chisel out fair between the spots; turn it over, and proceed in the same way. Bolt through them both and clinch the bolts. The shears may be brought from aft, and the stem raised and secured with one shore on each side near the head, and another forward of it. When it is plumb, put a chain around the scarf and wedge it together, observing to keep it exactly fore and aft with the keel. Then bolt it slightly, leaving the rest of the bolts to be driven through the keelson. It has long been fashionable to let the lower piece of the apron run two or three feet abaft the scarf, and butt the forward floor-timber; but it is abandoned in many parts of the country, and the forward floor-timber is brought as far forward as the after part of the scarf; the lower piece of the apron comes down as far as the forward part, and is champered off, and a short wedging piece is butted against the forward floor-timber and fayed to the scarf and to the after part of the apron, and its top is on a level with the top of the floor-timbers; the keelson runs over it and fays on the apron. When it is bolted there cannot be any weakness felt, for it is then as strong as any part of the ship; and moreover, you can have one more floor-timber, which gives additional strength to the floor of the ship. The cants are hewn out by their proper bevels, and the tenons being cut on the heels, they are framed in the same manner as the square frames. After they are all ready for raising, prepare a couple of small shears, fifteen or twenty feet longer than the ship is deep, and place them forward of the stern frame, and commence with the cants; although some prefer raising the square body first, which is better. Fasten a strap between the timbers with a toggle, near the upper end of the top timber, and hook the tackle to it. The shears should be guyed fore and aft. Fasten a leading block to one of the floor-timbers, and reeve the fall, and raise with a horse or by hand. When the half frame is up, place a shore under it by sniping the end so as to enter between the third futtock and top timbers, and the end will bring up against the plank that is between them. Put a temporary shore under the bilge to take the weight; put a showel under each shore, and drive a riband nail to secure the shores upon them, and stay-lath or brace the frame, to keep it from going aft. You can then hook on the other half frame upon the opposite side and do likewise. If it does not stand square with the keel, you can haul in, or slack off, on the guys. Then put a cross-spall from one side to the other. The cross-spalls should all be prepared before you commence raising. A calculation is made in the loft to find the most proper places to put them. They should be put far enough below the top height to lay the upper deck stage on, and to run two streaks of clamps. You can set down from the wale of the body plan in the loft the height the spalls are intended to be placed, and take the width on every fourth frame, on a batten, and mark the name of the frame next to the width. Transfer the widths to the spalls; saw in a centre, and mark the name of the frame on the spalls. When you nail the spalls on the frames, place them as much below the wale mark as the widths were taken below it in the loft. Take care to let the end of the spalls project or fall as much short of coming to the outside of the timber as the frame bevels; for the widths were taken from the joints, and not from the edges of the frames. After the after frame is raised, the spalls should be bored three inches from the end; and a man should ascend the frame on each side, with a maul, when a rope may be fastened to each end of the spalls, which may be raised by means of a single block lashed on the head of the frame. One end should be fastened with a riband nail, and the shores wedged up or slackened, until the width comes right. Then hang a line over the saw-cut in the centre of the spalls, and plumb the frame with the centre of the keel, wedging it over on either side until it comes plumb, and fasten the line from the centre of the spalls to the centre of the keel. Then carry your shears forward and raise the next frame as before, and stay-lath it to the frame last raised, by measuring the proper distance from joint to joint, and nailing a short piece of plank on the inside, and so on until you come to the next spall frame. Put the spall on as before, and hang a line over the centre to the centre of the keel, and wedge the frame either way, until the line comes out of winding with the line on the after frame. Let the heels of your shores all stand aft to keep them from sagging; and proceed in the same way until you raise all the square body. Then put your standards in the ground, and build the stage of a proper height to hang the upper wale. The better way is to place two rows of standards abreast on both sides of the ship. Let the row next the ship be about four feet from the wale, except those on the luff, which may be farther off. You can nail a spall from one standard to the other, independent of the side of the ship. The stage, thus constructed, can be raised or lowered in half the time that it can when it is confined to the side of the ship. After the stage is complete, you can hang the harpins by first trying your harpin mould; and if the knight-head requires easing to make the mould fay, you can do it, and bring the forward frame to agree with the mark on the harpin mould. Then put up the harpin and spike it to the knight-head and foremost frame; put a shore from the luff of the harpin to the ground, observing to keep it level, or a little higher in the luff, for the weight of the cants will have a tendency to sag it.

Some men in the mean time may be faying the second futtock to the floor-timber, by taking the distance with the compasses that the side line on the first futtock is from the keel, and cutting the same length either off the floor-timber or second futtock. You must have a narrow saw about two inches wide, and one man should stand outside of the ship and one inside—in that way they can saw the piece off as required; or run a saw between them, by placing a wedge between the butts of the futtocks to keep them from binding the saw. Then plumb all the spall frames accurately and shore them, and in that position they must remain. Then bolt the first futtock and floor-timber together, by putting a piece of plank between them, and enter your auger in the corner of the first futtock, and bore slanting nearly through the floor-timber; drive two or more bolts in each arm, and start the bolts in, to clear your adz when dubbing for ceiling. Bend a batten to the third diagonal in the loft, and mark the joints of the frame on it; transfer them to a large riband and bend it to the third diagonal on the vessel's bottom; fasten its ends to the foremost square frame; bring the joints of all the frames to the marks on the riband, and drive a large riband nail or spike in each frame. If any of them do not come to the riband, you can put a clamp screw on them, haul them out to it, and put in an additional spike. Place another to the top height in the same way, and let one end reach to the fashion-piece or horn-timber, and place the other to the fifth diagonal, or half way between the two, and spike it on as before; drive a riband nail through the floor-timber riband whenever it may be required. Then hew out the keelson pieces by siding them the same size as the keel, or larger, amidships, and scarf them together. The scarfs in the keelson should not come over those on the keel, but they should break joints. If you cannot get the keelson deep enough, make it in two depths. Dub the top of the floor-timbers and first futtock fair, and run in the first tier of keelson pieces; prick them down to the floor-timbers, and put some bolts in to keep them in place. Trim off the top side and fay the upper pieces on them, observing to break joints as before. Put a chain around the keel and keelson; wedge them down solid, and drive the other keelson and deadwood bolts, observing to cut them all five or six inches longer than they are required to be when driven, for the ends often get racked and you have to cut them off. Then fay on the after rider and stemson, and bolt them. The after rider will butt against the inner post, and fay under the lower side of the lower transom, and extend forward to the after side of the step of the mizzen-mast.

Square off the forward and after deadwood to receive the cants; square up their joints and mark the bearding line, or set up their several heights from the base, and cut the boxings or mortises, to receive the tenons on the cants. Then raise the larger portion of the forward cants with the same shears, and they may be unlashed and a derrick made of one of them, which may stand on the inside of the vessel, and will answer to raise the remainder of the cants and the hause-pieces. After the cants are raised, spike the heels and bring the heads to their stations on the harpins and fasten them. Then bolt the heels, and bend smaller ribands than those on the bottom from the hooden ends to the square frames, and on the diagonal; bring them to their proper places and spike them as before. The after cants may be raised with a derrick and guys to the head. After they are raised, they must be shored the same as the square frames, and the heels must be spiked to keep them in the boxings. Regulate them in the same manner as those in the fore body, by setting off their proper stations on the top-height riband. Make moulds to the first hause-piece, and take the bevels on the ribands and harpin moulds, by placing the stock of the bevel against the mould, and let the tongue extend in the direction of the riband. After they are hewn to fay against the foremast cant, you can hoist them up by putting a ring bolt through the hause-piece and hooking the tackle in the ring. If you have a port on the lower deck, you can make the starboard one in two pieces, and spike them to the ribands and harpins. After this is done and the side counter-timbers are in their places, the vessel is ready for shearing.

As there are a diversity of opinions on the expediency of framing and raising vessels, I will mention other methods. Some prefer laying down the whole frame, fitting all the joints, and bolting the half frame together, as in the method already described. They then lay them all aside, and build the stern frame and bore it off. Then they take it all apart and turn the keel down on one side, and enter the tenon of the stem post, fay the stern knee, and bolt it to the keel and stern post. The stem is also bolted on the keel, and shears rigged forward and aft, and tackles attached to the head of the stem and stern post. It is then raised about half way up, the falls belayed, and the whole fabric shored up. The after tackle is then cast off from the stern post, and attached to the main transom, and it is hoisted up to its place, and the bolts driven. It is then cast off, and the second is hoisted in the same way, and so on until they are all bolted and the fashion-pieces are hoisted and secured. While in that position, the after tackle is then attached to the stern post or main transom, as before, and the stem, stern and keel are all raised at one time and shored in their proper position. A stage may then be built level with the top of the keel by nailing cleets on it to receive beams or spalls. To support the stage, the other end of the spall may be supported either by blocks or a piece of timber laid fore and aft on each side of the keel for that purpose. After the stage is completed, the wings of the frames are brought to the stage, commencing with ⊕, and the top-timbers of the frames in the after body, will lie forward of the stern; the floor-timber is laid across the keel two feet or more abaft its station. The wing or first futtock is then laid on it; the frame is brought to its proper width, and the cross spall spiked on the first futtock is bolted to the floor-timber, and the frame raised by attaching a tackle to each top-timber and to the head of the main transom for the fore body, and to the end of the stem for the after body. Then lift the frame as high as you can; put blocks under the top-timbers; attach a small tackle from the floor-timber to the keel, and haul it taut, to keep it from going forward while raising the frame. It is then raised by hauling on the side tackles, and should be shored plumb and well braced; and after three or more are raised, the tackles may be cast off from the stem and made fast to the first frame; and in this way all the square frames are raised.

Many who have more time to build vessels, and consequently have less hands, lay down the floor-timber, second futtock, and top-timber, cut their butts on the stage, bolt the upper tier on, and raise the frame as before. The reasons for so doing in such a case are obvious. It requires less hands to handle the several pieces separately than it does to bring the half frame on the stage; and the stage being level, it is much easier to lay them out than it would be on the ground. But I have tried all these three methods, and would recommend the first, as being the most expedient, except for steamboats or shoal vessels, for which I prefer the method last described. The keel, stem and stern frames should always be raised separate from each other.

Sheering.—The ship being all raised and regulated, you may dub a streak for your upper wale, which should be as wide as two streaks, part of which should be above the wale sheer, and the remaining and greatest width below. Prepare a line or a two and a half inch rope, and fasten one end in the hooden ends at the height of the upper edge of the wale, and drive some spikes along the side and luff of the bow at the same height to keep it up; lay the line on them and carry it aft; make it fast on the side counter-timber, observing not to haul it too taut, but let it sag with the sheer of the ship. Then get in a position abreast the ship and as near level with the wale as you can, and cause an assistant on the stage to raise or lower it at the proper points, which may be done by signs. After you have got it to look fair, you can mark spots at every ten or twelve feet on the upper edge of the line; bend a long batten to the several spots, and scratch on each frame all around the ship.

Get the sheer on the luff and flare of the bow by taking a piece of board as wide as the wale is to be thick, and about six inches long. Make one end square, which will represent the upper edge of the wale, and by laying the edge of this board on any of the flaring frames, you will see that the outside square corner is not on a level with the corner next the timber, but much lower; and if the wale was bent to that sheer, the outside of the seam would come where the outside and upper edge of your board is, which would spoil the sheer of the vessel. To avoid this, you will raise the sheer on the luff. The sheer of vessels is often spoiled by throwing it too high; but to get it properly you can stretch out a line level from the wale mark abaft the luff of the bow; haul the line taut and make it fast to one of the outside standards. Then take a straight-edge and place the lower edge of one end against the scratch on the side of the ship, and raise the outer end until it comes out of wind with the line, or any other level object, and run your piece of board up above the scratch until the outside corner comes as high as the batten. Mark on the timber where the inside corner is, and that will be the spot for the height of the sheer. Shift to another frame and proceed in the same way, until you get them on every frame around the flare of the bow. Bend a batten to the several spots to meet the line first drawn; make it fair and scratch it in; and if the flare of the bow was the same from the wale to the heads of the frames, the distance between these lines would be added to any streak of the same thickness, and at the luff, and it would show the same width as it does amidships; but it is not necessary to line the wales any wider on the luff than they are amidships; make them the same width, and diminish them from the luff forward. Get the sheer on the opposite side by stretching a chalk-line across amidships, hauling it taut; let one man stand inside of the ship, and one on each side, to pass a line between the frames; keep one end to the sheer already obtained; haul the line taut, and the man on the opposite side will raise or lower the line until it comes out of winding with the other line, and mark it on the side of the frame. Do this at every ten or fifteen feet amidships, and much closer around the bows. Then bend a batten to each of the spots; make it fair and mark it. Then line out your wale and hew it square; heat the forward ones and bend them to the bow. Bore some set holes in the frames, put in bolts; bring up the midship pieces; bring them to the mark on the timbers, and put no more fastenings in than is barely sufficient to hold them. After you have got them to their place, you will measure off spots at twenty feet distance, and find how much sheer there should be in twenty feet in length. If it is six eighths of an inch, you will hold a line from one twenty foot spot to another; measure from the wale on the centre, or half way between the spots, to the line, and if it is precisely six eighths, and the wale is fair, it is right. Then shift twenty feet further aft, and if it is too high or low you must raise or lower it by nailing a cleet to the side or putting in a set bolt, and the sheer should be a little more crooked aft than amidships.

After you have regulated the sheer, which should be done with the utmost care, you can spike it fast and work your wales under it, or set down the width to the upper edge of the lower wale and work it next. Work up and fill in. The latter is the most expedient. If you get the sheer without hanging the upper wale, it is seldom, if ever, correct, although in many instances the ship may look well.

Next get the sheer of the deck. The ship should be straightened on the deck line from amidships to aft, about five inches; and lay out the height of the waist strings and mouldings amidships. Suppose the waist to be 20 inches, which is wide for a ship of this size, and the string above it six and a quarter inches, and the first moulding four and a half, the second string five inches, the second moulding four and a half, and the upper string five and a quarter inches. This last one is lined wider than the rest because you may have to run it down to make it fair. The sum of the several widths make forty-five inches and six eighths to the under side of the plank sheer, which is more than is required for a ship of this size. The draft (Plate I.) is calculated to have a waist of eighteen inches; the first string six and a half; one moulding four and a half; the upper string five and a quarter, and the plank-sheer four and a half; which gives thirty-four inches and a quarter to the under side of the plank-sheer amidships. You will take two battens thirty-four inches and a quarter each, and run your beam mould athwartships between the frames, commencing abaft the fore chains; hold the battens plumb, and bring the upper edge of the beam mould to the upper end of the battens, and scribe by the mould on the side of the frame on both sides of the ship. Shift your beam mould forward, and get the height and mark as before. Shift again until you get as far forward as you can, observing to keep the battens plumb, and on the outside edge of the wale when on the flare of the bow. Get the height of the sheer on the flare of the bow in the same manner as on the wale, only having the strip of board the thickness of the string, instead of the thickness of the wale. Drop the sheer aft $4\frac{1}{2}$ inches, and do this accurately, take the difference between the depth amidships and aft, viz., $4\frac{1}{2}$ inches, in your compasses, and strike a circle. Bisect it and divide the $\frac{1}{4}$ in as many equal parts as you have 12 foot spots on the wale abaft the extreme width of the waist or fore chains. Divide the base into as many parts as the arch, draw lines from one to the other, and number them 1, 2, 3, to correspond to those on the wale, commencing from the centre of the arch, and mark the proper width on a batten for the after opening, which is 30 inches, and place the 30 inch mark on the base of the arch, on the several divisions in the direction of the lines; mark on the batten where they intersect the arch; number each width on the batten as they are on the arch or base; and set the several heights up from the wale by placing the end of the batten on it and on their corresponding spots; make marks for each height; bend a long batten to each of them and make it fair; continue the batten around the bow to the several spots set up for the flare, or cant of the streak.

The sheer being now complete, you can transfer it to the opposite side, by setting it up from the wale on the corresponding frames. You can now build the upper-deck stage, and dub out for the clamps and waterways. Get the height and sheer of the clamps by placing the beam mould athwartships between the frames and as much below the sheer line for the deck as the depth of the waterways. Scribe by the lower edge of the mould on the frame, and if you intend to let the beams into the clamp, you must set down as much less and mark on the upper and lower edge of the beam mould. After you have got the heights for the clamps, bend a wide thin batten, like a spiling batten, to the several spots; keep its upper edge to the shore; scratch by it on the timber, and bend a batten to the heights for the top of the beam; make it fair and mark as before. The clamps, being different from any other plank about a vessel, are lined on the inside; and the bevel is taken when you are getting the heights, by placing the stock of your bevel on the frame and the tongue against the under edge of the beam mould, which will give the bevel of it on that frame. If the clamps are properly placed and bevelled, you can fay your knees much faster and better than if you have to hew them away, as is frequently the case when they are hove on the bows at random. The clamps should not be butted, but scarfed with hook scarfs, or keyed, which is equally as good, and much less expensive. If you intend to key them, lay the scarfs together; mark the size of the key across them; take them apart and saw one half in each piece, and cut them out rough. After they are fastened, you can chisel out and drive the keys.

Get the station for the lower edge of the lower string, or upper edge of the waist, by making an artificial square out of two pieces of board; measure the depth of the waist amidships, or at the widest place, and saw off one arm of the square to that length. You will then hold the other part level on the wale, and mark on its upper edge on every frame forward; observing, as before, to keep the base of the square level, and on the outside of the wale. This done, you can diminish the waist aft, which may be $2\frac{1}{2}$ inches less than amidships. Take the said width, $2\frac{1}{2}$ inches, in your compasses, and sweep an arch, and divide it into as many spaces as the one struck for the deck sheer; take the widths from it, by placing the $15\frac{1}{2}$ inch mark of your rule below the base of the arch at each of the divisions, and mark the intersection made by each of the divisions with the circle on your rule, and number them as before. Set your rule on the wale; transfer them to their corresponding divisions on the frames, and bend a batten to each of the spots; mark it, and scratch it in as before. You will get the cant of the streak in the flare of the bow, as before, raise your batten on the luff, make it fair and scratch it in; and the distance between the two lines on any of the frames will be added to the midship width, which will be the width to be lined on that frame, and the upper one will line in the same way. The string and both mouldings are two inches narrower aft than they are amidships; consequently each string may be lined six eighths of an inch less on the after end than amidships, and the moulding three eighths or half an inch less, both being diminished fair from that to their width amidships. The most expedient method to diminish a streak fair is to divide the difference between the widest and narrowest end in 8ths or 16ths; divide the streak into the same number of equal parts; line one edge of it fair, and set off the widths as they are on your rule, by placing the width amidships on its proper place on the plank; and on the first division you will set off $\frac{1}{8}$ less, and the next $\frac{1}{4}$ of an inch less, and so on if you diminish by 8ths; but if by 16ths, the first diminish will be $\frac{1}{16}$ less, and so on.

