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# HOW TO BUILD A MODEL STEAMER

(WITH FOUR LARGE SCALE DESIGNS)

By

**J. Vines**

MARINE MODELS PUBLICATIONS, LTD.
52, FETTER LANE
LONDON - E.C.4

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*Photo: L. J. French*

MODEL RIVER TUG "DANUBE II"
*Owned by Mr. F. J. Pierson, Victoria M.S.C.*
*Built by Mr. Wm. Morss*

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# PREFACE

ALTHOUGH several books on the subject of Model Steamers have been published in recent years, none of them seems to give quite the information required by the average beginner. The object of the present volume is to fill this want, and supply the necessary information and advice in concise form without unnecessary elaboration.

The modeller who can design his own vessel and engines, making everything from start to finish with his own hands, is in little need of instruction, but for one craftsman who can do this there are hundreds who would like to build a model but hesitate to start, through doubt as to their ability to turn out a successful craft. Others who actually build models, fail to turn out good boats simply through lack of a little information in readily accessible form.

Actually there is no reason why anybody, who is moderately handy and prepared to take time and pains, cannot build a most creditable steamship model. The builder must not consider the construction as a laborious task, but as pleasure. Then, as the vessel gradually takes shape and the work is carried forward step by step toward completion, the builder will take pride in making the best possible job.

When, finally, the model is finished, there comes the great day when the little ship makes her maiden voyage. How great is the builder's joy if she steams bravely across the lake, but how great his chagrin if, through lack of knowledge, he finds that he has wasted time and money on an inferior design of hull or plant. By following the advice and instructions given in the present little book, the embryo modeller will be spared this disappointment. The writer has many years of model building behind him, and the methods detailed are dictated throughout by practical experience, and will be found the easiest and most practical for attaining the desired results.

In order to give the most up-to-date methods of wooden hull construction, I consulted Mr. H. B. Tucker, Editor of *Marine Models*, who kindly supplied much of the material contained in the chapters dealing with this subject and the general naval architecture contained in this volume.

I have also to acknowledge the kindness of the proprietors of *Marine Models* for permission to republish matter, photographs and diagrams which have already appeared in that magazine.

If the reader finds as much pleasure in his models as the writer does, he is assured of many happy hours. May his lamps burn well and his boilers maintain a good head of steam!

# HOW TO BUILD A MODEL STEAMER

## CHAPTER I.

*Introductory Remarks—Notes on Designs supplied with Book—Plan Reading—Enlarging Plans to Full Size—Selecting Wood and marking out for Building a Hull.*

MODELMAKING is a most fascinating hobby, as it offers scope for the creative instinct, and provides congenial and instructive recreation.

A working model steamship is a very attractive subject for the modelmaker, and provided he is prepared to take the necessary pains, it should not be beyond the powers of any intelligent person to produce a creditable model that will be a lasting pleasure to its builder. The beginner, however, needs a certain amount of guidance and advice in order to make a success of his work.

The first thing to settle is the type of vessel to reproduce. Most beginners start by trying to model a destroyer, a battleship or a large liner, all of which present great difficulty to the novice.

A vessel floating in water displaces a volume of water having a weight equal to her own weight. Now if the modeller is making a 3ft. model of a vessel 600ft. long, the scale is 1/200th and all dimensions are reduced accordingly. As the length, depth and breadth are reduced to 1/200th, the displacement, which is a cubic measure, is reduced to $1/200^3$ ($=1/8000000$). If the reader will work this out on the displacement of any vessel of this size, he will see that not only will the resulting model lack the requisite beam and depth to house the propelling machinery, but she will also lack displacement and stability. A skilful naval architect will be able to make the necessary amendments to the design, but the novice is well advised not to attempt this.

Again there is the question of detail work and fittings. Many of the fittings in a vessel—such as the rails, steering wheel, etc.—are not dependent on the size of the vessel, but the size of the crew. Thus a steering wheel for a 1/200th scale model of a 600ft. liner would be approximately $\frac{1}{4}$in. high, and that for a 1/30th scale model of a 90ft. trawler would be about $1\frac{5}{8}$in. high. Yet both the models would be the same overall length.

For both these reasons the beginner is strongly advised to select a small vessel as his prototype, and the models whose plans are given in this book are all of rather small ships. Further, the author advises the reader (unless he has some knowledge of naval architecture) to work to plans specially drawn for model-builders by a skilled naval architect. This will save waste of time and money, and subsequent disappointment.

Many models are commenced in a haphazard fashion by the builder either carving a hull and then wondering what sort of ship it can be made to represent, or else building an engine and then making some sort of hull to carry it. This is all wrong, as the model must be considered as a single entity and planned as a concrete whole. The hull must be properly designed and the displacement calculated, and a suitable plant selected for the actual work it has to perform.

Four large-scale designs are supplied with this book. While none of them represents any specific vessel, all are characteristic examples of their types. These boats were specially designed as models and should, therefore, be far more satisfactory as working models than scale reductions from full-sized vessels. For the benefit of beginners a few notes on these designs are appended.