You may line the moulding in the same way, but the better way is to work the strings and leave the openings between them of the proper width; line the mouldings afterwards, and drive them in after the upper-deck knees are bolted off. If you wish to be more particular, put up all the strings without fastening any of those abaft the luff of the bow, by laying them on set bolts, and spiking cleets on the wale, and lashing the upper end to the stanchion, the same as a rainstaff for planking. Then put a wedge between each of the streaks and the cleet, or rainstaff, and drive them taut, and you can knock the strings up or down until they all come fair, and fasten them by plugging the spikes and bolt-heads of every streak above the wales. Lay out the deck by transferring the stanchions of the beams from the draft to the upper deck clamp; mark the centre of each beam; and if they are sided at equal widths amidships, you may set off the siding size. Then take a long batten and transfer the stanchions of the beams from the clamp to the batten, and lay it on the opposite clamp by marking the joints of one or more frames on the batten. Place it to the same frames on the opposite side, and mark the beams as before. Then get the length of the beams with a batten or a sliding gunter made for that purpose, by measuring across the vessel from the line which shows the height of their upper side, and at the longest side of the beam, and mark the length and name of the beam on the batten. Stretch a line across the ship at the same side of the beam; take a standing bevel by holding the stock under the line and parallel to it, and let the tongue lay against the inside of the timber; mark it on a bevel board prepared for that purpose; get your fore and aft bevel by placing the tongue fore and aft, and the stock parallel with the line, and take the widths and bevels of every beam in the same way. Then select your beams. They may be sided at different widths, and those in the upper deck may be moulded thinner than those in the lower deck. For this ship the lower deck should be 13 inches, and moulded $11\frac{1}{2}$ or 12, the ends $8\frac{1}{2}$, and the round of the beam may be 7 inches. Those in the upper deck may be moulded 7 inches. Select the handsomest one for the hatches; turn them down on their sides and mark their length by laying the batten on the side of the beam; mark it on the upper side and on the corner. Take the fore and after bevel of the same beam, and apply it on the side and across the beam on both ends; mark and strike a straight line from one end to the other; apply the bevel on the line; let the tongue extend in a perpendicular direction, and saw the ends off to the bevel with a cross-cut saw. Run them on board through the bow port, or a port left for that purpose; place them all in their proper stations, and let them down in the clamp by canting them right, and take the distance in your compasses that the end of the beam is above the line scratched in the frames, which shows their proper height. Hold your compasses under the lower side of the beam; scribe on the clamp; mark its width on the same, and shove your beam forward or aft; cut out the jog, and put the beam in its place. Proceed in the same way with all the beams. Fay your knees and bolt them through every timber; drive a proportionable quantity of fastenings through them in the beams; stretch a line from the centre of the apron to the centre of the stern-post; saw a centre mark in each beam, and let down the mast partners, the fore and aft hatch-combings, the windlass and capstan beds, and all the fore and aft carlines composing the deck frame. The handiest method is the old-fashioned way, called the "tumbling stroke." To do this, you have simply to set off their station on the fore and aft carline and knee, and turn the carline down on one side; mark the intersection of the corner of the fore and aft piece and knee on it; turn its rounding side up, and place it on its station as before. Raise the end that lies on the knee until it lies parallel with the top of the beam; hold the edge of your rule against the fore and aft carline; let the side of the rule lie against the carline; knock the carline on end until the mark which was marked on it for the length comes to the edge of the rule, and scribe on the carline up and down the edge of the rule. Shift your rule to the opposite side and do likewise. Turn the side of your rule against the fore and aft piece, and the edge against the carline; scribe by the edge of the rule on the fore and aft pieces, and set the siding width off from it, or scribe in the same way on it. Lay out the other end by placing the edge of your rule against the knee and the side against the carline, and knock the carline on end until the mark on it comes to the edge of the rule as before. Mark on the carline and knee the same as on the other end. Then get the length that is required, by scribing across the top of the carline where the scribe is on the sides. If you want to let them into the knee and fore and aft carline three inches, you will open your compasses three inches, and set one leg on the scribe on the side of the carline, and let the other extend towards the end. Mark on the sides, and set off the same from the edge of the knee and carline, and prick it down by taking part out of the carline and part out of the knee and fore and aft carline. You may let your carlines down by striking a straight line on the side, and lay them in their proper places. Lay a square on the straight line, and the tongue against the knee or fore and aft carline, and see how much the knee or carline inclines from a square, as far down them as where the lower edge of the carline will be when it is in its place, and set it off from the square, which will give its true length. Fay the deck-hook and fasten it with two bolts in each timber; dub off the beams and carlines; fay the waterways, and lower the upper-deck stage to dub for your lower-deck clamps and waterways. Set down

from the upper deck beams the height required between decks, and add the thickness of the lower-deck plank to the depth; set it down plumb from every beam fore and aft, and bend a batten to the side, and make it fair fore and aft. It will be well, however, to drop the lower deck aft, to give more height in the cabin. After this is regulated and scribed on the frames, you can transfer it to the opposite side and scratch as before. Set down the thickness of the ends of the beams or height of the upper edge of the clamps on every sixth or eighth frame, and get the bevel of the clamps in the same manner as those for the upper deck. Scarf them together and fasten them to the several spots set down for their height, and lay out your deck beams. They should be directly under the upper-deck beams, except those in the hatches, which may each be three or four inches forward and aft, which will make the lower hatches six or eight inches longer than the upper. The lower-deck hatch-combings or bed-pieces should be ten or twelve inches further apart than those of the upper deck, which will afford greater facility for breaking out cargo, and is no material injury to the strength of the ship.

The ship may be ceiled before she is planked, or afterwards; but the most desirable way is to ceil first, for in that case there will be no chips or dirt between the timbers. The only objection is, that the treenail auger may come in contact with the spikes which fasten the ceiling. To avoid this evil, you should not drive any more spikes in the ceiling than are actually necessary to enable you to work the plank, and let the rest be driven after the vessel is planked. If you ceil up before you put in the lower-deck clamp, it will be well to run the forward ends of the ceiling plank up to the upper edge of the clamps, and to have your fore-hood clamps thiner than the midship ones, and bend them over the fore-hood ends of the ceiling planks. If the clamps are worked first, you can line the fore-hoods of the ceilings narrower than you otherwise would, and butt them under the lower clamps, which requires much less labor and less plank than to make the hooden-ends narrow and butt them all against the apron. The latter practice is abandoned in nearly all parts of the country. The after hood-ends of the ceiling may run up above the clamp, or butt, under the upper one, and let the lower ones bend over them or butt against them. Cut the rabbett for the garboard by planing up a piece of board as wide as the thickness of the plank; make one end square and bevel the other about eighteen inches long on the longest corner; dub for the upper edge of the streak by a line, and strike it on the timbers; set down the thickness of the plank on the side of the keel, below the upper edge of the rabbett, and line it on the side of the keel fore and aft. Then place the short side of your garboard mould on any of the frames, and dub until the outside and sharp corner comes to the line on the keel, and the upper edge of the mould will lie on the line run for the upper edge of the streak. You will do this on every timber, and turn the square end of the mould to the keel; cut in the keel with a large chisel until the outside of the end of the mould comes to the line struck on the keel. Cut in spots five or six feet apart, and chisel out between them; line your garboard straight on the lower edge, and hew it square; line it parallel amidships, and wider fore and aft, so as to bring the lower edge of the next streak straight. On many flat, shoal vessels, you can line the lower edge of every after-hood straight, and to get the width of the after end of each streak, tack the upper edge of a spiling batten to the width of the streak on the after square frame and forward of it. Carry the end in to the rabbett, without springing it edgewise, and scribe on the timber by the upper edge of the batten; take the widths by setting off two-feet spots from the hood-ends, and take the widths on each of the spots and set them off from a straight line on the after end of the plank. But for deep and narrow vessels you must line your hooden-ends wider to get up faster, and consequently the lower ends of the after-hoods will come round, and the upper edges will sometimes come hollow. The reason why you have to get up so fast on the stern-post of a deep ship will be seen when you reflect that the distance from the rabbett of the keel to the counter, and from that to the lower wale, is much greater than the width taken on the after square frame; and as the after part of the ship is much the most difficult for the young mechanic, I will express my views more fully. Take the distance from the lower wale on the cross-seam to the stern-post; set that width down from the wale on the after square frame; make a spot, and line all the hooden-ends of the cross-seam of an equal width; and the upper edge of the last streak that butts in the hooden-ends, or against the stern-post, should come to that spot or thereabouts. You will find, when you measure square from the wale on the cross-seam to the streak last worked, that the opening is much narrower than it is on the after frame, and it is proper it should be. You can have a guide forward and amidships at the same time, by first calculating how many streaks you will have nearly of an equal width below the wale amidships; add the width of each of them together; measure it off on a batten and set it down from the lower wale. The upper streaks will look well to diminish an eighth of an inch to a foot. They should come to their full width at the fore chains and line parallel to the main chains, and diminish fair to its width on the after frame and transom. Suppose you have 7 streaks of 10 inches each, measure off 5 feet 10 inches on a batten, and measure off 8-feet spots on the wale or on the frames from the fore chains forward, and if you diminish an eighth of an inch to a foot, each streak will be one inch narrower on the first setting off than they are amidships; and as there are 7 streaks in the opening, the first spot should be 7 inches less than it is amidships, and on the second spot it will be 14 inches less, and so on until you get to the hooden-ends. Line the streak at the height to agree with the several spots; observing, at the same time, to keep your streak fair and to agree with the opening as near as you can. After you get the streak fair you can divide the space in as many equal parts as there are to be streaks. Suppose the opening requires 5 streaks amidships 10 inches each; the handiest way to get the diminish of each streak is to mark the width on a batten and saw it off; measure one and a ¼ inches from the end, make a mark on a batten, and measure off one and a quarter inches from that mark; make a sufficient number of marks, each one and a quarter inches apart; carry your batten fore and aft; keep one end on the outside of the wale, and when you find the opening to be one and a quarter less than the width amidships, make a mark on the plank and go forward until the opening agrees with the second mark on your batten, and mark again; and so on until you get forward and aft from amidships. Each plank will be a quarter of an inch narrower on the first spot than it is amidships, and on the second spot each will be half an inch less, and so on. This method is applicable to the diminishing of the waist and decks; only that when you are diminishing the former you should set sixteenths of an inch on your batten instead of quarters; and when diminishing the decks you can do it by eighths, and mark as many eighths on your batten as you have streaks. This rule will be found accurate and useful to the young mechanic who has not had a practical knowledge of this part of the profession, which has heretofore been obscure to them. This very important part of the work has been known only to old and experienced men, merely because the rules were not made familiar to the younger, and consequently less advanced in the duties of their profession. Another useless burthen on the hands of many workmen in different parts of the country, is that of lining with a spiling batten; an incumbrance that has long been dispensed with in this city and many other parts of the country. If you will only line one vessel without a spiling batten, it will convince you that they can be dispensed with, and that you can always line a plank without it as well, and even better than you could with it, except when it works to the spiling, which is seldom the case. To line without a spiling, you have simply to measure off and mark two-feet spots from the butts or hooden-ends, and the same on your plank when lining; take your bevels as near each spot as you can, and if any of the spots on the streak come between the timbers, and if the bevel is taken a few inches further forward or aft, it will make little or no difference in your bevel. In lining in this way, you will be careful to keep the upper edge of your streak fair, and run a plane fore and aft on the lumps or butts, and on the outside of the streak, and hew or chisel it off. It may not be amiss to mention the vast advantage that is derived from planking and ceiling screws, which are used in every yard in this city, and many other places, but are not yet brought into general use throughout the country. A set of those screws will last a number of years, and more than pay for themselves in the building of two ships. The cost of the clamp-screw does not exceed $14, and four or six are sufficient for two gangs to ceil with; that is, if you ceil before you plank. If you plank first, you have only to lay the plank up or hooden it, and hook the screws on the inside of the frame, and turn the screw until the plank comes to its place; but the planking-screw is much the handiest; for you can stand it on the stage or against a standard, and screw the plank to its place. There is no necessity for ring-bolts or rainstaffs. The planking-screw is manufactured by William Ballard, No. 11 Eldridge Street, New York, and is sold by his agent, Daniel Ballard, 263 Ann Street, Boston; and the clamp-screw at the same places. The former will not cost over $20, and will last a lifetime with care. It is a small, handy screw, and may be shifted to any part of the stage with convenience, and every builder who studies his interest and economy will have two or more in his yard.

When working a streak of the plank it is not necessary to put in any more spikes than are actually necessary to keep the streak in its place. There should be two tree-nails in each timber, and in every streak, except where they come narrow forward. If they are usually wide in the bottom, there should be six trunnels through the streak in each frame, and no allowance should be made for a spike. Half or more of all the trunnels should be driven through the ceiling and clamps, and wedged on the inside. The best trunnel is the eight square one, fitted with a drawing-knife or axe. In addition to this fastening, one or more butt-bolts are driven through the timber nearest the butt, and clinched on the inside. The butt-bolts in the hooden-ends should be composition and spike-pointed; and when the streaks are wide, there should be two in each plank. The breast-hooks may be fayed either before you plank the ship or after; but the better way is to drive the largest portion of all the bolts through the knees and hooks before the vessel is planked, and the remainder afterward; for if you drive them all through the streak, it is more than sufficient to hold it to its place, and if the streak is narrow, it is all cut to pieces with auger holes. The knee-bolts, being iron, are more exposed to the wet, and they soon rot the streaks. Moreover, the iron rust is always running down the side of the ship, which materially injures her appearance. The fashion of plugging the bolts has been an improvement to the latter; but as the plug hole has to be one and a half or two inches in diameter, to receive the head of the bolt, it weakens the streak still more.

You can now nail a riband across the side counter-timbers; put up your midship counter-timber mould, and nail it on the side of the stern-post; get the height where to place the lower edge of the ends of your archboard, by placing one square on each side counter-timber; let the tongue of the square extend aft; stretch a line from one square to the other, and raise or lower your squares on the counter-timbers until the line strikes the knuckle of the midship counter-timber mould; observe at the same time to have both squares at the same height from the cross-seam, and mark where the corners of the squares rest on the counter-timber. Take the round of the archboard and set it down below the marks on the counter-timber, and that will be the height of the lower edge on the end of the archboard. Dub the corner, or end, off the side counter-timbers, below the mark, until they come out of winding with the counter-timber mould below the knuckle. Then spike on the archboard, and spring it aft amidships as much as you see fit. Shore it in that position, and mould out two pieces with your midship mould to be fayed against the stern-post and transom and archboard, to butt the counter-planks on where they come against the rudder. Spike them to the archboard, and bolt them to the transom and stern-post. Cut off the ends of the plank, by striking a straight and level line at the height, level with the cross-seam on the transom, and bend a batten from the under side of the archboard to form an easy curve to meet the straight line. Bore and chisel off the ends of the plank so as to give a square garboard, and lay off the stations of your counter-timbers; cut jogs in the transom to receive their ends, and fit your moulds to the one nearest the centre; and it will mould its mate on the opposite side of the stern-post. After the two are moulded, fit the mould to the next one, by shortening the heel, to bring the knuckle to the archboard. Bolt the heels of the counter-timbers to the transom; dub their heels to receive the counter, and make a mould to the outside of the garboard, and divide the counter into four equal parts; or you can line the garboard wider than either of the other streaks, and divide the opening in equal parts after the garboard is in. Line the upper edge of the garboard straight, and the other streaks will all be moulded out by the sweep of the archboard, and the counter will look much better than if the streaks were all lined straight. (See figure 20, plate 6.)

Build a temporary stage, and dub the stanchions to receive the plank-sheer. The better way is to make the upper edge of the upper streak fair, and lay a straight edge across it and the waterways between the stanchions; let it lie parallel with the top of the beam; tack a nail in it, and lay another across 8 or 10 feet forward or aft. Look it out of winding by the one that is fastened to the waterway, and take the distance in your compasses which the batten is from the outside edge of the streak; scribe it on the waterway from the under side of the batten, and dub straight through to the outside of the streak. Shift the batten 10 feet further, and do likewise; and in the same way until you get entirely around the ship. Then run your plane along the top of the waterways, and plane it fair from one spot to the other; dub the top of the waterway, streak level, and saw off your timber-heads. Measure upon the stanchion the length that is required for the under side of the rail, and set the length of the tenon of the stanchion up from the under side of the rail. Take a wide board, and stand one end on the waterways; fay the end on the waterways and outside streak when the edge stands plumb; cut the upper end off the length required for the stanchion heads, and parallel to the end on the waterways. Stand it on the waterways against the side of the stanchion, and scribe by the end on the stanchion. After you have got the heights on every stanchion you can bend a batten to the outside of the stanchions; and, at their several lengths, mark by the batten, and saw them off to the scribe. If you wish to straighten the sheer on the rail you will do it by the same rule by which you straighten the deck. Then take one of your longest battens out of the mould-loft, and place it on the heads of the stanchions on the outside; bend it fair, from end to end, by driving nails in the stanchion-heads. When you have got it to suit your eye, scratch by the outside of it on each stanchion, and line them straight from the mark on the head to the inside of the upper string, or scribe both sides of each stanchion with a straight edge, and set off their size at the head. Line to the inside of the waterways, and trim them to their proper thickness with your adz. You will find this method to be much quicker than to dub and fair a line on their heads, and it is much the most accurate method. After their out and in sides are trimmed you can lay a long batten on the waterways, and mark both sides of each stanchion on the batten, and bring the batten up to the head of the stanchions, and as much smaller as you wish to have them on the heads will be set off on the stanchion forward and aft of the marks on the batten. Suppose, for instance, you wish to diminish the heads two inches; strike a centre line on one stanchion, and mark it on the batten, where it lies on the waterway, and place it to the centre, when the batten is raised to their heads, and set one inch forward of the mark on the batten for the after side of the stanchion. Mark on the stanchion where it intersects, and place your rule on the batten from the forward side, and one inch nearer the centre, and mark on your stanchions. The distance between the two marks will be two inches less than the bottom of the stanchion; and if they are all of one size at the plank-sheer they will be the same on the head. This method is quicker than to strike a centre line on each stanchion. Line from each of those marks to the edge, at the under side of the plank-sheer, and square the width across the head on the forward and after side, and line or scratch with a straight edge as before. Then bring them to the lines, and have them planed and beaded by the joiners. Put salt stops between the frames before you put the waist in.

You can then put on your plank-sheers; set off their width from the stanchions, and take them up; and after they are hewn you should put two bolts through them between each stanchion. They should be plugged and bored, angling each way, and driven one half from the outside, and one half from the inside. They are not to come through, but should be cut three inches shorter than the width of the plank-sheer. When those bolts are rusted, the plank-sheer cannot be split, but will resist force enough to carry away the stanchions. After the deck is layed you can trim off the waterways from the deck to the under side of the plank-sheer. After the mouldings are worked on it, fasten it down, and put on your rails, and lay out your chains. The first one should be abreast the centre of the mast, and should stand plumb. Get the rake of all the rest by laying the mast down in the mould loft, and giving it its proper rake. Suppose the foremast of this ship, figure 1, to rake half an inch to a foot, and the mainmast five eighths, and mizzenmast three quarters; to get the range of the chains, strike a line on the floor for the centre of the mast, and draw a line from it as much within a square as the mast may rake. This line, so drawn, will represent the rail or height of the deadeyes. Lay off the spread of your shrouds on the line, which may be from 28 to 36 inches, according to the length of the mast. (See figure 25, plate 7.) Measure up the line representing the centre of the mast, until you get to the height of the trussletrees, and strike a straight line from that height to each of the stations for the deadeyes; range the line below them, and strike them on the floor. Range up the topmast, and get the rake of the topmast backstay; tack a piece of board on the floor, and on the rail line; nail strips of boards in the direction of each of the lines, and transfer it to the rail of the ship; mark the range of each of the battens on the side and rail, and if the bolts will not come in the timber you must shift the chains forward or aft to get on the nearest timber.

After you have caulked the strings you can put the chains in their place, fay the outside rail, and fasten it on. Get the height of the tafferel rail, by placing your beam mould across the ship forward of the counter-timbers; bring its upper edge to the height of the rail; range a line from the top of it to the counter-timber, and look it out of winding with the main rail, or with a line stretched for that purpose. Strike the line on the side of the counter-timbers, and shift to another, by keeping the line fore and aft. Proceed in the same way until you get the height of all the counter-timbers. If you tenon them into the rail, you will leave them as much longer as the tenon in a perpendicular direction. After you have ceiled up between decks, fay the hanging knees; and the arms of the knees should be fayed under the upper deck beam, and not on the lower deck plank. They should be fayed before the upper deck is laid; and the bolts should be driven through the arm and beam, and clinched on the beam; and the knees in the lower hold should be fayed before the lower deck is laid, and fastened in the same way. They should be larger than those between decks; their fastening should be in proportion to their size. The bowsprit bits may be put in so as to stand plumb when the ship is on an even keel. Cut away the knight-heads and stem, to receive the bowsprit. The head of the stem and apron should be coppered, and the copper nailed on the side of the knight-heads. The opening between them should be the width on the upper and forward side of the bowsprit; the narrowest place should be on the lower and after side, and the bowsprit must be fitted accurately. It will then shove in and go down gaining. If the widths are equal it is difficult to get a good fit. The better way is to take the widths from the knight-heads on a batten, both outside and inside, above and below. Apply the respective widths to their corresponding stations, bevelled up, and square across the bowsprit, and plane it precisely to the several widths on the batten. You can ship it either before the head is finished or afterwards.

The most expedient method of laying the decks is to divide the widths of your streaks off amidships, and see how many times the width of one streak will go between the hatch-combings and the waterways. Line a streak and lay it to the sides of the main combings, and lay another to the waterways. Diminish the streaks with your diminishing batten, and line out the planks by taking their length, in order to butt them properly on the beams, from a streak, as they are laid, or from a draft of the deck, and drive a shutter between every three streaks. The deck plank should all be hewn and planed square from the under side. After you are ready for the shutters, line and square one edge; bring them on board and lay them on blocks, near where they belong. Take the width of the opening on the upper side, transfer it to the top of the plank; make a deep prick mark where you set off the widths; and when you are planing up the planks, observe to leave part of them in, and your shutters will drive taut without making them any larger than the opening; for the round of the beam causes the opening to be much wider on the upper edge of the plank than it is on the lower.