"BRUNHILDE."—Length 39.5in., Beam 8.0in., Draught 3.4in., Weight 15 lb. This model represents a typical power-driven yacht of some 100ft. to 120ft. length. The prototype would probably be driven by a Diesel or semi-Diesel engine (or engines). She makes an excellent steam-driven model. Well-built, with the weight kept low, she would make a stiff and sea-kindly little ship, able to stand up to a lot of dirty weather. This design is published one-fourth of full size. It could be built as a bigger model by taking the plans as one-fifth of full size and increasing all dimensions accordingly, when the displacement would be increased to $29\frac{1}{4}$ lb. If enlarged to six times, she would make a very powerful boat, and the displacement would be $50\frac{1}{2}$ lb.

"ZINGARA."—Length 49.5in., Beam 8.0in., Draught 4.25in., Weight 35 lb. This vessel is shown as a three-island cargo steamer, but with a little alteration to the upper works, the design could be adapted as a cargo-passenger liner, an oil tanker, a collier, etc. Fairly full deck detail is given, but the hull is so adaptable that the reader is advised to select his own prototype and copy the detail work and deck arrangements from her. The design is given one-sixth of full size, but if taken as one-fifth the weight would be $20\frac{1}{4}$ lb., and as one-seventh $55\frac{1}{2}$ lb.



"CORONET" is a typical modern paddle excursion steamer, and "BOADICEA" a fine type of sea-going tug. Full description and particulars of these are given later in the book in the chapter on Metal Hull Building. If desired, however, they could be built of wood.

It is considered better to give four good designs, on a large scale, which really can be worked to, instead of a greater number of small-scale designs that merely mislead the builder.

If the builder is at all dubious whether a design is capable of a moderate amount of enlargement or reduction, he should remember that the displacement is altered as the cube of the scale. Thus, if it is wished to build a 4ft. design as a 5ft. boat, the ratio for increase of displacement is as $(4)^3:(5)^3$, or $(4/5)^3=64:125$. Thus, if the 4ft. boat weighed 32 lb. the 5ft. would weigh $62\frac{1}{2}$ lb.

Building a working model is very different from building a showcase model. In the showcase model the miniature vessel must be a scale replica of the original down to the smallest detail, and this involves a great deal of very delicate work. For instance, each of the miniature deck-winches must be a little model in itself, and so with each of the other fittings. In the working model the broad effect has to be studied, and it is a mistake to have too much small and delicate detail, as this does not show, and is sure to be injured sooner or later either by collision with another craft or in handling the model. Again, for a working model, it may be necessary to modify the proportions of the hull somewhat in order to get sufficient displacement and stability. Likewise minor deck fittings can be omitted whilst others need not be modelled so closely, and many require making more strongly than strict scale proportions would permit. In the engine-room, also, considerable modification is not only admissible, but desirable, and a very simple plant will do all that is requisite. What the builder has to aim at is the broad effect so that his model will not only look like the prototype, but behave like her when under way.

The beginner is, therefore, advised not to over-elaborate his model for a start, but to content himself with the main features, as additional details can be added when more experience is gained.

In any case the modeller should lose no chances of going aboard similar craft to the one he is modelling, and with rule, notebook, camera and sketchbook, he will soon gather a priceless store of valuable information.

In this book all fittings, etc., are simplified as far as possible, and the author has concentrated on making a good working job, leaving the modeller to add the trimmings later.

Hulls for a prototype model can be of either metal or wood, but the beginner will find the latter easier to build, and though notes on building metal hulls are given in a later chapter, it is recommended that for a first venture a wooden hull be selected, and instructions are given accordingly.

The best way to construct a wooden hull is bread-and-butter fashion from layers glued together. These layers are partially shaped inside and out before being glued up. It will assist the reader to understand the bread-and-butter system of building if he refers to *Figs.* 1 *and* 2. This not only saves labour in carving, but also ensures the hull being true to the designed shape, and what is possibly even more important, having the two sides alike. Obviously a model cannot be expected to run straight if her two sides are different or the keel is out of truth. Yet one sees many models that are obviously untrue which have to be held on their course (or as near it as they can be persuaded to run) by excessive helm.

The reader need have no fears that a laminated hull of this kind is less strong than one carved from a solid block, as the joints are actually stronger than the wood itself, and the laminated construction minimises the danger of warping and twisting.

A brief explanation of the lines of a vessel will assist the reader to understand what follows. Let us assume that it has been decided to build a model from the lines of the motor yacht "Brunhilde" (*see folding plate in pocket at end of book*). This vessel is a typical modern yacht and makes an excellent steam-driven model.

Turning to the plans, we see that the sheet contains four drawings. The one at the top is a Profile Plan showing the rigging and general appearance of the vessel, and the other three plans give her lines. The small plan to the left is the Body Plan and gives the transverse sections. It will be seen that the line of flotation is marked L.W.L. (Load Water Line), and that there are lines parallel to the L.W.L., above and below it, which are called Waterlines (W.L.), and numbered for identification. The left side of the Body Plan gives the forward sections numbered 0-4, and the right side the after sections numbered 5-9 plus the Transom. The three upright lines on each of the centreline of the body plan are the Buttocks, and represent longitudinal sections taken through the boat.