You can now finish the vessel on deck. Let down your fife-rail posts and make a rail around the after side of the mainmast and pumps. The fife-rail may be made of straight timber and butted together, instead of scarfing in the old-fashioned way. After they are fitted, mark for a key across the butts on the upper side, and on an angle with the butts. This piece or key may be one inch and a quarter thick and six inches in length. Take the rails apart and cut out to admit the tenon. The rails may then be put to their places, the mortise cleaned out, and the tenons driven in. The rails may be bolted to the posts, but the better way is to bolt the two after ones through the rail and posts, and fasten them with a nut under the upper deck. They will thereby be enabled to resist the strain of the topsail sheets, which lead through under a sheeve in the posts and belay to the rail; but if your posts can be so arranged as to fasten to the beam or partners, it is the preferable method. The belaying rails should be fastened to the lower and inside edge of the main rail; they may be four inches wide and half the thickness of the main rail, and the edges finished with a plane half round. They should be continued all around the ship, except the tafferel, where they will terminate with a knee, fayed to the main and tafferel rail for that purpose. Mortise in for the monkey-rail stanchions; let them all stand out of winding with each other, and nearly plumb or on a parallel line with the outside of the bulwarks amidships. The stanchions should be carefully fitted with a shoulder on the inside, planed smooth, beaded and driven solid. The monkey rail may be made of yellow pine and tenoned on. It should be straightened from the main rail by lowering it on the forward and after ends, and on the same principles which I have recommended in sheering. The masts should be wedged in the lower deck only; if they are wedged on the upper deck they only serve to strain the upper-works. The steps of the fore and main masts of a large vessel should be made like trussletrees, by bolting two pieces of five or six inch stuff on the sides of the keelson; let their edges be five or six inches above, and dovetail two pieces of the same thickness across the keelson in the side pieces. The main step may be fitted, but not bolted, until the water tank is stowed, which has to be lowered in the main hold, and launched aft on the keelson; and as the depth of the hold from the keelson to the beams should limit its length, it would be difficult to get it to its place if the step was fastened.

The pumps are to be let down within one or two inches of the plank, and a small piece taken off the side of the cylinder, to admit of a ready water-course. The best pumps for durability are the common chain pumps, with composition cylinders fitted in the pumps to extend down below the lower boxes, which may be connected to a lead pipe to lead to the bottom, and which will prevent a fatal injury should the wooden part split, or rend so as to admit air. One pump of this description, with composition boxes and six-inch cylinders, will throw forty gallons of water per minute; and notwithstanding the great variety of improvements, I have seen none as yet so easily repaired and so well adapted to our use as the one above mentioned.

Windlass.—You can proceed to make the windlass. The best now in use are round; 13 feet 6 inches in length will answer for a common-sized brig or schooner, and 16 feet for our largest ships. The diameter of the latter may be from 26 to 30 inches, and the former from 24 to 26 inches. The size at the head or ends should be but little more than half the size at the barrel or centre. First line the barrel out by itself, as it is difficult to get a stick large enough to make the barrel and end in one piece; but if the piece will make the whole, you can line it with the proper swell, and hew it out round by 8 and 16 squaring it. Observe to line it two or three inches larger than it is to be when done. After it is round, saw off the heads. Their length may vary from 26 to 30 inches. Then prepare it for turning; find the centre of the barrel at each end; strike out the size of the necks and spindles; plane up a strip of thin board four or five feet in length and as wide as the diameter of the spindle in the largest place, and diminish one end of the board the same as the spindle, by laying the spindle on it and scribing around it. Observe to place the centre line on the board to the centre of the spindle; bore in the end of the windlass, and chisel out and fit the mould; observing, at the same time, to keep the mould horizontal with a centre line on the windlass, or look it out of wind by a line or straight edge placed for that purpose. After you have fitted the mould, drive in the spindle, and build a frame to turn it on by spiking two large planks to standards on the side of the shop, and as far apart as the length of the barrel or squares on the spindles brace, and shore the frame so as to be perfectly permanent. Draw a line square from one plank to the other and cut down for the boxes. Observe to cut down so as to bring the boxes level, otherwise the windlass will crowd hard against the descending or lower box; confine one box with spikes, and put the other in its place. Roll the windlass on the frame, by placing skids from the ground to the frame. When it is in its place, you can bring one edge of the boxes to bear against the square corners. When they are both so placed as to prevent the windlass from going on end either way, when rolling on its axis, fasten the other box in order to keep it permanent. Then fit a crank on the ends of the spindles similar to that of a grindstone, by fitting on a piece of plank and driving a treenail in it to turn by. The windlass may then be turned by two men. The best chisel that I have yet seen for turning is made like a cooper's inshave, only that the handle is bent short so as to bring it against the windlass when the edge is cutting; and by lowering or raising the hand, you can cut as deep or as fine as you please.

To make myself understood with regard to the form, I have projected the form as represented in figure 21. The chisel part is made ovaling, about two and a half inches the largest way; it is ground with a rounding bevil from the outside, and is so simple that it may be made by any blacksmith, and used by any carpenter, no matter how ignorant they may be of the art of turning. Turn in spots or scores two feet apart, and hew off between them. After you have got it to its proper form, you can smooth it by holding a plane. Get its exact length between the bits; likewise lay out the handspike holes, &c. Set them off from a centre on the windlass, and place the corner edge of a chisel to the several marks, and turn the windlass slow, until you mark them all in. Set off half the size of the palls from the centre, and do likewise. Then mortise out the heads, and drive them on one at a time, and turn it by one crank. Mark the length, and handspike holes in the heads, and scribe around them as before. You can cut your pall-scores after having first laid them out at equal distances apart, and in even numbers, as an odd number will spoil the windlass. You may have 8, 10, 12, 14, or 16; and they should all cut square. After the handspike holes are cut, you can turn it so as to bring either of the handspikes horizontal. Strike a centre line on the upper side, which will be the forward side of the first score; set off all the rest from that by opening your compasses the proper width, and step them around on either of the lines. When you find the opening to give the required number of divisions, without any remainder or over-running, you can mark for each of them, and draw lines from one side of the pall-scores to the other, observing, at the same time, to keep them parallel to the centre or first score. You can then set off a quarter of an inch forward of each score, and do likewise. Cut the scores square, from one line to the other, which will limit their depth. They should be cut very carefully and exact; if not, the palls cannot all take at once. The better way is to cut the first one; fit a mould to the windlass by sweeping out a circle the size of the windlass; saw out a board to fit to it; let it fay in the score at the same time; and when you are cutting out, apply this mould to any of them, and cut to fit the mould. Then cut away for your plates, and drive them in. Unhang the windlass; knock out the spindles, and cut down the ends at the scribes for their length to the circle on the end, showing the size of the necks. Scribe up the centre on each end, and square a scribe from the first centre, and at a right angle from the first line; draw a line from one end to the other, from the line on the ends, by placing a straight edge on the scribe, and raising the line on the straight edge, and striking it on the windlass. Having done this on four sides, take the distance that the bolt holes are from the commencement of the round of the spindle, and set it off from the windlass, and on the said lines, by making correct calculations for the length of the necks; observing to put them on their proper lines, for the spindle is to be driven in as it was at first. Form the neck round and smooth; fit the mould so as to drive the spindles into their shoulders; hoop the necks; drive the spindles; bore for your bolts with a smaller auger than the holes. Keep the auger out of winding with a batten tacked to the scribe on the ends, or tack a batten on each end, and keep the auger on the line with them and perpendicular with the windlass. In this way you can always avoid bringing up against the neck, and strike the hole in the spindle the first trial. Proceed in the same way with the heads, and if you have shoulder pieces let into the heads and barrel, fit and fasten them in the heads before you fasten them on. The windlass and heads should be hooped before they are driven in, to prevent them from splitting. After it is hooped and smoothed off, fit your boxes and necks in the bits, and hoist it on board; and fit the palls.

Anchor stocks.—The old rule is to make the stock the length of the shank of the anchor, and half the diameter of the ring; making the diameter of the stock, in the centre, one inch for every foot in length, and half that size at the ends; but as they are now made round they are usually larger. The above rule is a good guide, perhaps as well adapted to the purpose as any that could be made.

Rudder.—To construct the rudder, first consider the build or form of the vessel. If she has a heavy buttock, she will require a wider and stouter rudder than a well modelled one; but, on ordinary occasions, a rudder as wide as one eighth of the extreme breadth of the ship is a proper proportion for sea-going vessels; but for steamers and river vessels, which have to contend against strong currents, one of that dimension would be found insufficient to command them with safety.

The size of the rudder-head cannot be proportioned by its breadth; for although a river vessel may require a much wider rudder than a vessel of the same tonnage built for sea, yet the head does not require to be so large; for on the former the strain is regular, and even a wider rudder than might be required would not be injurious; but it must be remembered that when a vessel is lying to, at sea, or scudding, the rudder has the force and violence of the sea to contend with; and if it is any wider than is actually necessary to command the vessel, it only serves to endanger the whole fabric. Moreover, a wide ungainly rudder will not control the ship as well as one made of a proper proportion, and will not require any less helm to veer the ship. It is a very common saying that so much will serve her, but, that we may make no mistake, we will make it so much wider; the latter, however, is generally the mistake.

I have known in several instances of the rudder being unshipped and made narrower, and the vessel steer better; and it will be readily admitted that it is less liable to injury from the sea. There are strong objections held out against the patent rudder, on the ground that it is not so safe as the old fashion. That may be admitted, but, if it is properly made, it is far more preferable; for it is evident that you can get a much neater and stronger counter, and the whole stern will be much more neat.

It is not surprising that the ship-masters do not put confidence in them, for many are not well made, and often give way at sea; but if the head is made a proper size, and the backing runs up a sufficient length above the upper brace, and is well fastened in all directions with composition dovetails across the backing, and if it is bolted through them, and well clinched, it will resist as much force as will be required.

One of the builders in this city who has been in business for fourteen or fifteen years, building three or four ships each year, all with patent rudders, and as yet not one of them has given way. I enter into these details of the patent rudder not only to show the causes and impropriety of the objections made by the masters of vessels against them, but to show to builders a method which will in a few years overcome them. I will now construct a rudder for a ship of 450 tons, say 27 feet wide, and will make the rudder 3 feet 5 inches wide at the lower brace, which is about one eighth of the beam. The diameter of the head should be about 16 inches, which is about three eighths of its width.

Let the stock or post be a tough piece of wood, and well grown; if not, when forming the plug, or the convex part, above the upper pintle, it will cut across the grain. Select a tough piece for the backing, which should run up above the upper pintle about five feet. You will first make a concave and convex mould by which to fit the socket and plug. Plane a board about half an inch thick, and half the diameter of the rudder-head in width; let it be exactly straight, and about six feet long; run a gauge on both sides of one edge, and half the size of the pintles from the edge. Square across one end, three inches from the end, and measure up three and a half feet from the spot squared across; square across another mark, and those two spots will limit the diminishing of the plug. Tack a small batten to where the spot squared across the end crosses the gauge mark; tack the other end of the batten to the opposite side of the board where the other square mark crosses it; fill out the batten so as to make a fair easy curve line; pencil it in, and form the mould to that width; and plane it smooth and fair. The line squared across the lower end will be the upper side of the upper pintle; and the square mark three and a half feet from it will be two feet below the arch-board. Measure up five and a half feet from the end and square a mark across on both sides, marking them arch-board. The square mark that is on the end must be squared over to the opposite side of the board; then get out another board of the same thickness and length, but a little wider, and lay the round part of the mould already made on the edge of it; mark round it, and cut it out so that the rounding mould will fay in the hollow one; lay them both on the floor and extend the arch-board mark across the hollow one, observing where the line squared for the upper side of the pintle intersects it, and square it across, when the moulds will be complete. Next get the length of the post by applying the mould up and down the stern-post. Let the arch-board mark on the mould be placed as high up the stern-post as the arch-board, and mark the height of the upper pintle on the stern-post; take a long batten and run it down to the bottom of the keel; mark its intersection with the upper edge of the upper pintle; measure up from the pintle as high as the rudder-head is required to be; take the width of the stern-post at the top of the keel and at the upper pintle, and you bave the length and siding width of your post. Block the post and set down from the head the station of the upper pintle. If it is a large or round stick, it should be lined out two or three inches larger than it is required to be; it should be rough hewn and laid by for several days. so that it may spring, if it is inclined so to do, in seasoning. Then proceed to line it to the required size; let the forward side be uppermost; strike a centre line exactly straight from end to end, and set off the size of the stern-post at the upper pintle mark and on the lower end; set off the size of the head from the centre line two feet below the arch-board, and at the head, and line parallel from the head to the mark two feet below the arcb-board, and line the diminishing part from the settings off, or widths taken from the stern-post. Strike a line from the parallel width two feet below the arch-board to the upper pintle, and hew it exactly plumb and out of winding; turn it down on its side and strike a centre line through the centre of the head, far enough from the forward side below the plug to give half the diameter of the pintles forward of the centre line.

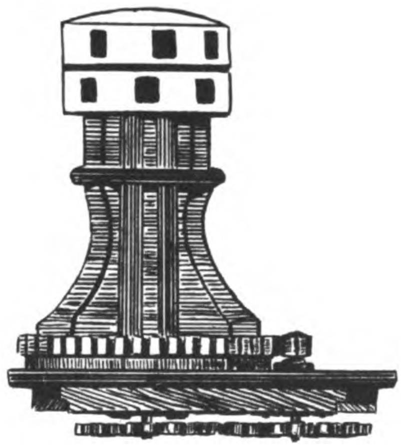
A line so struck will be the centre of the head and pintles. Set half the diameter of the pintle forward of the centre, and strike a line from the upper pintle to the lower end. It is a preferable method to leave about one and a half inches more wood on the forward side at the lower end, and strike a line to meet the one last struck at the upper pintle; for it is generally the case that the lower part from the upper pintle springs aft, and if so, it will bring the line last struck parallel with the centre line through the head, and if it remains without springing it will work quite as easy. Then mark on the rudder, square from the centre, precisely where the upper pintle is to come, and traverse-plane a level surface across, to square from, and look three spots out of winding by it, one below the arch-board, one at the head, and likewise one at the lower end. Then place the plug or convex mould on the rudder by placing the pintle mark on the mould to the pintle mark on the rudder; let the straight edge of the mould come to the centre line; scratch round the forward side of your mould; and if it does not reach the head, range up a line, or run up the mould and scratch as before. Transfer the arch-board mark from the mould to the rudder, and measure down one foot from the arch-board mark; set off half the diameter of the head, and strike a line from it to the head parallel to the centre. Set off all the width your stick will allow abaft the upper pintle; for when the pintle is let in, it weakens the stock in a very material degree, and it is necessary to have 14 or 16 inches of well-grown wood. Strike a straight line from the spot so set off a little below the pintle to the line for the back of the head one foot below the arch-board, which is the spot where the backing ends, or set off two inches, which will leave a jog on the stock; and have the backing as much thiner. The necessity of keeping the backing one foot below the arch-board will be seen when you reflect that the rudder must rise to allow it to ship and unship; and the length of the pintle will limit the distance that the backing is to be below the arch-board. You can next set off the width that the post will work on the lower end, and strike a straight line to meet the line last struck below the pintle. Having done this, you will hew it square. The better way is to square a spot exactly square where the plug terminates at the pintle; turn it up and look it out of winding by a batten across that spot. Turn it down on the lined side, and counter-mould the upper side; observe not to let your mould be any higher up or lower down than the pintle mark on the opposite side, but exactly square from it. Mould it out and scratch by the straight side of the mould, which will be the centre line of the head; set off your sizes as they are on the opposite side, counter line it, and hew it carefully. Turn the forward side up, and strike a centre line from end to end, observing to be very careful, or you will get it to one side or the other, at the upper pintle. The better way is to tack a straight edge plumb from the centre line on the head, fastening the line to the centre on the lower end of the rudder, and on the edge of the batten that comes to the centre, and about a foot or more above the rudder; haul the line taut and fasten it. Take another straight edge and hold it plumb from the centre, from the upper pintle, letting its edge come to the line, and look it out of winding with the batten tacked on the end; move it, if necessary, so as not to spring the line; but keep the edge to the line, and move the end that rests on the rudder, and when they are out of winding, mark on the rudder where the edge that comes to the line rests on it. Get another spot in the same way, half way up the plug; then strike your centre line straight from the lower end to the centre mark, at the throat or upper pintle. Take the centre of the head at the arch-board; scratch up and down the batten on the head, and strike a centre line from it to the throat or upper pintle. As your line will be liable to spring when striking it on the rounding surface of the plug, it is best to take a wide thin batten, with one edge straight, and bend it from the upper pintle to the arch-board, scratching it in deep, that it may remain visible even when the rudder is finished. You will then mould the plug by bringing the straight edge of your rounding mould to the line last scratched in, and place the pintle mark on the mould to the corresponding mark on the rudder. Bend the mould sideways, and scratch round the rounding side from the pintle to where the edge of the mould meets the side of the rudder below the arch-board; turn your mould over and do likewise on the opposite side. Then take the eight square of the pintle from the eight square line on your rule. Suppose the diameter of the pintles to be three inches, the eight square of three is found to be five eighths of an inch from a centre. Set off five eighths from the centre line on both sides, on the upper and lower pintles, and line from the upper pintle to the lower end of the post; and the bearding will cut to those two lines, and not to a mitre on the centre. You will then turn it down on the side and set off the bearding from the forward side, which should be about two fifths of the width. Suppose it sides twelve inches at the height of the upper pintle strap; you will find two fifths of twelve to be four inches six eighths and a fraction over. Set this four and six eighths from the forward side, at the height the width of twelve inches was taken from. Proceed in the same way with the lower end of the rudder, or hew the bearding on it at the spot first set off, and look the lower end out of winding by it. Strike a straight line from the lower end to pass over the spot set off or hewn on for the bearding, to the arch-board, and it will be found to come abaft the centre line on the side. Measure the distance on the arch-board height, or top of the stern-post, which is about the same to the bearding line so struck, and that distance is to be lined off on the head of the stern-post. Set it off on both sides of the stern-post at the height it was taken from on the rudder, and line to the after side of the stern-post at the height of the upper pintle, hewing and dubbing it fair from one edge to the other, and your rudder will ship easy and swing clear, without cutting the plug down square with its sides and the bearding line above the upper pintle. But you can turn it out on the same bevel with the bearding. Having formed the plug and bearded the upper side, you can eight-square the head, so as to make it round on the forward side from the upper pintle to the head, and also on the back from one foot below the arch-board to the head. Take the size of any part of the plug with a rule and find what the eight-square of that may be, and set it off from the scratched mark on the centre. Hew out the eight-squares of the plug, and apply the hollow mould on it, and you will see if it is correct; if not, rectify it; square it in sixteen sides in the same way; plane it smooth and exactly round. The better way is to sweep a semicircle the size of the rudder-head, and saw it out with a circling saw; make it smooth, and apply it across the rudder, which will show where the imperfections may be. Plane the head about an eighth smaller than it is at the arch-board, and it will ship much easier. Next turn the after side up, brace it well, and put on the back piece, which should be about seven inches in a fore and aft direction, where it terminates under the arch-board, and line it straight to a loaded waterline. Bolt on your back piece first; fill in under it with pine, and mark out on the stern-post the stations of all the braces, which may be shifted above or below a bolt as the case may require. Place a batten up and down the stern-post, marking the stations of the braces on it, and transfer them to the rudder, and the pintles will come above the marks for the braces, which will show you how to avoid driving bolts in them, or in the saucer which is placed below the second pintle. One bolt between each pintle strap will be sufficient, and it matters but little whether the lower ones are clinched or not. The backing above the upper brace may be bolted with iron if you please; it is much stronger than copper, and I would have it in preference. Drive the bolts angling; let them come through on the outside of the plug, or on the bearding above the upper pintle. There should be eight bolts above the upper pintle, four of which should be driven through dovetail plates, let in across the backing; one near the end, and one near and above the upper pintle. Let the bolts all be well clinched level with the surface, and finish the backing in any way your fancy may direct. Square or hew the whole rudder fair, and traverse-plane the sides. Get the exact length and bevel from the stern-post; saw it off four inches above the lower edge of the keel; spike a four-inch shoe-piece on it, and the bottom of the shoe of the rudder will come to the upper side of the shoe of the keel. Let the shoe of the keel run aft five or six inches, and round off the corners. Proceed to cut the sockets in the stern-post; and it is proper that the stern-post should be bearded the same as the rudder, but much less; one inch should be set forward on each side at the head of stern-post, and enough at the lower end to bring it out of winding. In that case you would beard the rudder one inch less, which would give more strength to it. If you intend bearding the stern-post, do it when you are getting it out; and it is a saving to rough out the socket at the same time; but if not, you will make an artificial brace mould out of a piece of board; fit it to the stern-post; strike a centre line fore and aft on it; measure aft one half the diameters of the pintles on it; square a line from the line last drawn fore and aft; take a five eighths bitt and bore a hole through the centre, and the centre of the hole should be exactly where the two lines crossed. Nail it on the upper edge of the upper brace, if the mould is long enough to reach it without lowering it below the pintle mark on the stern-post; if not, raise it a little higher. Fasten a chalk-line at the lower end of the stern-post, and half the diameters of the pintles abaft it; observe not to have it to starboard or larboard; bring the line up and pass it through the hole in your artificial mould, and pass it on the deck. Let one person hold the line on deck, haul it taut, and carry it forward or aft, to the right or left, until it comes exactly in the centre of the hole, which will easily be seen by bringing it in a range with the fore and aft line on the mould, and also the thwartship one; when it is right, fasten it on deck. Then lay out the lower part of your mould in sections four or five inches apart, squaring them across the mould, and number them 1, 2, 3. Transfer the section from the mould to the stern-post, square them across, and number them as they are on the mould; then take a large pair of compasses, and take the widths from the sections on the mould; transfer that width from the line on the same section by placing one leg on the corresponding section marked across the stern-post; carry it off, or on, until you can sweep the line with the other, and when you do so, mark where the leg is stationed on the stern-post, and it will show where the socket cuts from or to. Proceed in this way with all the sections; transfer them to the opposite side of the stern-post from a centre line; bend a batten to pass through each of those spots, and pencil it in. Then take a treenail auger, lay it across each of the sections on the mould, mark the widths on the auger, and bore into the stern-post on the corresponding section, until the mark on the auger meets the centre line; draw the auger, and upon entering each new hole carry your handle to starboard or larboard so as to bore at the proper angle; and continue so to bore till all the wood can be easily cut out; observing to stop each hole when the mark on the auger meets the line. Hollow out the stern-post with adzes, gouges, &c., all of which can be done much more easy before the stern is built than afterwards, when the counter is in. Hang the rudder-mould by forming one pintle on the upper and one on the lower end, and ship the lower end on the artificial brace mould at the upper brace, and another where the line was fastened on deck. It will be necessary to champer the rounding edge of the mould, to prevent the corners from touching before the centre. Cut where it may require, until your mould will swing clear on all parts. The stern-post being cut off at the top of the main transom, cut forward on the end about three inches further than the mould may require, and let it meet the socket one foot or more below the head; otherwide the rudder will not ship without cutting away the arch-board and fitting in a chock after the rudder is hung, which is not only unnecessary, but injurious to the strength of the stern; and, moreover, you can hang and unhang your rudder at any time without regard to the cap or chock, which would otherwise have to be split away or detached by backing screw-bolts. Put the braces on the stern-post by placing the upper brace the width of the strap of the pintle below the socket, or half an inch lower, so as not to raise the rudder above its proper place when it bears on the saucer, or dumb-brace. Square across from the middle line at the height of the upper side, and square forward from the after side of the stern-post, and look the other side out of winding by a batten on that scribe. Set down the widths of straps, and saw in on the after sides and corners; chisel it out and fay the strap moulds and the braces will be let in so that the forward side of the pintle hole will be about an eighth abaft the stern-post, to allow the thickness of the copper. The braces should be fastened with bolts to pass through both straps and clinch; for it is a common occurrence for the spike-pointed bolts to work out and the brace becomes loose. Having fastened all the braces, and the saucer under the second brace, take the distance between them on the upper side with a batten, and transfer the widths from the batten to the rudder, by placing the mark that shows the upper side of the upper brace to the under side of the upper pintle strap; transfer all the other marks; saw them in; and the lower part of the pintle strap will come to the saw-cuts. Let the forward part of the pintle project one eighth above or forward of the fore side of the rudder, and in all respects the same as the old-fashioned rudder. Cut the tiller hole as far above the deck as you see fit; but the lower part of the tiller should be about four inches from the deck. If it is nearer the deck, it is liable to catch, and jam the helmsman's feet. The tiller hole should be about one third of the diameter of the rudder athwartships, and as deep in a perpendicular direction as you see fit. This ship, figure I, will require a tiller head five and two eighths by seven and four eighths, and the length of the tiller should be one half more than the extreme width of the rudder, which will give five feet.