The big plan to the right of the Body Plan is the Sheer Plan, and gives the elevation of the vessel. On this the Waterlines and Section Stations are easily identifiable. The three curved lines inside the actual profile are the Buttocks



which show the shape of the vessel if cut longitudinally at these points.

Below the Sheer Plan is the Waterline Plan. The Section Lines are easily identifiable, and the three longitudinal lines parallel to the centreline are the Buttocks. The curved lines represent the horizontal shapes through the boat at each Waterline.

It will be seen that actually the plans represent a half-model, but this saves repetition, as the other side is exactly the same. It will also be observed that the various measurements coincide for the three plans. Thus the stem intersects the L.W.L. at Section 1 on all the plans, and other measurements likewise agree.

It will be seen that the Waterlines on the drawings are spaced $\frac{3}{16}$in. apart, and, as the drawing is one-fourth the size of the model, the Waterlines on the actual model will be $\frac{3}{4}$in. apart. The hull will accordingly be built of layers of wood $\frac{3}{4}$in. thick. This does not apply throughout, however, as it is slightly more than $\frac{3}{4}$in. from the bottom of the boat (exclusive of keel) to W.L. 1, which forms the bottom layer of the boat. W.L. 1 is not lettered on the Sheer Plan, but is easily identifiable. This is shown in *Figs.* 1 *and* 2 as layer *K*, and is made of 1in. wood. Likewise the top short layer *A* is made of 1in. wood. Layer *M* is a small piece of thin wood required to bring the height of the transom in the centre up to that shown in the plans, and *N* a piece required to raise the bridge deck to its proper height. The keel is a separate piece, let in and glued as shown in *Fig.* 2. It will be seen that in both *Figs.* 1 *and* 2 the Bulwarks are shown. These are added after the hull is shaped, and the diagrams show how they are let in and glued.

The first step is to enlarge the Waterline Plan and Profile to full size. This can be done on ordinary drawing paper or on engineer's squared paper which can be obtained ruled either in inches and tenths of an inch, or in inches and eighths of an inch. This is considerably more expensive than ordinary drawing paper, but will be found worth its cost as it is very convenient in use. For drawing, use a fairly hard pencil with a really sharp point so as to get fine thin lines. You also require a good rubber, a long straightedge, and a thin flexible batten for drawing curves.

The latter is a long thin strip of wood such as is sold as "strip wood" for model aeroplane builders. Its exact size is unimportant, so long as it will bend and is long enough to run the curves in one length.

Pin a suitable sheet of paper on the drawing board. If using an ordinary table, it will protect the top if you cover

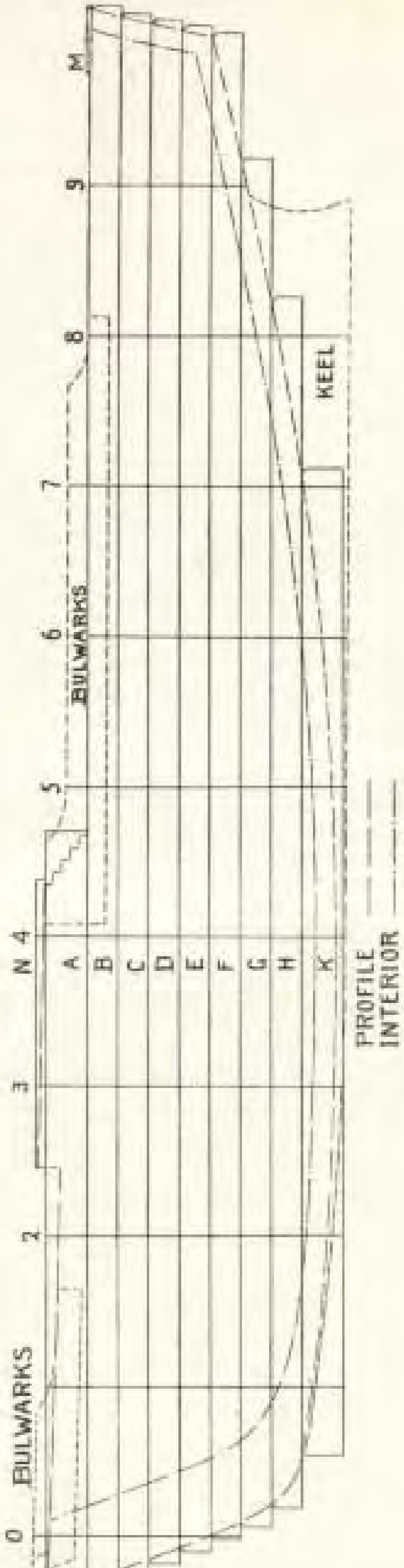



*Fig.* 1—BREAD-AND-BUTTER CONSTRUCTION.
Method of adding Bulwarks and Keel is also shown in above drawing.
The Profile and Interior Lines show shape after carving and hollowing out.



it with a piece of clean plain linoleum. Rule the centre line and square the section station lines carefully across it.