A still greater improvement has been made by some of the English, and already adapted to some of the ferry boats in this city. As I am informed, by Brindel's Naval Architecture, orders have been given from the board of admiralty to construct the rudders of all ships building and repairing on Rear Admiral Brooking's construction. For illustration, I have constructed the rudder on this plan. (See figure 22.) Its greatest properties are that the stern-post being grooved, the water is thereby enabled to pass directly from the stern-post to the face or most efficient part, instead of being opposed by the bearding of the rudder, which impedes the ship in no small degree. This rudder works in a rule joint in the stern-post, which facilitates its being shipped at sea. The pins of the straps, unlike the old-fashioned ones, are made tapering, and are not cast on the strap, but can be detached from the strap in case of their breaking at sea. They are made cylindrical, or tapering, so as to fall out of the brace in case of such an event. It appears, from reports in the above-mentioned work, that surveys have been held on them in the royal dock-yards, and that the surveying officers have pronounced them preferable to any other rudders now in use. But they, like every other new improvement, have the banner of monopoly to contend against; consequently make but slow headway. They would certainly answer a most excellent purpose for our steamers. This rudder, you will also perceive from the cut, is not parallel, but tapers like the most of our steamers, which is evidently advantageous to the ship; and all who study nature's law will admit that every creature is possessed of the proper qualities to fit him for the sphere in which he was destined to move; and if we acknowledge the perfection of the fish, let us copy his form and adapt it to the rudder; for the fact of the fish's tail being tapered to a thin edge goes directly and positively to prove that it is the easiest possible form to afford speed. The greatest opposition to this improvement is that the vessel requires more helm. This is evidently the case, and it may be bearded more in order to allow it to swing; but it would require no more helm to keep the ship on her course after the helm had been once hove to starboard or port. Suppose, for instance, that a ship with a parallel rudder required the helm to be ten degrees to starboard when sailing with the wind on the starboard beam; when on that course, she will require the helm to be shifted two points to keep her steady; whereas, if the rudder was diminished two degrees, she would require twelve degrees to answer the same purpose. She would not require any more helm to keep her steady than she would on the former construction; and the action of the water on the opposite side is much more favorable to her progress, for its pressure on the tapering side serves to propel the ship; whereas, when it is parallel, the vacancy created by the ship's headway causes a constant eruption in changing its course and has a retarding tendency. Every angle of the helm gives an equal angle to the rudder, whatever may be its shape, whether parallel or tapered; and every line of the tapered rudder will, according to the angle it may make with the current, have the same steering power that the parallel sided rudder would have. The figure 23 shows the action of the water on the bearding when the rudder is fore and aft, from which it will appear that the analogy holds good.

Heads and Cutwaters.—To procure the most sightly form for the head and cutwater, it is necessary that they should be laid down from the draft in the loft, and if you have room forward of the rabbet of the stem in the sheer plan it is best to do so, by setting the moulding size of the stem forward of the rabbet, and strike out the lower side of the bowsprit at its proper height. The steeve may be from 14 to 18 degrees, which may be taken from a sweep of 90 degrees, which will be found in every case of mathematical instruments, by placing the centre mark which is on the centre of the base of the arch to a perpendicular on your draft, and bring the cut that is marked ninety, which is square from the centre of the base of the arch, to the same perpendicular; pencil a mark on the lower side of the base, and mark the height of the 14 or 18 degrees on the paper which will be above the base of the arch. Draw a line from the dot, or 14 or 18 degrees, to where the base mark crosses the perpendicular, and place the stock of a bevel on the perpendicular, letting the tongue lie in the direction of the angle. Place the stock of your bevel to the forward perpendicular on the floor; let the tongue cross it at the height of the bowsprit, and range out a line in direction of the tongue, which will give the required steeve. You will next conclude on the width of the cutwater, and set it forward from the rabbet. Strike a perpendicular square from the base to it, and the whole fabric will be drawn on the after side of it. Set down the length of the billet, bust, figure, or whatever it may be, and draw a line nearly square from the perpendicular, and as much below it as the bowsprit is to be clear of the figure. Take the width of the billet, or figure, in a fore and aft direction, set it off from the forward perpendicular, square from the base of the figure to the bowsprit, and the line will show where the forward and upper part of the cutwater terminates. Then take the width of the after end of the trail-board, and both cheek knees, set them down on the forward edge of the rabbet, and pin a batten to the spot. Let the forward end of the batten be fastened to the line drawn for the lower part of the billet, and three inches abaft the perpendicular. Fill it out to form a fair curve, pencil or chalk it in, and it will be a guide to form your cutwater from. Then form your cutwater to diminish gradually from the knee until you get half way down, when you must leave it, and form the hollow easy and fair. If it is a full statue, the best way is to run your cutwater and cheek up near the bowsprit, set down for its length, and let the back of the figure and forward part of the cut-

water stand parallel with the rake of the stem. When they are in the attitude of striking a blow, or any other leaning position, they should be more slanting than when the figure is represented reading, writing, or sleeping. Having concluded on the position of the figure, form your upper cheek knee to conform to the back of the figure, by letting the after end terminate on the upper wale for a billet; but for a full figure it should be placed below, otherwise the knees will be stiff, and will not conform to the figure. Set off the siding thickness of the cheek knees on the rabbet, and about one half the size, where it terminates under a billet head; bend a thin batten to diminish fair; mark it with pencil, and set off the width of the trailboard, which will be governed by the size of the billet. If the billet is carved, take the distance between the knees which are usually formed on it, and set it forward from the upper knee; add two or three inches to that width; set it off square from the knee on the rabbet, and diminish gradually from the lower edge of the upper cheek knee; pencil it in, set off its siding width, and do likewise; and if your cutwater requires altering to conform to it you can cut accordingly. Run in your head rail by taking the length from the back of the billet to the cathead; and if you do it before the ship is built you can mark the cathead on the rail in the half-breadth, which should be about 10 feet from the stem for 27 feet beam; square it up to the rail in the sheer plan, and that spot will be the after side of the crooked rail. Take the distance between the cheek knees on the rabbet, and set it up above the upper knee, which will show the lower edge of the rail; bend a batten to the back of the billet, and to the spot for its height on the rabbet, letting the after end come to the after side of the cathead, and form an easy curve. Set off its moulding size, which should be the size of the cathead on the after end, and the size of the cheek knees at the billet. The lacing or rail knees will be divided off in equal parts; the after one should stand with the rake of the stem, and the cant of all the others should increase as you proceed and go forward, otherwise the forward ones will appear to range aft. Then form the middle rail, by placing it half way between the upper edge of the upper knee and the lower edge of the crooked rail. Having got the form of the cutwater, knees, &c., you can make a mould to the cutwater and forward side of the stem; fill in between them, or nail battens across. Make an artificial mould the form of the billet; nail it on, and mark the station of the knees and wale on it and the cutwater. Then make moulds to the cheek knees and crooked rail; fasten the cutwater mould to the stem of the ship on one side or the other, and tack up all your mould; you will thereby be enabled to see the imperfections and correct them.

Having done this, your moulds may be called correct, and you may proceed to line out your stuff the proper thickness at both ends; fit and treenail them together as you fay them, and put two or three bolts in it, and mould the whole fabric correctly, and hew it square, and set off the size on the upper and lower end, and line the part that fays to the stem to a proper width, and nail a straight edge from the size on the after side to that on the forward on both ends, and hew or dub it off until a straight edge applied to the cutwater will strike the line stretched from one straight edge to the other; fay the lacing piece and smooth it off, and drive a sufficient number of bolts to secure it previous to raising. The head rail should cant with the rake or flare of the bow, and the straight rail should be out of winding with it. This brief explanation will also apply to the construction of the head on paper; and, for further illustrations, see the heads in the engravings.



The Capstan.—The common capstan and its uses are so well known that it seems unnecessary to give any description. The bed must be prepared of sufficient strength to hold the shaft or spindle firm, in proportion to the strain which may be demanded in service. There have been a vast number of attempts to increase the power of capstans and windlasses, so that, when the ship is short-handed, a small number of persons may obtain the increased power of machinery to enable them to perform what is ordinarily the work of many. These attempts have generally failed, either from want of firmness and durability in the construction, or from intricacy and difficulty in the operation; and in some the loss of speed in executing light work is altogether objectionable. An invention has, however, been made by Mr. Andrew Morse Jr., in Boston, which is the best within my knowledge. By procuring a capstan of large size upon this plan, with substantial timbers to support the hollow shaft, which takes all the strain, it may be used in the same manner as the capstan of a man-of-war; and in many cases, certainly of smaller kinds of vessels, it will prevent the necessity of using a windlass, which is an incumbrance in the bows, and not so safe or convenient to use.

"This capstan consists of a hollow shaft fixed firmly in the deck, around which the body of the capstan, propelled by levers at the lower head, revolves as a simple capstan, whenever it is wanted for quick and easy movements. Whenever an increase of power is required, the levers are applied to the upper drumhead, which is fixed upon a stout iron shaft, passing through the hollow one first mentioned, and extending to the lower surface of the deck. Upon the lower end of the shaft is fixed a spur-wheel, which engages another spur-wheel fixed upon a second shaft, which passes up through the deck. The upper end of this second shaft is furnished with a pinion wheel, removable at pleasure, which plays into a strong spur-wheel made fast to the bottom of the capstan. Thus the power is increased in a degree dependent upon the proportionate sizes of the train of wheels. The only portion of the work which occupies space in the vessel more than the common capstan, is the pinion wheel above deck, about six or eight inches in diameter, which may be removed when the ordinary capstan is sufficient, and can be instantaneously replaced whenever increased power is needed. The wheelwork below plays so near the deck as not to occupy any space which might be needed for other purposes. The part answering to the common capstan may be worked without removing the pinion, as it has been found by actual trial that its operations are impeded thereby in scarcely a perceptible degree; and in this case, each part can be used at pleasure by merely transferring the levers from one drumhead to the other.

"Several of these capstans have been attached to vessels, and are found to possess all the advantages which the most sanguine could anticipate. To the leading novelties of this improvement, viz. *the hollow shaft*, *the extra* *cap and outward gear*, the inventor has added a very judicious arrangement, uniting in his improved capstan immense power with great simiplicity of construction and perfect adaptation to use. The journals being independent of each other, and the gearing communicating at the periphery of the wheels, will not be subject to increase of friction, and the machinery will not be liable to bind when power is heavily applied at the levers."

The first capstan upon this principle was placed on board the steamer Narragansett. After that, one was put into the fine ship Tagus, unfortunately destroyed in New Orleans by fire. Others are now in use upon several revenue cutters; and without any exception they have been highly approved. The operation of the simple capstan does not vary at all from that of the common capstan; but when thrown into gear, the power will be increased four, six, or ten fold; so that one man can accomplish all that could be done by so many more men upon the ordinary plan. "The great advantages of this multiplied and concentrated power will at once strike every ship-owner and every practical navigator. But even the most experienced will find the benefits resulting from its use to exceed their most sanguine expectations. For its arrangement is peculiarly adapted to the structure of vessels of every description; and the heavy power exerted at the capstan bars, and the severe strains and wrenches which necessarily come upon the barrel of the capstan, will not impede or endanger the operations of the machinery, which will be found in practice *not to bind*, and subject only to slight ordinary friction. Whale ships, and indeed mercantile vessels of every description, should be furnished with these capstans, in every instance, for its advantages to them will be incalculable, especially when short-handed, or in the absence or sickness of part of the crew. Aside from the results of its daily use on ship-board, the unqualified commendations which this valuable invention has received from distinguished and scientific officers of the navy and practical ship-masters, among whom may be named the Board of Navy Commissioners, Commodores Downes, Craine, Barron, Smith, T. App. C. Jones, &c., would ensure to it the utmost confidence of the mercantile community."

The Wheel.—Various improvements have been attempted in the steering wheel, so as to produce steadiness, certainty, and an increase of power, with a facility for holding on in a lashing sea. None of these have been satisfactory. A semicircular horizontal segment of a cog wheel has been affixed to the tiller, while a stationary pinion wheel above it on being turned would cause the segment to revolve, and thus the tiller would be turned from side to side. The defect is that there is a great jarring in the cogs of the two wheels, which is always bad, and by which they are liable to be broken, so as to render the whole wheel useless. Samuel Nicholson, of Boston, has invented a wheel, which promises to accomplish a most useful purpose. The movement and power are not, as in others, confined to cogs alone; but combine their increase of power with the steady, firm motion afforded by ropes. The cogs are so arranged as to allow the wheel to operate as a common steering-wheel, when rapid motions are required by the rudder; but in heavy weather, if from any cause the vessel is light-handed, the cogs may be instantly thrown into gear, when, although the motion will be slower, the power will be so much increased as to render it easy and safe. There is also a device to conduct the ropes direct to the tiller, round a grooved grating on the deck, which is so constructed as to keep them always taught, and to prevent the back lash, by which hands are sometimes thrown over the wheel and injured. I hope this invention may realize what it seems to promise.

My limits will not allow me to enter into minute particulars relating to the finishing of different classes of vessels. It would require a work more than twenty times the size of this to contain the details; neither do I believe it called for. I have only undertaken to explain the leading principles of the profession, and shall confine myself more particularly to the primary elements of practical ship building. I do this, because the ship-wrights throughout our whole country are as well skilled in finishing vessels as any people in other parts of the world in which I have travelled; and, strictly speaking, I believe they excel all others. It is to be regretted that the scientific instruction has so long been neglected, causing every builder to depend on the result of his own experience for successful improvement.

The navy has suffered from an opposite course, and consequently has made no advancement for the last twenty years. I hear of no reason for this other than that the constructers have not been allowed to alter their models according to their own judgment, but have been confined to the improvements of a few individuals who must be united in their plans; whereas, if constructers had been allowed to put their individual plans into execution, the result would have been the introduction of a course of rapid and advantageous improvements. We have reason to rejoice that a more vigorous desire for perfection seems to prevail in the navy department at the present time.

Masting.—The philosophy of placing the masts in vessels has been studied and developed to a great extent both by English and French naval architects. Many of them are much opposed in their conclusions. The French have tried experiments on a small scale; they have built small boats for the purpose, and on different models. For the purpose of these experiments, a long trough was prepared, with pulleys at one end, and filled with water. The boat was then placed in the water, and cords were attached to the several masts, which, running over the pulleys, would draw the boat through the water by means of weights suspended at the other end of the cords. By trying the different masts, at different heights and stations, with the same weights, and noting the different rates of speed in the motion of the boat by a stop watch, conclusions were formed for the most advantageous point at which to apply the power. By increasing the weight, it could be ascertained what was the ratio of the speed to the power, or whether an increase of power would increase the speed in the same proportion. Trials with the different masts, at different heights and stations, and with different weights, would afford data from which to infer some true results in naval architecture, and to ascertain what form of hull, and what mode of masting, would be impelled with the greatest speed by the same propelling power. But the action of the wind and sea on a vessel is widely different from that of weights and cords; consequently it has been difficult to determine on any proportion that can be relied upon. I shall therefore give proportions as they are to be found in many vessels that sail and work well, and the ship-builders can vary from them as their judgment or model may differ from the original.

The body of a ship propelled through the water meets the resistance of the fluid on and around the bows, where the water must be forced partly onwards, and then must be divided and thrown off by the sides. The friction of the water is trifling upon a clean bottom; and the vacuum formed astern, though it demands a portion of the impelling force, is mainly counteracted by the returning force of the water as it rushes in to fill up the space where it had been displaced by the ship's headway. The two last impediments are of small importance, and need not be dwelt upon in making calculations. The main resistance to be overcome upon the stem and bows is an important element in determining the form of the ship and the position and size of the masts and sails.