Now comes the task of enlarging the lines. The published plan is a quarter size, so all measurements have to be multiplied by four. For example, let us start with the Waterline Plan and commence by putting in the deckline. The measurement from the centreline to the deckline on Section 1 is taken from the plan, multiplied by four and transferred to our full-size plan. For this purpose dividers can be used, but they have a habit of springing; also the points go into the paper at an angle instead of vertically, and thus tend to introduce errors. The best way is to use

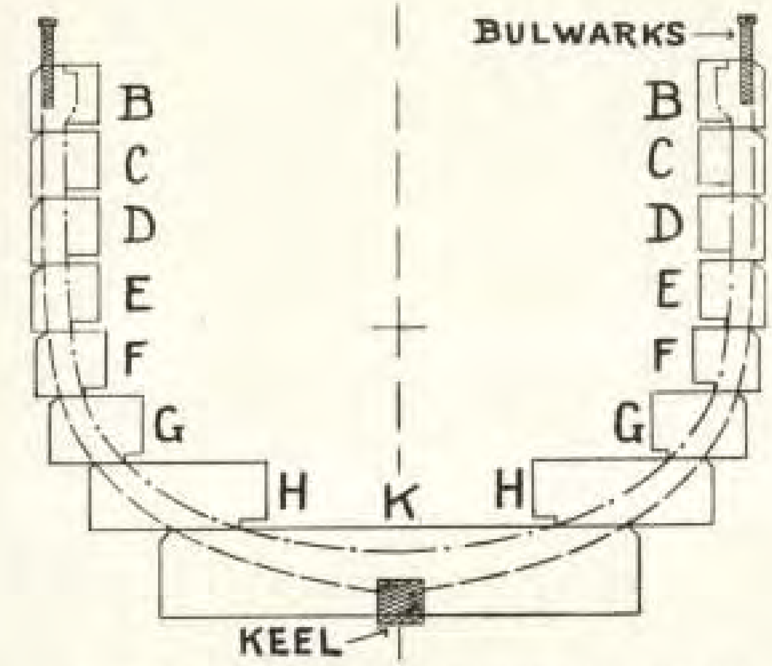



*Fig.* 2—BREAD-AND-BUTTER CONSTRUCTION.
Method of adding Bulwarks and Keel is also shown in above diagram.

measuring slips. Cut some slips of fairly stiff paper about ½in. wide and mark the distances on these. Go right along the boat and put the measurement on each section. A curved line has then to be drawn through the points found. For this the thin batten is used, and it must be held in position with weights. If the builder has no proper drawing weights he will have to use the family flat irons, weights from the scales, etc. Be careful to get the line exactly through the spots and see it is a true, fair curve without humps or flats. If one of the spots seems a little off, check carefully to see that no error has occurred in the transfer and enlargement.

The other curves on the Waterline Plan are treated similarly. The straight lines representing the Buttocks should also be drawn in, as measurements taken on these will be most useful in drawing the ends of the curves. In this case the distances can be taken from the nearest intersection of a Buttock and a Section line.

When the Waterline Plan has been enlarged, the Sheer Plan can be dealt with. The Body Plan can also be enlarged, but will be mainly useful to the bread-and-butter builder for reference.

Now we come to the question of the wood. The best timber is fine-quality white or yellow pine, and it is important to select light boards. Take the lengths you will require from the full-sized plan so that you can pick boards of suitable length to cut with as little waste as possible. As the waterlines are spaced ¾in., you will want all your wood finished to ¾in. exact, except a piece of 1in. for layers *A* and *H*. You can get the wood planed and sanded to this exact thickness at the sawmill. When taking delivery, check the thickness by putting several boards together and seeing that they measure the exact number of inches. By measuring over several boards, you will easily detect an error in thicknessing, as any error will be multiplied. This is important, as if your boards are, say, 1/16in. too thin you will lose one-sixteenth of the total displacement of the boat besides upsetting the design.

All wood should be free from knots or shakes (splits), and as even grained as possible. One good reason for the use of white or yellow pine is that this wood is very easy to work. The keel is cut from a piece of ½in. oak, and the bulwarks ⅛in. pine or mahogany.

To mark out the layers start by ruling a centreline down one of the boards. Square this across the ends and put on the bottom also, so that you have a continuous centreline right round the board. Next square the section station lines right round the board for the length of the layer you are marking out. We will assume this is layer *B*, so the length of the wood required will be 39in., which gives a little margin at each end.

Take a sheet of tracing paper and a **B** pencil, but give it a really sharp point. Pin the tracing paper over the Waterline Plan and make a tracing of the top of layer *B*, putting in the centreline and section station lines. Take this tracing and place face down on your wood, taking care that the centreline and station lines register exactly. With the **B** pencil go over the outline, pressing firmly on the pencil. This will transfer the shape onto the wood. Turn the tracing over and place on the wood the other side of the centreline. Once more go over the outline with the



pencil, and you will have the complete shape of the layer marked on the wood.

It should be understood that when we speak of the shape of the layer we are referring to the upper face unless otherwise stated. As a matter of fact the upper face is invariably larger than the lower unless the vessel happens to have a tumblehome, when the reverse will be the case. As the layer is cut to the shape of its largest face this will be the upper face except when there is a tumblehome, but as a tumblehome only extends for part of the length the shape will then be a combination of the upper and lower faces. In any vessel where this occurs the tracing of the lower face will also have to be put on the top of the plank and the cut made outside, whichever is bigger at the particular point in question.