The first question to be settled is the best mode of applying the force to overcome the resistance. The ship being a solid body, moving in a fluid, it follows that force applied directly and horizontally to any central point of the hull, whether in the bows, amidships, or astern, will move it in a level, horizontal, forward direction; and the force would be equally effective applied as a push midway up the stern, or by a pull midway up the bows. But in applying the force at any other points it operates in an angular direction with the centre of gravity, and has a tendency to cant or vary, in one way or another, the line of motion. Thus force applied horizontally to the keel at the stern will depress the stern and raise the bows; and if applied at the top of the stern-post, it will act in a contrary manner, and will raise the stern and depress the bows. The whole action would be as if the entire mass of ship and cargo were suspended on a pivot at the centre of gravity, which, with proper form of model and good stowage, would be near the centre of the ship. In applying the force to the masts, they act as levers, and tend to vary the motion of the ship in different directions, according to the direction of the force. When the wind is directly astern, its pressure operates to drive the vessel directly ahead, and upon perfectly flat sails would also tend to press the bows down into the water, and to raise the stern in an equal degree; and the more it varies from a true line with the course of the ship, the more it operates to cant or heel the whole mass. But the sails do not present flat and permanent surfaces. In square-rigged vessels, the lower part of the sail is at some distance from the mast, and also from a perpendicular line with the top of the sail, the middle part bellying out still further. Consequently it presents an angular surface to the horizontal propelling force of the wind; which angle varies, more or less, according to the rake of the mast, and to the flatness or taughtness with which the sail is braced.

The operation of the force of the wind, which is always horizontal, except when interfered with by some disturbing causes, is therefore in a double direction, as it acts upon the angle. One portion of the force goes to propel the vessel forward, and another portion is divided, and acts in an upward direction, nearly at a right angle with the sail; and what thus acts upwardly is precisely so much lost to the propelling power. The first portion of this power also has a double action; it tends to impel the vessel onward, and also, as it acts upon the long lever, the mast, it operates to press the bows downwards, and to raise the stern. But the full effect of the depression is in part counteracted again by the upward force, which tends to lift the vessel upwards and to lighten her, in exact proportion to the strength of the wind and the angle of the sail.

If too great a proportion of the sail is aloft, the evil of pressing down the bows will be sensibly felt; but the greatest difference in the sailing of the vessel is made by the arrangement of the quantity of sail either in the bows or the stern. Suppose the whole mass of sail to be forward; it will propel the vessel with equal force, provided it could be as advantageously arranged to receive the power of the wind; it would tend also to plunge the bows under, by the leverage of the mast; but, as the whole lifting power would be forward, it would in a considerable measure overcome that, and keep the vessel nearly on an even keel; she would sail tolerably well, and steer with much ease, but not so well as with sails properly balanced fore and aft. Suppose, however, all the sail to be placed in the after part of the vessel; the leverage will operate as before, and in the same degree, to depress the bows and raise the stern; and the upward or lifting power will also operate with equal force, but with a very different effect. The whole tendency of the forces, except that portion which propels horizontally, is to raise the stern and to plunge the bows under; consequently the bows will have more than the proportionate power to hold on upon the water, while the same proportion is taken from the stern. In such a case, the centre point or turning pivot is changed further forward; the power of the wind, acting entirely aft as a lever, will, upon the slightest irregularity, swing the stern about; and under the most favorable circumstances the steering will be bad, because the rudder will be lessened in its own power; the stern will be raised and lightened of its due balance, and the action of the wind will tend directly to force the stern round and drive it forward. If the ship could be of a perfect construction, without the least imperfection in form, and the sails could be set with exactly equal power on each side of the centre, a vessel with her whole press of sail on the stern might be forced steadily in the direction of the wind, and would require no other steering than would be necessary to counteract the motion of the sea; but the whole tendency, and the whole danger would be, to plunge the bows under, and to overstrain the whole fabric. But if the wind in such an arrangement of sail should vary from directly astern, the rudder would be almost powerless, and the stern, lifted up by two forces, would be immediately swung round, and the vessel would be propelled stern foremost.

These remarks are applicable to all square sails; but the position and action of fore and aft sails, as in sloops and schooners, demands a different consideration. Suppose the mast to be perpendicular, and the sail to be drawn flat aft. The clue being confined by the boom, and the swell being also prevented from reaching to the lower part of the sail, it is evident that there can be no upward or lifting power. All the lifting force of the upper part of the sail above the belly is counteracted by the downward pressure, when it is drawn in below. The horizontal propelling force, and the plunging down of the bows from the leverage, are the main forces. But if the mast be raked aft, the angle is obtained for the sail, in which it will exert a lifting power, to counteract the downward pressure of the bows. For this reason, the masts of fore and aft vessels should be raked as much as is necessary to gain the requisite lifting power, and at the same time to preserve the greatest amount of propelling force, in correspondence with the form of the hull and the size and form of the sails.

The considerations here presented lead to the conclusion, that a rake of the masts is only useful to lighten the action of the vessel from the downward pressure of the leverage, and should be adopted to the extent that will accomplish that and no more. If the sails are properly adjusted to the forces, the vessel, saving only the swell of the sea, will sail horizontally. The resistance at the bows will be less than if they are crowded into the water, and the motion will be lively. But if the sails are set at too great an angle, the propelling force will be too much diminished; so that what will be gained in the life and spirit of motion will be lost in speed.

At an angle of forty-five degrees, the action of the wind upon a plane surface will be equal upwards and forwards, and the upward force, at that angle, is the greatest; the upward power diminishing from that angle both as you lessen it to a perpendicular direction downwards or increase it to a horizontal direction upwards. The propelling power is greatest upon a perpendicular, flat surface, and diminishes as the angle is increased upward; till, as it lies horizontal, the force is entirely lost. In adjusting the position and rake of the masts, therefore, it is necessary to consider the model, the kind and determined trim of the sails, the height of the mast, and the probable weight of the cargo, in order that as the wind varies, or as the direction of the vessel may be, the operation of the wind may, at the same time, propel the vessel at its greatest possible speed, and so that the lifting power of the sail may prevent the leverage power of the masts from depressing the bows into the water.

In fore and aft rigged vessels, it may be considered that the masts can hardly be raked too much, if they are firmly and strongly set; and the exceeding liveliness and swiftness of the famous Baltimore schooners are mainly owing to this manner of setting the masts and sails. It will be observed that the jibs have a powerful effect in lifting the bows and counteracting the downward pressure; being far forward, and being set at the most powerful lifting angle, they operate with a force in that direction proportioned to their size. In square-rigged vessels, however, there are objections to so great a rake. The top hamper, being supported from abaft, and not forward, would render it dangerous to slope the mast in that direction; nor is it so necessary, as the sails, of themselves, make a considerable angle; but a considerable rake, according to the model, is expedient. The practice has prevailed of raking the after masts more than the foremast, especially in the Baltimore clippers; though that is gradually getting into disuse. The same practice prevails in ships, but for no good reason that we can perceive. It is not requisite that the stern should be lifted, except to counterbalance the leverage; and the more it is raised, the more the leverage of the mast is aided to force the bows downwards. The lifting power is needed forward to counteract that leverage, and the more the masts rake astern, the more they must rake forward to preserve the true equilibrium, and the more propelling force will be expended for that purpose. In running before the wind, the after sails have the most power in proportion to their size, and if they are much raked, they do precisely so much more to raise the stern and plunge the bows. Lifting power is only required forward, and that should be merely enough to oppose the leverage and prevent the tendency to the depression of the bows.

The general principle of adapting and proportioning the sails is, that all the sail, necessary and safe to carry, should be as low down as possible, and should be so placed, in different parts of the vessel, as to accomplish the objects before named, and to keep her on an even and lively course of motion. That course and motion should be invariable, except by the motion of the sea; and when a vessel plunges, it will be found that, if it is consistent in other respects, the taking in the after sail, and increasing it forward, together with increasing the angle so as to gain more lifting power, will enable her to ride easier, without any essential loss of headway.

The true principle then of adapting the sails and masts, is to adjust them as low down as possible, so as to approach near the direct point where the horizontal propelling force would operate with the most advantage. The greatest quantity of sail to draw well can be arranged on two or three masts; and it should be kept well down to the deck, in such a manner and in such proportion, fore and aft, as to keep the vessel upon her true balance in the water, lively both fore and aft, with good steering power in the rudder, and the lifting force to annihilate the leverage of the masts. The masts should be set with this view, and varying in their position according to the model. If the vessel is full bowed, the masts should be proportionately further forward; for that will be the part requiring to be eased by the lifting power. If the bow is sharp, they may be much further aft, because the centre of gravity will be further aft in the latter case than in the former, and because the strain of the mast requires the additional support of the beam near its greatest width, and where it gains the external support of the water on the immersed part of the vessel. The bowsprit should be set at the smallest angle compatible with the size and form of the hull, which will prevent its dipping in a sea; and in that case the sails are nearer the surface, have more propelling power in proportion to the lifting power, and avoid the leverage of sails high aloft, which increases exactly in proportion to their elevation.

The height of the masts should correspond to the length of the vessel, and especially to the breadth of the beam; and the yards should be extended in order to spread the requisite quantity of canvass, rather than to contract them and elevate the masts. It is notoriously the case that many of our vessels, especially men-of-war, cannot carry their courses, and top and top-gallant sails, in a good sailing breeze, because the height acts with so much power upon the leverage of the mast; whereas the same quantity of sail brought nearer the deck could be carried with advantage. There is a medium to be observed, which will enable the lower sail to have as much power as is compatible with ability to handle it readily. If the lower sails are too much extended, the difficulty of taking in sail in an emergency will be increased, and that should be guarded against, as the crew may be small or large. In the navy, men enough are generally to be found who can take in sail almost instantly; but in the merchant service, where men are dispensed with as much as possible for purposes of economy, more caution is necessary in adapting the labor to the means of accomplishing it. It has been found that a well-constructed merchant ship would make good weather on the wind, when a sloop of war could not carry her proper proportion of sail; and the experience and knowledge to be gained from a philosophical examination of such facts, should teach us to introduce far greater improvements in naval architecture than have hitherto been made. Those who have the direction of the construction of our ships of war have appeared, heretofore, to turn a deaf ear to the counsels of that wisdom which comes of experience.

In advancing the latter assertion I am not alone, nor could I rely upon my own experience to support it. It is the prevailing opinion of the larger portion of our scientific commanders, lieutenants and other experienced officers; but as yet modern experience is overruled by the navy department, and is opposed chiefly by those who prepared the original proportions, and got them adopted in general use. But it is to be hoped that as soon as they have given them a sufficient trial, and found that the ship is unable to bear the present elevated masts and sails with ease, they will vary from the general rule, and, considering the result of experience since that period, will consent to adopt plans that will continue to add the laurels won by improvement to those plucked from the ocean. The chance for improvement in the navy is now very considerable, perhaps greater than it has been at any previous period. All the captains now living have entered the service as midshipmen, and have risen, step by step, to their present elevation; and scarcely a man among them has not had the advantage of a scientific education. It is of this body of men that the navy board may be composed; while at the head of the navy department is the Secretary of the Navy, who is said to be one of the most scientific men who has ever held the office. Together with these advantages, the constructers in all the yards are not only scientific, but complete practical mechanics; and had they not been bound to the traditions of our illustrious fathers, they would long since have been as far in the advance of other nations as they now stand in the rear. A certain degree of restriction may be actually necessary in building large ships; still the constructers should individually advance their opinions and judgments, which, when examined by experienced mariners, will lead steadily and rapidly towards perfection. For a proof of this, let us look at our merchantships, and inquire who have made improvements within the last twenty-five years. It will be admitted that they were inferior at the commencement of that period to those of many other nations, and that they now excel all others in beauty and safety. I answer, that these improvements have been made by men possessing inferior advantages to the commanders and constructers in the navy. They were made by the mechanics and sea captains in the merchant service with individual resources of our country. Moreover, since that period, talent and a spirit of improvement have been encouraged, and men were thereby enabled to put their plans in immediate execution. But this has not been the case in the navy. It has been neglected and discouraged, or tolerated at times, only upon a penurious, saving principle. A saving indeed! like "saving at the spigot and losing at the bung." Let us hope that these things will take a turn. I trust the rulers of the nation will no longer neglect to cherish this very important art of protection. To neglect or trifle with it must eventually be at the expense of human blood. It matters not how well the commander of a ship may be skilled in naval tactics, or however brave may be his officers and men, they must die or yield when the enemy's ship is superior in her several properties. This fact is established by the history of ages.

The government have not only got the improvement of the navy in their hands, but they have the power of encouraging a still greater improvement in trading vessels, by altering the rule for reckoning tonnage. Never did a more unreasonable law exist, even in the darker ages, than the law for calculating tonnage, and yet it is allowed to exist without a murmur. According to our present law, like that of the English, you can build a double-decked vessel a mile high, and she will not measure by the rule one inch more than though she was but twenty feet. Is not this corrupt? is it not affording an opportunity for fraud? In consequence of it, vessels are decidedly ill-proportioned. Moreover, the law is not all that is imposed on; but the builder, the honest, hard-working mechanic also. I would ask the reader if the mechanic gets paid for as many tons as he builds when he constructs a ship twenty-three feet deep, twenty-eight feet wide, and one hundred and twenty-five feet long? No. There are nine feet of depth that he builds for nothing, or that he is not allowed pay for by law. As long as one half of the beam of a ship is accounted equivalent to her depth, just so long will vessels be built narrower and deeper than they should be. A merchant is not asleep to his own interest when he wants a ship built. She is built by the ton, and he finds it for his interest to have her measure as little as possible. He makes a standing calculation that he will build her as deep and narrow as possible to be safe; and if she is found one foot too high, he will put in fifty tons more ballast, which is said to remedy the evil; but if the deep could tell a tale, the evidence would be much stronger than it is even now. Ask a sea captain how deep he would have the above-mentioned ship if he was hired by the month, and he would at once say that she should be about eighteen and a half or nineteen feet. If his reasons were asked he could give such as would silence all opposition. I do not object to the present law in order to procure more money for the building of a ship, for in that respect it would make no difference. The same competition would exist, and the same money would be paid as is now paid, for a proper moulded ship; but a better form of construction would be adopted. The greatest improvement that has ever been made in the same space of time has been made since the tonnage duty was taken off. Previous to that, the ship was tumbled home on the top sides so as to measure as little as possible, giving the form called a "kettle bottom," by which means the merchant saved a considerable sum every time the vessel went into port. But as soon as that obstacle was removed, there being no saving on the tonnage duty, the clumsy shaped ships, a portion of which had been previously built for nothing, were found to lose more by their bad qualities than could be saved in the cost of building. A different law of measurement, in addition to the abatement of tonnage duty, would lead to still greater improvements in the construction of models.

Rules for Masting. For Ships.—The old rule to gain the centres between the perpendiculars and from the foremast perpendicular, has been as follows; viz. Divide the length into seven equal parts; place the foremast on the first, the mainmast on the fourth, and the mizzenmast on the sixth. But this rule is not adapted to our ships at the present day. I have found, by measuring a number of well-sparred ships, that the following rule is a proper medium: The foremast one sixth; the mainmast four sevenths; the mizzenmast six sevenths.

For Brigs.—The foremast two ninths; the mainmast three fifths, or half the distance from the foremast to the tafferel.

For Schooners.—The foremast one fifth; the mainmast eight thirteenths.

For Sloops.—Three tenths.

Length of Masts. For Ships.—The old rule has been, twice the length of the beam and the depth of the lower hold for the length of the mainmast; but it has been found to give too much lower mast for our deep ships. A proper medium, as they are now arranged in the merchant service, is two and a quarter times the extreme width of the ship for the mainmast; nineteen twentieths of the length of the mainmast for the length of the foremast; and nine tenths of the foremast for the length of the mizzenmast. The fore and main topmasts should be three fifths the length of the lower masts, or both of a length for substitution; the mizzen topmast three fourths of the mainmast; the top-gallant-mast one half of the topmast; the royal-mast two thirds of the top-gallant-mast, the head of the top-gallant-mast not included.

For Brigs.—The mainmast twice the length of the beam and the depth of the lower hold; the foremast eight ninths the length of the mainmast, or let the under part of the trussletrees be the length of the topmast above deck; the fore and main topmast three fifths of the mainmast; the fore and main top-gallant-masts one half the topmast; fore and main royal-masts two thirds of the top-gallant-masts.

For Schooners.—Three and one quarter times the breadth of the beam.

For Sloops.—The length of the keel and breadth of the beam; and for rivers or lakes the depth of the hold may also be added, which will give the required length of the mast.

Proportion of Yards. For Ships.—The fore and main yards have usually been twice the extreme breadth of the ship; but their medium length does not exceed one and seven eighths the extreme breadth of the ship. The topsail yards are from ten to twelve feet less than their respective lower yards; top-gallant yards two thirds of their respective lower yards; and royal yards usually one third, exclusive of the yard-arms. The height of the yards should be governed by the length of the several masts. The most proper method is to project a figure similar to figure 25, by drawing a level line to represent the lower yards, and raise a perpendicular from the centre of the base to represent the masts, and set up the height of all the yards on the perpendicular, as A B C, and level out lines at each height, which will represent the yards, and set off half the length of the lower yards, exclusive of the arm on the line drawn for its height, as from S to T, and take half the royal yard and set it off, as from C to E, and draw a straight line from S to E, which will limit the length of the topsail and top-gallant yards to the cleets or outside of the sheave-hole. You can find out how much yard-arm is required on the topsail yard by bringing up the width of the sail on the close reef, which is generally placed from one third to one half of its hoist from the foot; draw a line parallel with the topsail yard, and at the above-mentined height, as the dotted line, raise a perpendicular from where the dotted line crosses the line T E to the topsail yard, and it will limit the length of the topsail yard. The distance from *m* to *n* will be the length required for the yard-arm. Cross-jack yards have usually the same length as the main-topsail yard, but are now made about two diameters longer. Topsail, top-gallant, and royal yards diminish on the same principle as the main. This rule for yards applies to ships, brigs and schooners.

Bowsprits, Jib Booms, &c.—From five eighths to three fifths of the mainmast has usually been a rule for the length of the bowsprit, but this is found to be too long; the present medium is four sevenths of the mainmast for the length of the bowsprit, two thirds of which should be out-board. The old rule will apply to schooners, and the latter to square-rigged vessels; or half the main yard will answer well for the length of a ship's bowsprit out-board. The out-board of the jib boom two thirds that of the bowsprit, one third in-board, and the out-board of the flying jib boom two thirds of the out-board of the jib boom, exclusive of the pole.

Diameters.—Bowsprit the size of the mainmast. Jib boom one inch for every yard in length; flying jib boom one inch to every five feet; the pole or outside of the stop equal to one half the length within the stop.

Diameters of Masts.—One inch to every three feet in length is the most proper proportion for all masts; but for small fore and afters seven eighths of an inch to every three feet. The masts for sloops and schooners may be one inch to every four feet, and for small vessels even less.

The size of ships' or square-rigged vessels' masts in the trussletrees should be at least three fourths of the size in the partners; and schooners' masts two thirds the diameter in the partners for the diameter in the trussletrees, or one half at he top end or cap.

Diameter of the Yards.—One inch to every four feet is an old and appropriate rule for all yards; but as the upper yards are usually spruce, the diameter may be increased, but not to vary materially from this rule. The size of the yard at the end of the arm may be from one half to three sevenths the size in the slings. Royal yards are frequently made as small as one inch to every five feet of their length.

Mast Heads.—One foot for every six in length.

Yard-Arms.—The length of the lower yard-arms may be equal to twice the diameter of the yard in the slings. Topsail yard-arms one inch for every foot in length; top-gallant yards six eighths for every foot in length; royal yards half an inch to every foot in length.

Booms, Gaffs, &c.—Ship's spanker boom one third outside of the tafferel; brig's one fourth; schooner's one third. Ship's spanker gaff large three fourths of the boom, exclusive of the pole; brig's spanker gaffs two thirds; schooner's one half the length of their booms.

Tops.—Fore and main top, four ninths the extreme width of the ship; mizzen top three ninths, or three fourths of the main top. Topmast crosstrees from three fifths to four sevenths of the respective tops.

Size of the trussletrees.—Depth eleven twelfths of the heel of the topmast; thickness half of the depth; length half the width of the top.

Government Rule for Tonnage.—If the vessel be double decked, take the length from the fore part of the main stem to the after part of the stern-post, above the upper deck; the breadth thereof at the broadest place above the main wale, half of which breadth shall be accounted the depth of the hold; and then deduct three fifths of the breadth of the beam from the length; multiply the remainder by the breadth, and that product by the depth; divide the last product by ninety-five for tons, and the remainder, if any, will be feet, or ninety-fifths.

If the vessel be single-decked the only difference in the calculation will be that of taking the depth of the hold, whatever it may be, from the top of the ceiling in the main hold to the under side of the deck, instead of taking half the breadth of the beam, as in double-decked vessels.

For an example of calculating the tonnage, suppose a ship to be 125 feet long and 27 feet in width.

Breadth of the beam	5)27	0
One fifth	5	$4\frac{4}{5}$
		3
Three fifths of the breadth of the beam	16	$2\frac{2}{5}$

Breadth of beam	2)27	0
Depth of hold	13	6
Length on deck	125	0
Subtract	16	$2\frac{2}{5}$
Length for tonnage	108	$9\frac{3}{5}$
Breadth of beam		27
	777	$7\frac{1}{5}$
	216	
Product	2937	$7\frac{1}{5}$
Depth		$13\frac{1}{2}$
	8819	$1\frac{8}{10}$
	2937	
	1468	6
Divide the last product by	95)39657	$7\frac{8}{10}$
Answer, Tons	417	$5\frac{861}{10}$
or $417\frac{43}{95}$		

SECTION VI.

Steam Vessels.

The ambition of the present day to make every possible improvement in the transportation of merchandise by water, with the rivalry of different cities, have led to the development of the powers of steam, and very considerable advances have been made in its application. After many struggles by ingenious men in England and France to render the power of steam as it was exemplified in stationary engines subservient to locomotion upon water —after some considerable approaches to successful invention had been made, it was reserved for Robert Fulton, an American, to make the first successful attempt, and to add another power to the energetic use of man. But although we have taken advantage of this motive power upon every lake and river, and by its aid traverse with unexampled ease and rapidity our almost unbounded country, we have not made equal progress with England in vessels adapated to navigate the ocean; nor have improvements been made to lessen the weight of the engine, the consumption of fuel, and to increase the burthen of carrying vessels. Much more may be and must be done to render steam vessels useful; but as this branch of the art is not my peculiar province, I shall only intimate some points in the principle of construction, without going into full scientific details.

The steamboats of this country are built long, sharp, and with spacious, well-fitted accommodations for passengers. The object being to convey passengers with the greatest speed, they are constructed with little draught of water, in order that they may create as little resistance as possible; and they are for the most part built of light and slender timbers. They are admirably calculated for still waters, but are wholly unable to encounter storms and heavy seas; when put upon the ocean they are soon strained and ruined in consequence of the powerful action of the swell and the weight and strain of the engine; and if speedy decay were all the evil it would be well. Vessel after vessel has become the prey of confiding passengers, when exposed to the severity of an ocean tempest, in consequence of defects of structure which rendered her unfit for the service. It is evident that a strongly marked distinction should be made between boats for still waters, and those for the heavy seas and surges of the ocean. The model that would be admirably adapted to the North River, where Fulton first moved as if by magic, is ill-calculated to ride the tumultuous deep; and while speed with a moderate degree of strength may be well suited for inland navigation, it is becoming more and more apparent every day, by those dreadful calamities which carry sorrow to the hearts of families and whole communities, that for our treacherous and troubled Atlantic coast, and for sea voyages, the vessels should be more staunch and heavily timbered.

Around the coast of England, where there are rapid currents, and dangerous navigation, amid heavy seas and high winds, they know nothing of the flat, light, top-heavy vessels which we are accustomed to use in all parts of our waters. Being built for safety, their steam ships are of the most substantial form and construction. Nothing but the stoutest-built vessels could endure, upon various parts of the British seaboard, the turbulence of the seas, and the straining power of the engine. This circumstance in their situation has given the British navigators and builders an advantage, which has carried them far in advance of all other nations in the construction of steam ships for long voyages by sea; and at this moment they can compete with the whole world in their armed vessels propelled by steam, and supersede all other nations in transportation. from end to end of the world, by the same motive power.

From England to the uttermost bounds of navigable waters her steam vessels are to be found. In the Mediterranean, among the West India islands, in the Gulf of Mexico, in the East Indies, and along the far Pacific ocean, her armed or mercantile ships may be found. The contrast is great and humiliating, that the nation which first applied the power to practical use is still destitute of improvement; that if we venture upon the ocean at all it is only to cruise along the coast in frail and dangerous vessels, that, upon the slightest approach of hard weather, are compelled to make a harbor; or, if more venturesome, are lost, with hundreds of our best citizens coffined in their inappropriate fabric.

One great reason for this backwardness upon our part is to be found in the nature of our government, which expends no money for experiments, grants no aid to science, and rests contented with the doings of the past. While the British government has been liberal in expenditure, vigorous in encouraging improvements, and persevering in carrying every good suggestion into effect; ours has waited for individual wealth and individual enterprise to do every thing that has been thus far accomplished, and has stood still in the march of an improvement which should have been peculiarly her own. The competition of trade, and the necessity for protection, demand that further efforts should be made to put our marine, both naval and mercantile, upon a better footing both for active and powerful operations. The great objects to be accomplished are to increase the strength of the vessels, and to reduce the size and weight of the engines, so far as may be compatible with adequate power. As steam ships are constructed it requires nearly one third of the capacity to sustain the engine, and in long voyages at least another third must be appropriated for fuel; leaving only a third of the whole capacity for cargo. In this point of view, however well steam vessels may answer for the purpose of transporting passengers, or freight of great value compared with its bulk and weight, in a rapid manner, it is evident that the expense attendant on the use of steam will render them incompetent to compete with sailing vessels for the general purposes of trade. As packet ships, the recent improvements in the immense floating palaces of Great Britain have rendered them preeminent; and for all the use of naval warfare they possess great and important advantages over sailing vessels, having the power to move with velocity and certainty independent of the wind, and also to take advantage on every tack of all the aid the wind may afford. My purpose in this part of the treatise is to give only a few leading principles upon the use and construction of steamers, as I do not pretend to be qualified to give instruction in the details.

The leading consideration in the construction of steamers is the water in which they are intended to be navigated. When they are to ascend rapid streams they are made extremely sharp fore and aft, and at the same time drawing a light draught of water, to enable them to perform their trips, if possible, when the rivers are low; and as the boats are generally limited to a certain draught of water when fully equipped, a correct calculation must be made in order to ascertain the capacity required to sustain the weight of the engine, boilers, fuel, hull, &c. The weight of the steam engine, together with all the machinery, is a subject which comes under the head of engineering, and may be found by reference to a work on that science, from which you can make calculations near enough for practical purposes. The following are some of the principal elements of construction, being the only correct means in my possession of showing the weight of engines or boats, and this is taken from Tredgold's works on steam navigation. Alluding to H. M. steam ship the Nile, the following dimensions are given: Length on the range of decks 180 feet; extreme breadth 33 feet; draught of water forward 13 feet, aft 14 feet; weight of the hull 530 tons; weight of machinery, water in boilers, coals, &c., as follows:

	Tons.	cwt.	qrs.	lbs.
Weight of engine - - - -	135	00	3	00
Do. " boilers - - - -	65	07	3	13
Do. " coal boxes - - -	10	00	0	00
Do. " water - - - -	44	11	1	14

	Tons.	cwt.	qrs.	lbs.
Weight of coal - - - - -	320	00	0	00
Total tons -	575	00	0	00

Weight of masts, rigging, ordnance, stores, provisions, &c., 347 tons; total displacement 1452 tons; area of the loaded waterline 5086 square feet; area of the greatest transverse section, or dead-flat, 360 feet; distance of the centre of gravity of displacement before the middle of the length of the waterline, taken from the fore part of the stem, to the after part of the stern-post, 3 feet; depth of the centre of gravity of displacement below the loaded waterline, five feet.

After you have ascertained the probable weight to be sustained, make a rough calculation of the displacement of water required, by drawing the several waterlines on paper, like the annexed draught of a steamboat, according to the displacement rule which may be found in the first section; and if on the first trial you find your displacement either too great or small you can alter it as the occasion may require. Then, from the attained dimensions, construct the model by transferring the lines to the pieces of boards, and form the model to suit your judgment. After your model is finished in its proper form, take it to pieces, and transfer the lines to a draught-board or paper, and make a correct calculation of the area or displacement on the immersed part of the boat, which will show whether you have body enough to sustain the weight or not. If it is found to be more than sufficient you can make her a little sharper; if the breadth is not too limited she may be a little narrower; but a strict observance should also be had with regard to stability. If the displacement is found to fall short of the burthen you may easily increase it by putting in one or more frames amidships, observing to keep it over and above the wale, for as the boat becomes old she will become water-soaked, and the wood will weigh much more than when first built.

The foregoing, or similar rules, are always observed, and strictly followed, both by the French and English architects; but throughout this country the building of steamboats has been confined, comparatively speaking, to but few individuals, who, from their long experience alone, have generally been enabled to construct the boats of the proper size, without making any other calculation than the length, breadth, and depth. When the business has been spontaneously managed by men who had not the advantage of that practical knowledge, they have seldom met with any better success than that of the engine either immersing the entire hull of the boat, or of making her too large and deep to navigate her destined route. Yet the owners bear it patiently, believing it in many instances to be an unavoidable failure, and consequently they haul her on on the marine railway, cut her in two, and put twenty or thirty feet in her amidships, which enables the boat to sustain the engine, and draw less water. But all this may be avoided by constructing the boat on scientific and mathematical principles, all of which cannot cost more than six days' labor.

The proper arrangement of the wheel, engine, &c. has long been a contested point, and consequently the wheels have been placed in nearly all parts of the boat. Most persons at present acknowledge that the wheels should be placed nearly amidships, or a little abaft, and the boat is thereby made more manageable than if they were at any other point. Moreover, it is the most proper point, being at the extreme breadth, to afford velocity; and the main breadth should always be placed near the wheel or engine. There are obvious reasons for this rule; the strongest of which is that the immense weight of the machinery has to be supported at that point which preponderates over any other part of the boat; and, moreover, wherever the wheels are placed, a great part of the buoyancy of the water is lost from the confusion occasioned by the revolution of the paddles. This evil tendency, together with the weight of the engine, seldom fails to settle or hog the boat. To construct a boat properly, by observing these considerations, you will be enabled to ascertain the form which will suit the proposed waters.

The peculiarity of building steamboats properly is a point not generally understood in the ship-yards at the North, and in many instances a failure would be as liable to occur from the want of practical knowledge in building as in designing or drafting. As steamboats are generally employed in packeting business, carrying luggage, &c., a decided preference is given to the fastest boats; consequently every quality is sacrificed to speed; and as a light draught of water is also essential to this object, every pains is taken in order to procure all possible strength with as little material as possible. The long competition so prevalent in many parts of the country has had the result of materially improving this, like every other part of the theory. The latest and most advantageous improvement has been that of straightening the waterline, instead of making it concave as formerly. The first boat constructed in this new mode was the Lexington, which was designed by Captain Vanderbilt, a very distinguished owner and commander, as well as an intelligent man. The undertaking was extremely bold, and met with unparalleled success, considering the circumstances. She was first put upon the North River, and afterwards upon the Long Island Sound, in opposition to the best lines then established in the country. Tredgold, one of the English authors of the "Science of Steam Navigation," in speaking of Capt. Vanderbilt's improvement, says, "So successful was Captain Vanderbilt in his improvement, that a passage to Newport and Providence was attempted, and from the rapidity with which the voyage of the Lexington was performed, the proprietors of the old boats were compelled to withdraw them and substitute others designed on the new model." And from the same authority it may be seen from a number of observations on the velocity of steamers of different nations, that the American boats have decidedly the superiority.

The following is a list and dimensions of some of the boats constructed on the old and new model:

	Length on deck. Ft. In.	Breadth of beam. Ft. In.	Draught of water. Ft. In.
Swallow, new model,	232 8	22 6	
New York, Do.	230	22	
Belle, Do.	130	22	
Massachusetts, Do.	200	29 6	8 6
Utica, Do.	176	18	3 6
Boston, old model,	150	28	7 6
Highlander,	181	24	4 3
Huntress,	173	22	5 6
De Witt Clinton,	230	28	5 6
Neptune,	220	24	
Cornelius Vanderbilt,	175	24	
Champlain, (N.R.boat) on old model,	180	27	

The following is a list and dimensions of some of the English boats and steam ships, from which it will appear that the proportions render their capacity better adapted to sea-going vessels than for river navigation, and consequently a large proportion of speed is sacrificed to procure that essential quality in sea-going vessels.

Herne Bay steamer packet Red Rover; length between the perpendiculars, 154 feet; breadth, 23 feet 4 inches; depth, 10 feet 4 inches.

Steamboat Ruby, owned by the Diamond Company, and plying between London and Gravesend, is the fastest boat on the Thames. Length between the perpendiculars, 155 feet; breadth, 18 feet 6 inches; depth, 10 feet. This boat has all her plank tongued and grooved, and is slightly framed with iron diagonal braces let into the timbers on the inside, and fastened with a screw bolt, passing through each timber and every plate from the outside of the plank, and set up with a nut on the inside. The edges of the plank are also bolted together and caulked; and she is said to be the fastest boat in Europe, as she has frequently attained the speed of 14 miles per hour, which is within one mile per hour of our fastest boats.

Admiral Yatch Firebrand: length, 155 feet; breadth, 26 feet; depth, 14 feet 9 inches. H. M. steam frigate Medea; length between the perpendiculars, 180 feet; extreme breadth, 46 feet. This ship was built in 1833, and has been found, like many others, not only of the English but of the French ships, to be as safe, and even more so than any other vessels. The Medea has displayed her superiority not only as a steamer, but when propelled by canvass alone; and her superiority also over any other ship in the English squadron, whilst on a three years' cruise in the Mediterranean, has been tested beyond a shadow of doubt. During this period of three years, she was employed without repairs, other than those made by the engineers on board. There are a number of such boats employed in the naval service of England and France, and are found to be extremely useful, both in war and peace, as they embrace qualities for working with sails should the wheels be damaged by shot. The entire machinery is protected by wings, being stowed with light materials, such as the clothes and bedding of the seamen and marines; and the only part exposed to damage is the wheels, which present no greater exposure than the masts and yards of ordinary ships. Moreover they are enabled to take every advantage of a sailing vessel in action when acting singly, and when in a squadron they are found to be more useful for towing other ships to their proper station, or to remove them from under batteries, should they drift or become disabled. If any part of the engine becomes disabled by accident, the crank is detached from the engine in the space of five minutes, and the wheels are allowed to revolve as the vessel progresses through the water; and if they do not get the ascendency over other naval vessels, they will become much more general for such purposes. Our government has arisen from its slumbers, and is awake on the subject. The steamer Fulton, after having undergone extensive improvements, is an active and powerful vessel, 875 tons burthen, with an engine of 500 horse power, and equipped with a suitable armament.

A great loss of power is realized from the obliqueness of the paddles in entering and leaving the water, which has been a subject of deep consideration, and very considerable improvement has been already obtained; and it is believed that the evil will finally be removed either by applying a small quantity of the power to effect a change in their position when entering or leaving the water, or by some other construction in the wheel, to fit it with less loss and expense of power. This debility from the above may not be understood by those unacquainted with steamboats. The obliqueness of the paddle is the angle that the surface of the water forms with the radius of the wheel, to the centre of the shaft.

Again, suppose the surface of the water to be in line with A, on the sheer plan of the accompanying steamboat, and the radius of the wheel to strike the water at A. Draw a line from A to the centre of the shaft, and it would show the obliqueness of the paddle, and when the boat is loaded and brought lower in the water, the angle and speed is effected in like proportion.

The Iron Steamboat is another great improvement, and I am informed, from undoubted authority, that it has never yet failed of complete success in every particular. A boat constructed and firmly built, with the above material, does not weigh over one half as much as a wooden vessel of the same size; and moreover they have much more room for cargo, as both their sides do not measure more than five inches. The greatest obstacle for preventing them from being generally adopted in England, is that of their bottom corroding and collecting barnacles and many other marine substances, which in a great measure destroys their speed; and the salt in a very few years would rust and eat up the entire immersed part of the vessel. This however, would not be felt in our fresh-water rivers; and from my knowledge of them, I believe them to be well adapted to river navigation. By this means a promise of water conveyance is held out to our successors, after the forests are hewn down, by applying to the mountains, which will, in their turn, not only afford the material for building, but also for propelling the structure.

SECTION VII.

Explanation of Plates.

PLATE I. is the lines of a full ship, and if built from, would carry a large cargo, as may be seen by the following table showing her displacement. Her dimensions and scale may be seen on the plate; the room and space is two feet. If any of the drafts are selected to build from, it will be necessary to transfer the lines to a model, and smooth it off, which will procure a greater degree of accuracy than can be obtained from the drawings, as trivial errors are unavoidable, both from transferring the original lines from the drawings, and from the frequent uneven dampness of the paper when printing, which occasions one part of the sheet frequently to expand or contract more than the other. But notwithstanding the imperfections, they will be found near enough for mechanical purposes. It will also be seen that no one draft has all the necessary lines in it to complete it. This is done to make it more familiar to the learner; for it is evident that if they were all in one draft they would be much more complicated, and it would often be difficult to distinguish the lines from each other; but by consulting all the drafts you will find all the necessary lines to complete any ship. The multiplicity of letters and figures of references in the drawing is injurious to their appearance, for which I have no other apology to make than that already mentioned, which I trust will serve as an excuse.

The rule in page 11 for finding the displacement will be better understood by the following, to find the burthen, and also her natural position in the water when launched.

Suppose the ship, Plate I., to be required to be immersed to the third waterline amidships when launched, and to the seventh when loaded. First find the entire displacement abaft ⊕ in the immersed part of the ship at the seventh or loaded waterline; proceed as follows:

Breadth of the midship frame or ⊕ from centre,

	Feet.	In.
12 feet 6 inches, half of which is	6	3
Frame 4	12	5
Do. 8	12	3½
Do. 12	12	1½
Do. 16	12	0
Do. 20	11	9
Do. 24	11	6

	Feet.	In.
Frame 28 - - - - -	11	3
Do. 32 - - - - -	5	2
Total - - - -	94	9
Multiply by distance between which is		8 feet,
gives	758	
Area of the line abaft frame 32 is	80	
Area of the post, rudder, &c.	2	6
which added will give	840	6
multiplied by		2
will give the		
Area of the 7th waterline from ⊕ aft	1681	
Do. " " 6th " " "	1626	
Do. " " 5th " " "	1592	6
Do. " " 4th " " "	1502	
Do. " " 3d " " "	1381	9
Do. " " 2d " " "	1258	4
Do. " " 1st " " "	994	
Half of the 7th waterline	840	6
Whole " " 6th "	1626	
Do. " " 5th "	1592	6
Do. " " 4th "	1502	
Do. " " 3d "	1381	9
Do. " " 2d "	1258	4
Half " " 1st "	497	
	8698	1
Multiply by the distance between the waterlines		2
Number of cubic feet between the 7th and 1st waterline	17396	2

Brought up		17396	2
Area of the 1st waterline	994		
Upper side of keel	75		
divided by	2) 1069		
	534½		
Distance from 1st waterline to keel	2		
	1069		
Area of keel, false keel, rudder, &c.	131		
	1200	1200	
Number of cubic feet abaft ⊕ under the 7th waterline		18596	2
Area of fore body between the 7th and 1st waterline	2412		
Distance between the waterlines	2		
	4824		
	2		
Product between loaded waterline and lower	9648		
Area between the 1st waterline and keel	534½		
Area of keel, false keel, gripe, &c.	131		
Number of cubic feet below the 7th waterline	10313½	10313	6
Number of cubic feet	Total	28909	8
Cubic foot of salt water			74 lbs.
Number of lbs. to the ton	2240) 2139315 (955 23¾/48		

Making the entire weight of the ship when loaded to the seventh waterline 955 tons and 115 lbs.

The area of each body yet remains to be proved as being suited to the ship's natural position when launched or loaded. First find the area of the bottom below the light waterline by erecting a perpendicular half way between the foremost and aftermost ones. Find the area between the said perpendicular and ⊕, and add it to the area of the fore body below the third or light waterline, and deduct the same from the area of the after body below the said line, which will show to what body the greatest displacement belongs. It will be better illustrated by the following, taken from the same ship, figure 1.

Area of the fore body below the third waterline and forward of frame 8, which is nearly amidships, 4367 cubic feet. Area of the after body below the third waterline and abaft from 8, is 4082, which is 294, or 9 tons 1596 lbs. less than the fore body; and as the greatest heft of masts, anchors, chains, bowsprit, windlass, &c. are forward, it will bring her on an even keel when rigged.

The true burthen yet remains to be found, which may be accurately ascertained by adding the areas of the fore and after bodies together, below the light waterline, which appears from a brief calculation to be 8449 cubic feet, which being deducted from the entire displacement, leaves the remainder or burthen of the ship 20460, both of which being multiplied separately by the weight of a cubic foot of salt water, and divided by the number of pounds in a ton, will give the weight and burthen of the ship when at the third and seventh waterline. From the above it appears that the weight of the ship when at the third waterline is equal to 280 tons, which being subtracted from entire displacement, leaves the burthen for cargo equal to 675 tons, which is nearly twice her measurement according to the present law for reckoning. No allowance is here made for the thickness of the plank, which has to be added to the burthen already found.