Now as we are also going to remove the middle of the layer, the shape to cut from the centre will have to be taken from the lower (or smaller) face, and if there is a tumblehome a similar allowance will have to be made for the upper face. Now in marking out the inside a line will have to be drawn within the smaller face outline so as to allow for the thickness of the sides. Owing to the tendency of wood to warp it is necessary to allow additional thickness to take the strain of cramping-up for gluing.

The minimum thickness that should be left in any place when sawing is about ¾in., though ultimately we shall carve the sides down to about ¼in. and the bottom to ⅛in. Down the stem a thickness of 1¾in. to 2in. will be left in the finished boat, so about 3½in. will have to be left when cutting, and somewhat more for layer *H*. Now, if the side is vertical, it is a simple matter to allow ¾in., or whatever the desired thickness is, but it is not so simple when the side or end of the boat is at an angle. For instance, if the side or end has a rake of one in four and one wishes to allow ¾in., one has to cut 3in. inside the outer line of the smaller face.

The best way is to measure up on the midship section and profile. In fact the line of the inside can with advantage be struck on the plans. In doing this, allow for the sides being ¼in. full thickness, the bottom ⅛in., and the stem 1¾in. Although in most parts the builder will have to allow for a greater thickness than these plans will show, in order to observe the minimum ¾in. thickness for cutting, these points will come in handy later on, as will be seen in due course.

Having traced the shape for the top of layer B, turn the wood over and put in the shape of the bottom (which will also be the top of layer C) and mark on the underside of the board. Then, as explained above, mark out the inside of the layer for sawing out.

The remaining layers are marked out in a similar fashion, and the sawing can be commenced. The layers are cut $\frac{1}{8}$in. outside the outer line and $\frac{1}{8}$in. inside the inner line. It will save a considerable amount of labour if the wood is taken to a bandsawyer, and not be a very expensive matter. If this is done, be sure to ask the sawyer to see that his saw is cutting vertically to the table.

If the worker wishes to saw out his own layers this can be done with a pad or compass saw. For cutting the insides holes have to be drilled to start the saw.

## CHAPTER II.

### *Gluing up a Bread-and-Butter Hull—Carving out and Finishing.*

After the layers have been sawn out, they have to be prepared for gluing. As the outside edges have been cut about $\frac{1}{8}$in. outside the marked line, the next step is to trim them down sharp to the marked line on the upper faces only. This gives the builder the necessary guidance when he is shaping the outside of the boat.

Take a sharp paring chisel and trim the edge of the upper face back exactly to the marked line. In all woodwork it is most essential to have a keen edge on all cutting tools. For this purpose you need two oilstones—a quick-cutting stone such as a carborundum, for preliminary sharpening, and a fine hone for putting the final keen edge on tools. In stoning chisels and the like be careful to keep the tool at the correct angle to the stone, and use plenty of light oil.

Having trimmed the outer edges of all the layers, the insides have to be dealt with. This is a little more difficult to explain without an actual demonstration, but is really quite a simple process.

Place layer *B* face downwards on the table. You have made (as explained in the previous chapter) drawings of the profile and midship section with an inner line showing the extent of the hollowing at the bow and stern, and midship section respectively. Measuring from the outside, mark these positions on to the wood. You now have four spots through which the final inner line has to be drawn. The actual wood has been cut to an inner line in order to give the necessary thickness to avoid warping under pressure when the layers are cramped together for gluing.

Take layer *C* and place on layer *B* in its exact relative position. Stand at the stern of the layers and gently draw *C* back in a diagonal direction, uncovering more of layer *B* until the spot at the bow showing the extent of the hollowing is exposed, also the similar spot at one side on the midship section line. These two spots should just show. If the pencil is run round layer *C* you will then have a quarter of the desired line marked on the bottom of *B*. Complete in similar fashion. Take a small gouge or V-chisel and cut a groove $\frac{1}{8}$in. deep round the line. Cut inside the marked line so that the outer edge of your groove coincides with the line. If the cut is made on the line itself part of the thickness of the ship's skin will be taken away.

Having completed the groove, take the paring chisel and cut the wood away between the groove and the inner edge of the layer to a depth of about $\frac{1}{8}$in. This will leave the wood that will form the finished joint to come into contact with the next layer, and, when the layers are cramped-up in gluing, will concentrate the pressure on the desired surfaces. It will also let the air get in and facilitate the glue drying out. The grooves, of course, form a guide for hollowing out.

Prepare the other layers in similar fashion down to the lowest one, *H*, which forms the bottom of the ship and extends right across it. The centreline and section lines should now be squared across the edges of the layers, which are then ready to be glued up.