PLATE II. comprises the sheer draft body and half-breadth plans of a Pilot Boat, which would no doubt make an excellent sailer. The stem is much plumber than has usually been fashionable, but nevertheless it is the prevailing fashion at the South. The Mobile and Mississippi boats are all built on this plan, or at least all the new ones, and all who have seen them at sea will readily acknowledge their superiority over any boats either in the old or new world.

She is calculated to draw three feet more water forward than aft, which is called a drag line. You will see that the first waterline is three feet deep on the after part, and diminishes to a mitre on the heel of the stem, or termination of the straight rabbet, and all the other waterlines are horizontal and parallel to each other; and it is on this plan that all our sharp government vessels are built. The only difference in drafting such a vessel from one built on an even keel is in the first waterline; and you must make the upper edge of the first waterline in the sheer as a base for the sheer plan, and the same in the body plan, whereas in a vessel built on the usual plan the lower edge of the first waterline in both plans would be their bases. You will project the sheer plan precisely the same as for a vessel built on an even keel, with only the following exceptions. Take the depth that the drag is required to be in your compasses, and place one leg on the intersection of the after perpendicular with a line drawn for the upper edge of the first waterline, and sweep an arch with the other leg. Your rake being determined, draw in the stem, and draw a straight line from its intersection with the upper edge of the first waterline to the back of the arch, which will be the lower edge of the first waterline, and form the sheer by raking the stern-post, &c. Your sheer plan being complete, you can get the form required for the dead-flat by taking the widths from the half-breadth plan and transferring them to the body plan of the loft or parchment, by taking the height of sheer on any frame from the upper edge of the first waterline to its height, and set it up from the corresponding line in the body plan to get the ending of the same frame where it terminates on the keel or side line.

You must take the distance from the upper edge of the first waterline to the lower edge of the same frame, and set it down below, and from the upper edge of the first waterline in the body plan, which will give the height of the seat of the floor-timber of the said frame. The easiest way to end it in the side of the rabbet is to draw a line the thickness of the plank inside of the side lines of body plan, as those in the said figure or body plan of pilot boat, and where the heights squared across the side lines cross the lines drawn for the inner edge of rabbet there will be the ending of the frame, and they will end one above the other. For an example of the same, I will get the end and sheer height of frame ⊕ from the sheer. To get the top-height on frame ⊕, take the height from the upper edge of the first waterline to the sheer height as aforesaid, as from 1 to 2, figure 5, and set it up from the corresponding waterline in the body, as from 3 to 4, figure 7, and level out a line at 4, and get the ending by taking the drag as aforesaid, as from 1 to D, figure 5, and set it down from the corresponding line in the body, as from 3 to 5, figure 7, and square a line across the side line, and where that line crosses the inner edge of the rabbet will be the ending of the line. You can drive a nail at their intersection, and bring your batten to the nail when getting the form of the frame. You will also observe a deadwood and cutting-down line, the intent of which I have already referred to, as it is evident that the floors do not require to be as deep as the deadwood line or under edge of keelson would give them. If your keel is not deep enough to leave the necessary quantity of wood above the base on the after floor-timber, you can get out a piece diminishing like a wedge, and let its largest end butt against the inner post, and the thin end extend under 5 or 6 of the after floor-timbers, and fay the stern knee on to the same piece, and let it butt the floor-timber, and the after floor-timbers will be throated, and let down to the bearding line over the deadwood piece. The knight-heads are also laid down in this draft, it being the largest scale and the sharpest vessel, and will consequently show to a better advantage. The room and space is 18 inches; height of waterlines 18 inches; and the keelson is let down, and jogged in betwixt the frames.

Plate III. consists chiefly of a schooner, and is a passable model. One diagonal line is run in the sheer to show the principle of the harpins, (see page 39,) and also the horizontal range of the butts of the top-timbers. The line drawn inside of the 4th diagonal around the bow in the half-breadth plan is the form of the diagonal harpin. You are not to make the harpin to it; for it would be difficult to spring it down to its place when hanging it to the vessel, and it is thus constructed to show the true principle of all harpins.

Figure 13 is the cant plan, to show the principle of cants without being confused with the square frames.

Figure 14 is an elliptic for sweeping beam-moulds, arch-boards, &c.

Figure 15 is a bevel board, &c. It is drawn to show the principle of finding the bevels of any piece of timber having a standing bevel at one end, and an under at the other, as warping chocks, tafferel, &c. By dividing the space between the two extremities of the piece in equal parts, by marking two-feet spots on them, you can then take the bevel of both ends, and strike them across a bevel board, letting them intersect on one edge of bevel board, and divide the space between the two angles or bevel on the edge of the board in the same number of parts, and draw lines from the several divisions to the intersections of the lines on the opposite edge of the board, which will give you the bevels of the several spots on the warping chock, tafferel, &c.

PLATE IV. is the lines of a brig taken from a model, and the frames run in the body plan by them, and remain to be proved by diagonal lines.

PLATE V. consists chiefly of a sloop, and is a good model for speed and burthen, and has width to enable her to carry from 70 to 75 feet mast, according to the waters she may be required to navigate. If for a coasting vessel, the former would be quite sufficient, and if for river freighting, the latter may even be increased. You will perceive that both the sheer and half-breadth are laid down in one plan, which is to represent the section of laying down in the mould-loft. Figure 8 is a section of lines from which illustrations are drawn on the theory of sailing, steering, &c. (See page 17.) Figure 21 is a gouge for turning the windlass; for a description, see page 68. Figure 22 is the late constructed rudder invented by Rear Admiral Brooking, R. N., in 1816, and lately put in use in the British navy. (See page 75.) Figure 23 is the common tapered rudder, which is believed to embrace better qualities to afford speed than the parallel rudder.

PLATE VI. comprises a section of heads, stern, and deck plan of ship figure 1st, &c. Figure 17 is a perspective view of a head, cutwater, &c., sketched from a Philadelphia packet ship, and is one that presents an admirable appearance. The different parts are reduced to a scale of three eighths to a foot. Figure 18 is a sketch from a New York and Liverpool packet, and the original is truly admirable; the scale is three eighths also. Figure 19 is the draft of a head, cutwater, &c. of a ship built in Newburyport by Mr. Currier, who is one of the most successful and prosperous builders in the eastern country. Figure 20th is a sketch of the stern of the same ship on a scale of two eighths. Figure 24 is the cutwater of the same. All those cutwaters are too full to conform to the latest fashion in well-regulated ship-yards; and as the country advances in age she grows in intellect, which cannot fail to show that the ponderous mass of timber even now in use in cutwaters far exceeds the necessity, if nothing is consulted but beauty; but the principle should be based upon other and more substantial grounds, which would in themselves conduce to or promise better results. But following the prevailing fashion is not confined only to the decorating of the human frame, or any other object that serves to please the eye and retard better things, but has even found its way into the ship-yards of America, and is practised with more abuse or extravagance than in any other part of the known world, which will ere long bring about its opposite in a reaction, which must evidently come in its turn; and we may trust in economy alone for the increase of our commerce.

Our merchant vessels can be built, rigged, navigated, &c., with much less expense than now attends them, and yet be as good and comfortable as they now are. It would not be amiss to say that if a strict adherence was paid to economy, even in a less rigid degree than in France and England, and many other of the European nations, our commerce would now exceed its present quantity by even thousands of sail, and yet no greater capital invested; and in that case we might be released from the embarrassment that often exists, viz. that of vessels from other nations being able to carry freight for less money than ourselves, which is an embarrassment particularly familiar to many of our merchants and commanders. All those unacquainted with such competition have been fortunate in their escape. Hence it follows that those superfluities cannot exist without being injurious to the commercial wealth of the country. As the facility for making money decreases commerce will, of itself, adapt the expense to the income in like ratio. In the mean time the external appearance has not been got up at the expense of the strength and safety of the ship. Nothing of this kind can be alleged against the builders or merchants. Nothing has been spared to render vessels substantial, durable, and beautiful. The result of the former and latter war has done much honor to the American banner; and it is to be hoped that this very enthusiastic feeling will prompt the foreign merchant and philanthropist to place his entire confidence, his all, on board the American bark, relying on her national character for his castle and fortress.

We have every reason to believe that the rising generation will sustain the noble character which has been obtained only by the frugality, honesty and industry of their fathers, and with the advantage of our experience. Their difficulties compared with those of their fathers are but small, and there is yet a sufficiency of scope for advance, which will no doubt reward their labor with success.

Plate VII. is a steamboat, suitable for river navigation, and as sharp as her length will reasonably admit; as her length is limited, being only 173 feet, when many other boats but little wider are 230 feet; but those unacquainted with steamboat models will reap the same benefit from the lines of this dimension as could be obtained from larger ones. I do not, therefore, introduce the model as being one of perfect structure, but merely represent it as illustrative of the science of that particular kind of vessel which has hitherto occupied my notice, according to the field of information which I, like many of my brother mechanics, lack. The cross and angular lines in the sheer plan present the central or internal view of the diagonal braces, instead of ceiling in the whole. This system is advantageous to keep a boat from twisting or injuring, but, according to my views of the subject, affords less longitudinal strength, and brings more strain on the outside plank; but with the same quantity of wood the diagonal bracing would be the most mechanical way of applying it. The English boats are braced in this or a similar way, with iron plates 3½ inches wide and 6/8 thick, set in the frames, flush with the wood and bolted through every timber, and through the said plate; the bolts passing through the outside plank, and clinching or securing with a nut on the plate; and they are ceiled in many instances over them, and in other cases are braced with diagonal braces, and the open spaces neatly closed with light plank, fir, pine, &c., fited and bolted between the braces, and the whole surface is thereby made smooth. The steamboat, plate 7, would possibly draw 5½ feet of water, which would be too much for many rivers, and to avoid that difficulty the length must be increased until the burthen below the loaded line is equal to the weight to be sustained. The weight of the engine, fuel, &c., may be obtained by rules already mentioned. The weight of the timber, plank, fastening, &c., should be obtained; making one grand total, which yet remains to be calculated. To find the weight of the hull, the number of tons weight thus to be sustained may easily and accurately be ascertained, at least sufficiently so for all practical purposes, as will appear when the fact is well known, that both in England and France, the calculation both for ships and steamers of promiscuous sizes have been known previous to launching within one quarter of an inch of the truth. It appears from experiments that the average specific gravity of immersion is as follows:

White oak per cubic foot, 64, or 2560 pounds per ton; white pine, 50 cubic foot; average of chestnut, yellow pine, maple, elm, &c., 53 pounds per cubic foot, or 2120 lbs. per ton. The average weight of fastening for ships is 96 lbs. for each ton in measurement, rigging included; the average quantity of iron for the hull equal to 68 lbs. per ton; copper for fastening 8 lbs. per ton. Hence, a ship of six hundred tons would require 20 2/5 tons of iron and 2 2/5 tons of copper, and one of four hundred tons would require 13 3/5 tons of iron and 1 3/5 tons of copper nearly, or 19 1/5 tons to build, fit and rig the latter, and 28 4/5 tons for the former.

It will not be necessary to enter into the minute details of coppering. It may suffice to say, that the required quantity of copper for a ship may be ascertained as follows:

Measure the distance around the bilge from the keel to the height of the copper amidships, and multiply the length of the ship measured along the side and round the bow and stern from the fore side of the stem to the after side of the rudder by the said width, (that sum being doubled,) and the area of the surface of the keel added will give the necessary quantity in feet and inches, which being divided by four, will give the number of sheets. Every sheet of 32 oz. being multiplied by 9 1/3, of 30 oz. by 9, and of 14 oz. by 4 1/3, will give the number of pounds. This rule varies from the truth according to the form of the vessel; but on ordinary occasions the diminution of the width when measured forward and aft will account for the lapping and waste of the copper. The number of nails for one sheet is 90, and one pound is fully sufficient for a sheet, even if the nails are the largest kind, or 1¼ inch. The proportions vary materially at times from the above rule, more especially with regard to fastening. Ships built in different yards, for different men, at different prices, often vary with regard to the proportionable quantity of fastening 30, 50, and even 75 per cent. from each other, or from the necessary proportion; and moreover, the dimensions of the vessels, whether built to measure a proper proportion of tons or otherwise, according to the bulk of the ship, have an important bearing on the proportionable quantity of fastening required. This, together with the size and finish of the vessels, renders it difficult, if not impossible, to find a proper proportion adapted to all classes and sizes. Two vessels may be built, one with a single deck and one double, and yet about the same size; and it is evident that nearly all the fastening of the lower deck would be an addition or extra expense over and above the other. This, together with additional timber, plank, and labor, should always be duly considered by the builder, when contracting to build by the ton.

EXPLANATION OF TERMS.

Abaft, aft, after. That part of the ship from amidships to the stern.

Adz. A tool for dubbing.

Afloat. When the vessel is swimming on the water.

Afore. Same as forward.

After perpendicular. A line drawn square from the intersection of the cross-seam with the rabbet to the base of the sheer, half-breadth, &c.

Anchors, (*bower, sheet and stream.*) Instruments for holding the vessel.

Anchor-stock fashion. A method of planking, by letting the convex of one plank into the concave of another.

Apron. A timber fayed to the after side of the stem to support the sharps and fasten the floor-hoods.

Arch-board. The plank on the stern below the cabin windows, on which the ship's name is painted.

Athwart, athwartships. Any thing extending across the vessel.

Auger. An instrument to bore holes with.

Axe. A tool for hewing timber.

Barge. A boat used on board of government vessels, generally for the use of the captain or commander-in-chief.

Bars. Levers of wood used to work the capstan.

Bark. A vessel rigged like a ship, except that she carries only fore and aft sails on the mizzenmast.

Backstay channels. Abaft the principal ones, to support the top-masts.

Battens. Strips used in the mould loft.

Bearding. A diminution of any piece of timber from a given line to the rudder, stern-post, stem, cutwater, gripe, &c.

Bearding lines. Showing the length of the frames, cants, &c.; also the seats of transoms.

Beams. Cross pieces of timber holding the ship's sides together and supporting the decks.

Bearings. The lines of flotation, usually applied to the extreme breadth.

Belly. The inside of a hollow part of a compass timber.

Bends. A term applied to wales.

Bends. The form of a ship's side from the keel to the plank-sheer.

Bevel or bevelling rule, bevelling boards. Implements for taking the bevels.

Bevelling. Any alteration from a square. A standing bevel is without a square, and an under bevel is within.

Boat. Comprised under several different descriptions, distinct from ship's boats.

Bitts. Pieces for supporting the bowsprit amidships, for fastening the cable to on board of a vessel of war, and leading the top-sail sheets through, &c. *Windlass Bitts* are pieces for supporting the windlass and securing the cables to on board of merchant vessels.

Binnacle. The box that contains the compass.

Black streaks. The streaks above the wales on vessels that have no waist or ports. There are frequently three.

Blocks. The lower transom pieces of timber lodged on the ground, on which the keel is built or the way laid.

Bolts. Iron and copper fastenings. Ring-bolts, eye-bolts, &c., made with rings or eyes, driven into the deck or sides to secure hemp cables to, guns, &c., &c.

Bows. The round part of the ship forward on both sides.

Boxing. Projection left on the cants. A mortise is cut in the deadwood, and the boxing occupies it as a tenon.

Braces, pintles, gudgeons. The support for the braces.

Breadth line. An accurate line in the sheer plan, bisecting the frames at their widest place.

Breaking joints. The placing of one butt a sufficient distance forward of the after one under it to give it strength.

Break of the deck. When not flush.

Breech. The angle formed on a line or floor-timber, &c., the inside of which is called the throats.
Brig. A square-rigged vessel with two masts.
Brigantine. Rigged like a schooner aft and brig forward.
Brow. An inclined plane made of plank forward of the bows of the ship, to convey timber and plank on board.
Bilge. That part of the vessel which bears on the ground when the vessel is lying aground.
Bulk-heads. All partitions.
Bulwark. The planking on the outside of the stanchions.
Bumpkins. Pieces fitted against the stem, extending outwards through the head.
Butt. The opening between the ends of two plank when worked, or the ends of plank themselves; also the longest end of all timber.
Buttock. That part abaft bounded by the wing transoms and upper waterlines.
Base line. The upper edge of the rabbet of the keel.
Half-breadth lines. All the waterlines in the half-breadth plan.
Main-breadth line. A line around the ship at the broadest part or greatest height.
Buttock lines. Curves lengthways in the sheer plan, representing the vessel as if cut in sections.

Cabin, cabins. The different apartments allotted for officers.
Cant. Any thing that does not stand square, as the cant timbers.
Cant plan. The plan in which the cants are drawn, as figure 13; which do not stand square with the middle line of the ship.
Callipers. Instruments for measuring the diameter of timber.
Cant. The act of turning any thing from one side to the other.
Capstan. A machine by which heavy purchases are accomplished.
Carlines. Square pieces of timber low fore and aft and secured to the beams.
Carlines. Thwartship pieces rounding like the beams and let in the knees, and fore and aft carlines betwixt the beams.
Cat-heads. Pieces of timber on each side of the bow for the anchor to be suspended from.
Corvette. A flush-decked vessel with one tier of guns. A sloop of war.
Caulking. The filling of the seams between the planks with oakum.
Chains. Links or plates of iron from the dead-eyes to the ship's side; also to hold the ship at anchor.
Channels. Pieces fitted to the ship's side to spread the rigging and secure the dead-eyes.
Champer. The taking off a sharp edge from a piece of timber or plank.
Cheeks. Knees fitted to the ship's bow to support the cutwater and head.
Chocks. Pieces to supply a deficiency, &c.
Clamps. Thick plank worked inside, on which the edge of the beams rest.
Ceiling. The inside plank.
Clean. Sharpness of a ship's body.
Cleets. Wood or iron stoppers used for belaying leading ropes, &c.
Clinker-built. When planks are lapped one over the other.
Clinch. To secure bolts by a collar or ring, and forming a head.
Collar. The neck of any thing, as bolts, and a piece fitted around the rudder to support the head, or at the masts for the belaying pins or booms.
Collier. A vessel employed to carry coals.
Copper. To sheath a ship's bottom with sheets of copper.
Coppering line. The height of the copper around the ship.
Companion. The entrance, or berthing way to the cabin.
Combings. The sides of the hatches, resting on the beams or fore and aft carlines.
Counter. That part of the stern from the cross-seam to the archboard.
Counter timbers. Timbers from the main transom to the tafferel, to which the uprights of the stern and counter are fastened.
Cradle. The bilge ways which convey the ship into the water.
Crank. Opposed to stability.
Crank. Iron or wooden handles, by which the windlass, winch, grindstone, &c. are turned.
Cross-cut. All cuts with the saw across logs, planks, timbers, &c.
Cross-seam. The lower edge of the counter.
Cross spalls. Temporary beams to support ship when in frame.

Cutter. A sharp-built vessel with one mast; also applied to schooners of the revenue service, man-of-war's boats, &c.
Cutwater. Same as gripe.
Cutting down line. A line in the sheer plan representing the upper side of the floor-timbers, also the height of the deadwood forward and aft.

Dagger knees supply the place of hanging knees, their side arms being brought up, with a slant or cant, to the under side of the lodging knee.
Dead-eyes. Round blocks of wood fixed in the channels by the chains, with three holes in them, through which the lanyards are rove.
Dead-flat. Marked ⊕; a name given to the frame possessing the greatest capacity.
Dead-wood. Timbers placed fore and aft on the keel, on which the ship's floor-timbers rest, continued as high as the cutting down line in both bodies, to secure the heels of the cants.
Davits. Straight or compass timber, placed on the stern or quarter, for hoisting and suspending the boats.
Derrick. A crane. Also applied to a spar with a tackle secured to the head for hoisting up timber, &c.
Dowelling. The method of putting timber together with circular pieces of timber let in betwixt them.
Drafts. The lower dimensions of vessels drawn on a small scale.
Draught of water. The depth of water that a vessel draws, designated light water, load water, draught, &c.
Drift. The difference between the size of the auger and the size of the bolt is termed the drift of the bolt, which confines it in the wood.
Druxy. Timber in decay.
Dub, dubbing. The making fair the surface.
Diagonals. Lines in the body, sheer and half-breadth plans, to prove the frames of the vessel and cut the joints of the timber and show the course of the ribands on the battens and sides, &c.; also angling braces.
Dead rise. The height of the end of the floor-timbers above the base line.