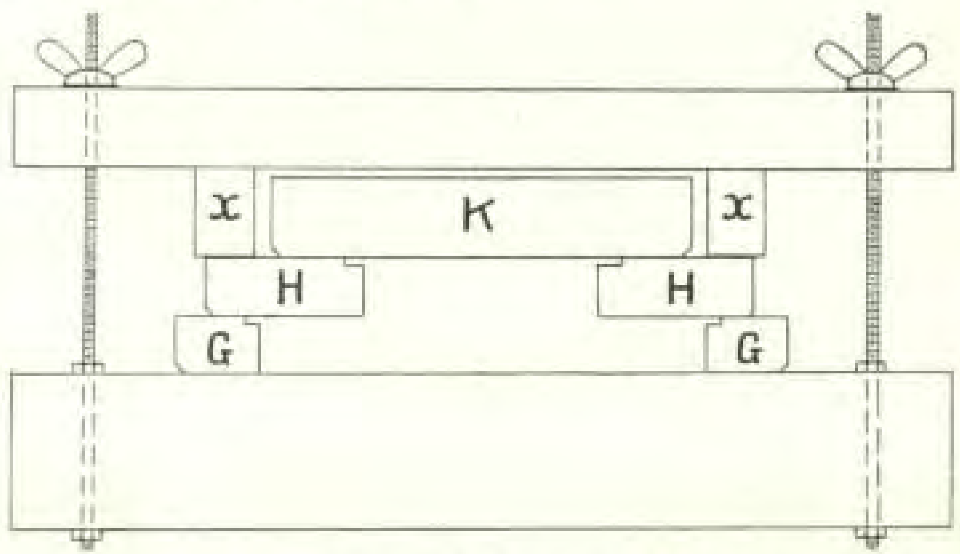



*Fig.* 3—CRAMP FOR GLUING UP LAYERS.

Before the invention of casein glue, model builders were forced to use Scotch cabinet glue, which is not waterproof, if they built by bread-and-butter methods. Casein glue has proved an inestimable boon to model steamer builders, as it is waterproof and heatproof. Moreover, it is far stronger than ordinary glue, and joints, when properly made, are actually stronger than the wood surrounding them. Casein glue is obtainable through most good ironmongers and oil-shops, and, in any case, is supplied by most of the model suppliers.

Before starting to glue up, the modeller must make up four special gluing cramps (*see Fig.* 3). The materials for these only cost a few pence, and they are essential if good joints are to be made.

The materials consist of eight 12in. lengths of $\frac{3}{16}$in. screwed rod (sometimes known as "studding"), eight butter-



fly nuts with washers, and sixteen ordinary hexagon nuts to fit, also four pieces of hardwood 12in. x 2in. x 1in., and four pieces 12in. x 1in. x 1in.

The construction of the cramps will be apparent from the diagram. The holes for the studding are 1in. from the outer ends of the wood bars. Having made the cramps, the glue can be prepared.

Casein glue is a fine white powder. Take a clean pot or tin, and put into it just sufficient water to make up the required quantity of glue. Add the powder little by little, stirring all the while with a piece of stick. Do not add too much glue at first, but mix gradually until it becomes the consistency of thick cream. After mixing, put the glue aside for 15 or 20 minutes. During this time a change in its appearance will be noticed. This is not easy to describe, but will be quite apparent when the builder has his glue mixed.

Always mix sufficient for the job, as it is fatal to run out and have to start mixing afresh in the middle of spreading the glue. On the other hand it is a mistake to mix too much, as any left over must be thrown away and not allowed to stand over until next day, as it loses its virtue, and cannot be rediluted.

For a start glue layer *K* to layer *H*. The reason for starting at the bottom is that the upper layers, having no insides, will not stand up to the pressure of cramping-up first. Coat both the surfaces to be joined thinly and evenly with glue. Then place in position, taking care that centreline and section lines register *exactly*. As this glue does not set quickly, you can take your time over the adjustment. The layers are now cramped up with the cramps just made. Put cramps at the extreme ends of the layers first, and then the other two in between. See that you screw down evenly, not lop-sided. Then make sure that the layers have not shifted during cramping-up. Screw down firmly, and give a final look to see that the alignment has not shifted. Then set aside to dry for at least 12, and preferably 24, hours.

Layer *G* is next added. If the reader looks at the diagram he will see that packing-pieces *X* are put on each side so as to concentrate the pressure on the surfaces of *G* and *H* that are being joined. It will be obvious that if these packing-pieces are not used, a great twisting strain will be put on layers *K* and *H*, which will distort even if it does not split them.

Layers *F*, *E*, *D*, *C*, and *B* are added in the order given. Then comes the half layer *A*, and finally the two small pieces *M* and *N*. On no account hurry the gluing process, but see that each layer is aligned correctly, and allow sufficient time for each to dry.

There is no need for the modeller to lose time during the time the glue is drying, as he can make the rudder or some of the fittings such as the ports. This will all save time later on.

At this point the hull is in "steps" inside and out, and the boat must now be fixed in a convenient position for carving. On no account attempt to hold the boat with one hand and carve with the other. This will not only result in bad work, but is a highly dangerous practice, as if a chisel or gouge slips and goes into the worker's hand or wrist, a bad and even dangerous wound may be caused. In fact, one should always cut away from oneself when using edged tools.