Entrance. The form of the fore body.
Even keel. When the vessel draws the same water forward as aft.
Flaring. Opposed to tumbling home; as flaring a bow, counter, &c.
False keel. An additional piece, formed so as to preserve the main keel, called shoe.
Falling home. When the top sides are within a perpendicular.
Falling out. The contrarywise.
False post. A post at the after part of the main post.
Fashion piece. Timbers secured to the ends of the transoms.
Felucca. A foreign galley.
Fife rail. A rail around the masts for belaying the rigging to.
Fay. Joining one piece close to another.
Figure head. The carved ornament under the bowsprit.
Filling timber. Intermediate timbers of the frames not bolted together.
Fish pieces. Pieces of wood bound opposite to each other, to secure a mast when sprung; all pieces fayed on the forward side of a large mast to prevent the lower yard from chafing on the hoops when lowering or swaying them aloft.
Float. To swim.
Flats. All timbers amidships crossing the keel, similar to dead-flat. The lowermost timbers of a frame, upon which the whole superstructure is built.
Floor-timbers. Synonymous with flats.
Flush. Any thing fair in equal lines.
Flush deck. When the deck ranges fair, without any break fore and aft, from bow to stern.
Forecastle. A short deck forward, in large vessels; but in more it is under the deck, and is a cabin for seamen.
Frames. The bends of the timbers constituting the shape of the ship.
Furs. Pieces to supply the deficiency of timber the moulding way.
Futtocks. The separate pieces which compose the frame.

Galley. Synonymous with camboose.
Galley. A Turkish vessel.
Gangway. The passage-way between the boats in a vessel of war. The space left open in the main or monkey rail of a merchant vessel for a passage or convenience for hoisting when taking in or discharging cargo.

Garboard streaks. The first streak on each side of the keel.

Gratings. The covering of the sky-lights and hatches on board of vessels of war.

Gripe. Synonymous with cutwater.

Gunwale. The plank that covers the end of the timbers; the same as plank-sheer.

Gun-room. In a seventy-four, the cabin abaft on the gun deck.

Ground ways. The large planks which support the cradle for launching.

Gudgeons. The braces with eyes for the pintles of the rudder to work in.

Half timbers. In common terms the timbers butting the third futtock and extended to the plank-sheer; but properly the timbers in the cant body answering to the lower futtock in the square body.

Handspike. Lever for working the windlass.

Harpins. The pieces which hold the cant body together until the ship is planked.

Hatches. The covering of the hatchways.

Hatch carlines. Cross-pieces to which the plank is fastened.

Hatchway. The opening in the decks.

Hause holes. Through which the cables run.

Hause-pipes. The tubes for leading the chains through.

Hause-pieces. Timbers which compose the bows of the ship.

Head rails. Ornamented rail, extending from the back of the figure to the cat-head.

Head ledges. Athwartship pieces which form a part of the hatch combings.

Heel. The lower end of a piece of timber. The after end of the keel.

Helm. The whole apparatus that steers the ship.

Height of waterline. Distance between, in common terms.

Hogging. Hogged when the sheer of the ship rises amidships and is destroyed.

Horn timber. A name given to a knee fayed to the main transome to fashion the quarter.

Hoods, hoodends. All the foremost and aftermost plank of the bottom, both inside and without.

Hooden ends. The ends of the plank which fit in the rabbet of the stem and stern.

Inner post. A piece fayed to the forward side of the stern-post, to receive the hoodends and the transoms.

Joints. Where any two pieces are placed together; expressive of the diagonal lines in the body plan, which limit the length of the timber or joint.

Keel. The base of the superstructure.

Keelson. The long range of timbers in direction of the keel, placed over the floors for additional strength.

Keelson's sisters. The same placed near the keelson in steamers, to support the engine.

Kavels. Supplying the place of timber heads.

Knees. Crooked timbers, securing the beams to the ship's side.

Ketch. A small vessel with four masts, similar to a galliot.

Knight-heads. Timbers on each side of the stem extending up for securing the bowsprit.

Knuckle timbers. Whose heads stand more perpendicular than the heels. Same as counter timbers.

Laying down, laying off. Describing of the lines of a vessel in the mould loft.

Launching planks. Same as ground ways.

Launching. The conveying of the ship from the stocks to the water.

Lacing. A knee or plank fayed and bolted on the top of the cutwater and forward part of the stem, to which the bowsprit is secured by the gammoning.

Ladders. Steps for conveyance from one deck to another.

Lean. As clean. Sharp.

Level. Horizontal lines.

Levelled out. Any line continued out from a given height or spot in a horizontal direction.

Ledges. Thwartship hatch combings.

Limber boards. Short pieces of plank covering the limber passage on each side of the keelson for the water to pass freely to the pumps.

Limber streak. Forming the above.

Lines. The various frames of a vessel in the mould loft.

Lining. The act of marking the form of any timber or plank.

Loaded waterline. The line of water when the vessel is at her greatest depth.

Luff. The round part of the bow of the vessel.

Main breadth. The widest part of the ship on any particular frame.
Main keel. The principal one.
Maul. A ship-carpenter's hammer, with one face and pointed at the other.
Main post. Stern-post.
Masts. On which the sails are set.
Mast steps. The parts that secure the heels.
Main wale. The government measurement selects the upper wale for a main, but in the naval service the lower wale is mentioned as the main wale.
Mast comings. Placed at the side of the mast for supporting the wedges or coating, &c.
Midships. The middle part.
Midship bends. The greatest area of a ship.
Moulds. The figures of the respective timbers, on and from the lines in the mould loft.
Moulded. The size of the timber the way the mould is laid.
Mould loft. The building in which the vessel is laid down.
Moulding. Transferring the form of the mould to the timber by marking round the mould with chalk or a racing knife.
Monkey rail. The upper rail, or next above the main rail.
Mouldings. A name given to the fluted streaks above the waist.
Modelling. The act of constructing the form of the vessel.

Navel hoods. Thick pieces fayed in the wake of the hause-holes, and projecting outside of the waist, to support the hause-pipes in leading the chain over the cheek knee.

Orlop. The lowest deck.
Overhang. Great projection; rake of stern outward.
Outboard. Outside.

Pay. The act of pitching the seams.
Partners. The mast in the deck; also the support of the wedges.
Palls. The iron and wooden brackets suspended to the pall bitts, and dropping into the scores of the windlass while the hand-spikes are fleeted. Also used horizontally for the capstan.
Paddles. The wheels of a steamer suspended externally to a shaft to propel her as oars.
Pilasters. Fluted columns for cabins and between the cabin windows externally.
Pillars. Perpendicular pieces of wood or iron between the decks to suspend them.
Pins. Fitted in racks for belaying ropes.
Plank. Timber used for covering the frame of a vessel.
Plank-sheer. Thick plank let down over the stanchions to cover the ends of the timbers.
Planking. The act of covering the external part of the bottom with plank.
Poop. The highest deck.
Poppets. Perpendicular pieces of timber between the bottom and bilge-ways at the run and entrance of the ship.
Ports. The square holes in the ship's side; termed gun, air, ballast, rudder, lumber ports, &c.
Preventer plates. Securing the chains to the side.
Post. The stern post.
Preventer bolts. Driven through the lower ends of the plates.
Pumps. Machines fitted in the well and reaching to or above the deck to clear the ship of water.

Quarter. The upper part of the top sides above the starboard and larboard.
Quarter deck. Extending from the mainmast aft.
Quarter piece. A piece for fashioning the stern; commonly called a fashion-piece.
Quarter galleries. The projection of the quarter windows ornamented.

Rabbet. An angular incision to receive the end and sides of plank.
Rack. The same as belaying rails.
Rake. Forming an obtuse angle fore and aft.
Race. The act of marking timber.
Rails. Long plank scarfed together and tenoned on the heads of the stanchions for the safety of men, cargo, &c.
Range length. As range of deck.
Razee. A vessel reduced; one deck taken off.
Ribs. The frame timbers.

Riband lines. Half-breadth line in the half-breadth plan, at the height of the diagonals.
Riband pieces. Nailed on the frames to keep them in their places until planked.
Riders. An additional keelson forward and aft.
Room and space. Distance from the moulding edges of one frame to the moulding edges of another.
Row locks. The pins between which oars are confined in a boat's gunwale.
Rudder. That by which a vessel is steered.
Run. The act of drawing a line on a ship or mould loft. Also the form of a ship's body abaft the frame amidships.

Saddles. A piece fitted round the masts of sloops, schooners, &c. to support the boom.
Scantling. The dimensions given for the timber and plank.
Scarf. The end of one piece of timber lapped over another, forming an even surface.
Scuppers. Holes in the ship's side for the purpose of conveying the water off the decks.
Schooner. A vessel with two masts and fore and aft sails.
Scuttles. Square holes in the deck smaller than a hatchway.
Seams. The opening between the edges of planks.
Seating. That part of a floor or transom that rests upon the place it was bolted.
Sections. Lines bisecting the body in a fore and aft direction.
Setts off. The different dots, &c. in laying off for the several lines to pass through.
Setting up. Taking the height from a given point and setting it off from a corresponding base, as setting up the sections and diagonals in the sheer.
Setting up. Raising a ship from her blocks with wedges.
Shaken. When a plank, &c., is split.
Sheathing. The boards nailed on a vessel's bottom, substituting copper.
Shear. The hanging of the ship's side in a fore and aft direction.
Shear streak. Usually the upper wale in the merchant service.
Shears. Spars lashed together for hoisting.
Shift. When one butt of a piece of timber over-launches the end or butt of another, without either being reduced in length, for the purpose of strength, as planks of the bottom, timbers of the frames, &c.
Ships of the line. Mounting sixty-four guns and upwards.
Ship. A three-masted vessel.
Shouls. Pieces of plank under the shores.
Shores. Pieces of timber supporting the ship.
Shores (dog.) Diagonal pieces formerly used to confine the ship on the stocks until the blocks were removed.
Surmarks. Lines on the ship's body from which the bevelling is taken.
Sills. The upper and lower part of the forming of the ports.
Skylight. Hatchway in the deck to admit light into the cabin.
Smack. A sharp vessel for bringing live fish to market. Also a Scotch trading vessel with one mast.
Sloop. A vessel with one mast.
Snying. When the edge of a plank rounds upwards, as the plank on the buttock and around the bow, when the middle is above a straight line.
Sloop of war. A minor-class vessel, sometimes frigate-built, and carrying one tier of guns.
Spar deck. The upper deck of a single banked frigate.
Spars. Round timber for masts, yards, &c.
Spikes. Iron nails by which the decks, ribands, &c. are fastened.
Spindle. The perpendicular bar on which the capstan revolves; also the windlass on horizontal ones.
Spalls. Beam pieces to support stages.
Spirketting. Plank above the deck, and on the frames, around the bow.
Splitting out. The act of removing the blocks, &c.
Spokes. The handles of the wheel.
Square body. The midship section.
Standards. Perpendicular spars placed round the ship for supporting staging.
Stanchions. Timbers running up to the rail. Also pillars for the decks.
Starboard and larboard. The former the right and the latter the left hand side of the ship when facing forward.
Stealer. The forward or after plank of the bottom that does not hooden into the stern-post.
Stemson. A piece of timber fastened to the keelson and apron.

Stem. The fore-piece that unites the bows.
Steeve. The inclination of the bowsprit.
Steering wheel. That by which the vessel's rudder is worked.
Steamer. Steam vessel.
Steps. For the masts, &c.
Stern frame. That which is composed of transom, stern-post, fashion-piece, &c.
String. Narrow pieces or streaks above the waist, between the mouldings.
Stocks. The ship's blocks.
Stuff. Timber or boards of different dimensions.
Sweeps. The form of the frame in the loft. Also long oars.

Tabling. The letting of one timber into another to keep them from hollowing apart endways, similar to hooking.
Tafferel. The upper part of the stern.
Thick stuff. Pieces of thick plank for ceiling and strengthening the bilge intermediately.
Throats. The middle inside of a floor or knee timber.
Thwarts (*boat's.*) Cross seats.
Timber. General name given to pieces composing the frame.
Top timbers. Those on the top sides butting the second futtock.
Top sides. All above the wales.
Tops. A platform built on the cross-trees for holding rigging.
Tonnage. The measurement of a ship.
Tiller. A lever to turn the rudder.
Trail board. The carved work between the head knees.
Transom. Crooked and straight timber which comprises the stern frame. Same as buttocks.
Treenails. Wooden bolts to hold the planks to the timber.
Trim. The fitting of any timber or plank to its form. Also the sitting of a vessel in the water.
Tuck. The upper part of the buttock.
Tumbling home. Same as falling home; side swells, &c.

Unship. Taking any thing out of its place.
Upper work. Comprising that part of the ship above water.

Wake. A name given to the confused water after a ship when sailing.
Waist. That part of the plank between the upper wale and the first black streak or string.
Wales. The thick plank of parallel and equal widths worked on the widest part of the ship fore and aft.
Wall sided. When a ship's side is plumb and continues the width very low down; as figure 3.
Ward room. An apartment for the commissioned officers in a ship of war.
Wedging up. Gaining security. Raising.
Waterway. Thick plank fayed to the timbers and beams, and forming the first streak of the deck.
Well. The enclosure round the pumps.
Wherry. A skiff with a flat bottom.
Winch. Cylindrical machine fixed to the fife-rail posts, used for hoisting out cargo.
Wing transom. The upper transom in the stern frame.
Windlass. A horizontal machine for heaving up the anchor.
Winding. Any thing that winds.
Withinboard. Inside.
Wrought. Any thing worked; as working plank, putting them on the bottom, &c.

Yawl. A small boat.
Yoke. A circular or angular board fitted to the head of a boat's rudder to steer by, instead of a tiller.

LAUCHLAN McKAY

Every new experiment in the maritime world was keenly watched by a multitude of men, when, in 1839, Lauchlan McKay published his authoritative Treatise on the Science of Shipbuilding, THE PRACTICAL SHIP-BUILDER. It may be claimed that American shipbuilders did not sufficiently know what made one ship handle and sail better than another, and therefore began to study, so this book, the first ever written in America fully covering the construction of vessels, was then readily adopted as a text book by nearly every shipyard in the United States.

From 1830 to 1840 probably more experiments and alterations were made on sailing vessels than during any other decade in the history of our merchant marine. It was then that so many experiments were made in the form of vessels as well as in the motive power. Shipbuilders found that more was required of them, and in order to hold their own and maintain the reputation of their yards they were forced to study the scientific principles involved in the form and the sparring of ships, &c. The old spoon-shaped bow was giving way to vessels with an easier entrance line, and a finer run aft; in fact, by the early thirties, not only was the shape of ships changing, but they had doubled in size. It was during this most interesting and eventful period in the Annals of American Shipbuilding that Lauchlan McKay, constantly acquiring skill and experience, and a thorough knowledge of shipbuilding, sought every source of information in ship designing, also. An unusually capable, intelligent and industrious mechanic, he readily found employment in the foremost shipyards of New York, such as Brown & Bell's, Christian Bergh's, Smith & Dimond's and Isaac Webb's, for with the last-named master-builder he and his brother Donald, who afterwards acquired fame as America's foremost designer and builder of clipper ships, had served their apprenticeship.

In June, 1836, Lauchlan McKay was appointed carpenter in the United States Navy. He saw service on the sloop-of-war NATCHEZ, then the frigate CONSTELLATION, aboard which Admiral Farragut was a lieutenant, and later upon other vessels until 1840, when he resigned from the Navy. During his naval service, he received leave of absence, and, going to Newburyport, Mass., where Donald McKay was entering upon his wonderful career, he wrote his Practical Treatise on Shipbuilding. In its preparation Donald and his wife assisted. Albenia Boole McKay was not only an intelligent, well-educated woman, but a capable draftsman and possessed a good, practical knowledge of shipbuilding; her father, John Boole, and various members of her family being active in and prominently identified with shipbuilding at New York.

Returning to New York, from Norfolk, Va., where he had left the Navy, Lauchlan McKay re-entered the employ of Brown & Bell as a master-shipwright or foreman. Afterwards, in company with his brother, Hugh, he opened a shipyard at East Boston. Here they did repairing, and in 1846 built the barque ODD FELLOW, in which Lauchlan sailed as master. In 1849 he commanded the ship JENNY LIND, built by Donald McKay, and made some excellent trans-Atlantic passages in her.

The Clipper hull, like so many other milestones of progress, was an evolution to which a number of persons contributed. In 1852, Donald McKay gave to the waters the SOVEREIGN OF THE SEAS, measuring 2421 tons, a new record in size, with the longest and sharpest ends of any vessel then built. She was sent out to San Francisco in command of Lauchlan McKay and electrified the nation with her performances, and he made a record unparalled in the history of a shipmaster. Off the coast of Chili, the SOVEREIGN was dismasted in a storm, but Captain McKay re-rigged her at sea and kept his vessel on her course, despite her disabled condition, eventually making a record passage from Sandy Hook to the Golden Gate.

We next see the SOVERIGN OF THE SEAS loading sperm oil at Honolulu—the pioneer vessel in transporting our whalers' catch in the Pacific to Atlantic home ports. With a crew numbering about one-third of what she had on the outward passage, she sailed for New York, February 12th, 1853, with a cargo of 8,000 barrels of whale oil and a small amount of bone. Captain McKay had occasion to display his ability to repair his ship on this passage also, for on the twentieth day at sea she sprung her fore-topmast, and although it was "fished" in a couple of days, that mast, with the main-topmast tender, was a source of anxiety for the remainder of the passage. The SOVEREIGN arrived off Sandy Hook in eighty-two days out from Honolulu, a record at that time. Ou this run she logged 374 knots or 433 statute miles in twenty-four hours, and sailed 5391 nautical miles in twenty-two days. Certainly this eventful voyage deserves to rank among the most notable in sailing ship annals. The SOVEREIGN left New York on June 18th, 1853, for Liverpool, crossing from pier to anchorage in thirteen days, twenty-two hours. Upon arrival at Liverpool she was chartered by James Baines for his Australian "Black Ball Line." Thenceforth Captain McKay knew her no more.

Returning to Boston, he superintendeded the outfit of Donald McKay's Ship O' Ships, the GREAT REPUBLIC, the largest and most magnificent sailing vessel in the world, which he was to command in recognition of his splendid services as master of the SOVEREIGN OF THE SEAS. Oue of the many innovations introduced on the REPUBLIC was a capstan for purchasing the anchors instead of a windlass, which could be worked on both decks, the invention of Captain McKay. But Lauchlan McKay was never to take the GREAT REPUBLIC out to sea. When laden at New York and nearly ready to sail for Liverpool, she was burnt, then scuttled and sunk. When raised and reconstructed a different ship sailed the seas.

When the LIGHTNING on her maiden voyage from Boston to Liverpool, in March, 1854, made the marvelous day's run of 436 nautical miles, her commander, James Nicol Forbes, had, as companion and adviser, Captain Lauchlan McKay, who also went as builder's representative. In the hands of these two experienced and skilful master-mariners, it is easy to understand how the LIGHTNING developed her finest speed and made one of the shortest, as well as most remarkable, trans-Atlantic passages ever recorded; and it was not until 1885, thirty-one years afterward, that an ocean steamship exceeded her day's work.

In England Captain McKay was offered command of the British ship NAGASAKI, and he took her on a voyage from Liverpool to Australia. While at Sydney, N. S. W., he raised a large ship which had been sunk and given up as a wreck. Other parties had tried for a month and failed. He raised her in less than a week, showing that his knowledge of ship construction and mechanical skill enabled him to succeed where others had failed.

At the disappearance of the clipper ship, he, in connection with his brother-in-law, Captain Henry Warner, who had served as his mate many years and succeeded him in command of the SOVEREIGN OF THE SEAS, when he left her at Liverpool, started shipbuilding in Quebec, Canada, where they launched twenty-nine vessels, ships, barques, brigs and schooners, and continued there from 1864 until 1876. Afterwards he entered into partnership with Charles B. Dix under the firm name of McKay & Dix, conducting a general shipping business and engaging extensively in the Greenland and Newfoundland trade, at New York, Boston and Philadelphia, for which they built fourteen vessels, all constructed under Captain McKay's superintendence. He retired in 1893, and moved to Roxbury, Mass., where he lived with his nephew, William L. Kean, whose wife was also Captain McKay's niece.

He died April 3rd, 1895, one of America's great men of action. The list is long and should ever remain memorable.

RICHARD C. McKAY.

This is No. 175 of a Limited Edition of 250

copies, issued August 28, 1940.

Richard C. McKay

This book may b