Cut two pieces of wood about 14in. by 2in. These can be ¾in. or 1in. thick, and will then keep the boat clear of the bench during working. Screw one piece across the gunwales about 12in. from the bow of the boat, using screws 1¾in. long, but taking care these are well inside the outer shell of the boat, as otherwise your tools will foul them as you carve down to shape. Fix the other piece of wood across the gunwales in the stern, using a piece of spare wood to pack up level with the bows. The strips will protrude several inches beyond the gunwales on either side of the boat. Put screws through the ends into the table or work bench. This will hold the boat firmly in position during shaping. With paring chisel and plane cut away the corners of the steps. The plane is the best tool to use as far as possible, as it will prevent the worker getting hollows and give a fair surface. The spokeshave is not a good tool to use for shaping, as it tends to produce hollows. Carve away carefully until within, say, 1/16in. of the finished shape. At the forward and after ends of each step you will be able to discern the centreline up to the point when the steps nearly disappear. At this point the complete centreline should be put in again. The part of it which is in the way of the actual keel can be cut in with the chisel to a depth of about ⅛in. Care should be taken that this part of the centreline is not lost during the final fairing-up of the hull. The hole for the rudder-tube can be drilled at this point.

Take a piece of flat wood and wrap a piece of stout No. 2 glasspaper round it. As far as possible rub diagonally across the layers. As you proceed, stand back occasionally from the work and look at it from all angles to see that the surface is fair, without bumps or hollows.

As the work proceeds, change to a finer grade of glasspaper, and finish with very fine. In order to get a good surface on the paint, it is essential to have the wood absolutely smooth. Paint will not cover up rough work, so make a good job of the glasspapering.



During the final stages of shaping the outside, the transom will have to be cut off to the correct profile and curvature. This can be done in part with a fine saw, and a rasp and glasspaper will also come into play.

When the outside is shaped, the keel will have to be made and fixed. The shape is taken from the sheer plan and the upper edge is checked by offering to the hull itself, allowing for the ⅛in. which the keel is to be let into the hull. When the keel has been shaped from ½in. oak, the groove for it has to be cut in the bottom of the hull. The centreline, that has been preserved, will be essential for marking this out. The groove must be ⅛in. deep, and will have to be carved out with a narrow chisel. The keel is glued in position. Care must, of course, be taken to get the keel absolutely perpendicular as well as on the centreline of the boat. This can be checked by chocking the boat up square using a spirit level, and then checking the keel with a plumb bob.

Having finished the outside, the next step is to cut the upper edge (Sheer) to its proper shape as given on the profile plan. By the way, *Fig.* 1 does not show the Sheer all the way along, as it runs very close to the top of layer *B* for some distance, and would not have reproduced on a small scale.

Unscrew the boat from the bench and take off the two pieces of wood. Take a piece of spare wood ¾in. thick and cut a rough cradle for the forward end of the boat. Screw to one end of the table or bench so as to hold the boat alongside the edge of the table top but about ½in. clear of it. The stern of the boat can be supported by one of the pieces of wood taken off the gunwales. Pad the cradle, piece of wood and the edge of the table itself with pieces of old cloth to obviate damaging the wood. The two supports should be arranged so that the boat is approximately level.

The line for the sheer has, however, to be marked before it can be cut. The station lines have all disappeared on the outside of the boat, but are still visible on the inside and top. Produce these a few inches down the outside, using a T-square. Measure the height of the sheer from a convenient waterline at each section, and spot onto the side. The joints between the layers, of course, represent the waterlines, that between layers *E* and *F* representing the Load Water Line (L.W.L.). A line now has to be drawn through the spots, using the flexible batten. The other side is marked in similar fashion.

Place the boat in the cradle and lash down at the after end, using stout, soft string or tape, but being careful not to mark the wood. Cut the wood down to just above the marked line with a paring chisel. By working from the bow aft you will avoid any chance of splitting. Shift the lashings to the bow and trim the after part of the sheer.

The sheer is the most prominent line in the boat, so great care should be taken to get a fair graceful curve without humps or hollows. Stand back from the boat and look at it from several points during the final part of the shaping of the sheer. To finish off the sheer, wrap a piece of medium glass-paper round one end of a piece of stick long enough to go right across the boat. Rest the spare end on the opposite gunwale during rubbing down. This ensures the top of the gunwale being level.

While the sheer is being cut, the builder should attend to the top of the transom, which should also be a graceful curve.

The inside of the boat has now to be hollowed out. For this purpose a spoon gouge of fairly flat section about ⅜in. wide is needed. This kind of gouge has a bent blade so that

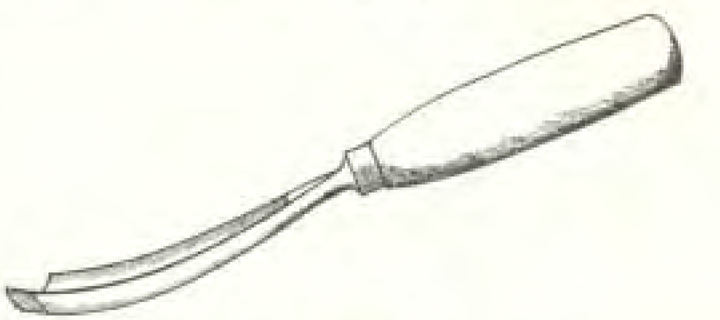


*Fig.* 4—A SPOON GOUGE.

it scoops the wood out (*see Fig.* 4). Another useful tool for carving the inside of a boat is a small round-bottomed plane with the sole curved fore-and-aft as well as from side to side. This is not absolutely essential, but lightens the work and assists the builder to get a nice finish on the inside of the boat. The spoon gouge is a carver's or pattern-maker's tool, and the little plane is a violin-maker's tool, and is often called a fiddle-plane. It may be necessary to go to one of the bigger toolshops for these tools, but the local ironmonger *can* get them for you if he takes the trouble.

When you are carving, the grooves will prove an invaluable guide, and there should be no excuse for going through the side of the boat. If you do have an accident, however, the best way is to cut a piece out of the complete layer, glue a fresh block of wood in, and fair to the surrounding surfaces. Do not forget to leave the extra thickness round the gunwale (*see Fig.* 2) as this is needed to provide a shelf for the deck to rest on.



Finish the inside with glasspaper wrapped round a cork. If the fiddle-plane has been used you should be able to get as good a finish here as on the outside.

The bulwarks can now be put on. To do this cut the recesses in the sides, as shown in *Figs.* 1 *and* 2. The bulwarks are ⅛in. wood, and, as will be seen, have a capping on top. The capping had better be mahogany, and can be put on later. It will be seen that the deck is dropped in flush into a chamber cut for it, and this should be cut out before the bulwarks are put on.

The bulwarks are glued in position and screwed with No. 0 x ⅛in. brass screws. When the capping is put on, it will be glued and pinned with tiny brass or copper pins.

At this point the builder should check the beam to make sure that the boat has not sprung during the process of carving. If she is not absolutely correct, the sides should be brought back gently to the correct beam. In any case, two pieces of wood, about 1in. wide by ⅜in. thick, should be screwed across the gunwales to act as temporary deckbeams and keep the boat in shape until the permanent beams are fitted.

It is impossible to make a satisfactory glued joint with casein (or, in fact, any other) glue, if the surfaces of the wood have been painted or varnished. No bare surfaces of wood should be left in contact, but unless they are actually glued, such surfaces should be varnished or painted. Similarly wood should always be protected in the way of metal fittings, which should be bedded down on luting or varnish. The usual luting consists of either a mixture of red (or white) lead and varnish (or gold size).

Now in order to provide the necessary swelling of the sternpost in the way of the propeller shaft, it will be necessary to glue two pieces of wood on either side of the sternpost. In fact, these will extend across the after-deadwood to the hull, so all paint must be kept clear of this part of the boat until this has been done. Unfortunately it will be impossible to determine the exact shaft line until the plant has been purchased and placed temporarily in the hull, so this is best left until a little later in the proceedings.

In a similar way it will not be possible to paint or varnish the inside of the hull until the engine bearers are in position, unless we decide to bed the bearers down in varnish instead of gluing them, but on the whole it will be found more satisfactory to glue.

## CHAPTER III.

*Some Notes on Naval Architecture—Why a Vessel floats upright—Selection of a suitable Motor or Engine.*

HAVING finished carving the hull, the next step is to check its weight. If the designer has given a table of weights (as in the case of "Brunhilde") this will be of great assistance to the builder, but if not, he will have to estimate matters for himself, and get out an approximate schedule of weights. This should be pinned on the workshop wall, and as each successive part is completed, its actual weight should be noted. In this way the builder can see how he stands, and any excess in one direction can be corrected by cutting down weight in another. One item the beginner invariably under-estimates is the weight of paint and varnish used on a model.

The designer of "Brunhilde" has allowed 4 lb. for her bare hull and, if nice light pine has been used, it should come out at about this figure. If it is much too heavy, it is probable that additional wood can be carved from the inside, particularly in parts where there is little danger of weakening the hull unduly. A little extra weight in the bottom is not a serious matter, however, as this is practically ballast, and the designer has allowed a full 8 lb. for plant and ballast.

Having checked the weight of the hull and decided that there is no more to come out of the inside, tape ribs can be glued in.

As a matter of fact, joints made with casein glue are stronger than the actual wood, and the object of tape ribs is to guard against splits between joints rather than breakage of the joints themselves. In the case of the bulwarks screws were used as well as glue, but the object of these was to keep the surfaces of the joint together until the glue had set properly rather than afford additional strength afterwards.

To make tape ribs, use strong, pure linen tape $\frac{1}{2}$in. wide, and glue inside the boat from gunwale to gunwale. Put a tape rib about every 6in., spacing evenly throughout the boat.

Except for fixing the engine bearers, boring the hole for the stern tubs, and one or two other little things, the hull itself is now complete. Most of these cannot be attended to until the plant has been purchased.



It will assist the novice in the selection of his plant if a few simple facts of naval architecture are detailed. The most important point of all is the question of trim and stability.

As was stated earlier in this book, a vessel floating in water displaces a volume of water having a weight equivalent to its own weight. The two main forces acting on a vessel's hull are buoyancy and gravity. Buoyancy can be considered as a supporting force acting upwards. The Centre of Buoyancy is the centre of the mass of water displaced by the hull, and the force of buoyancy can be considered as an upward thrust acting through the C.B. Gravity can be considered as a depressing force acting downward through the Centre of Gravity.

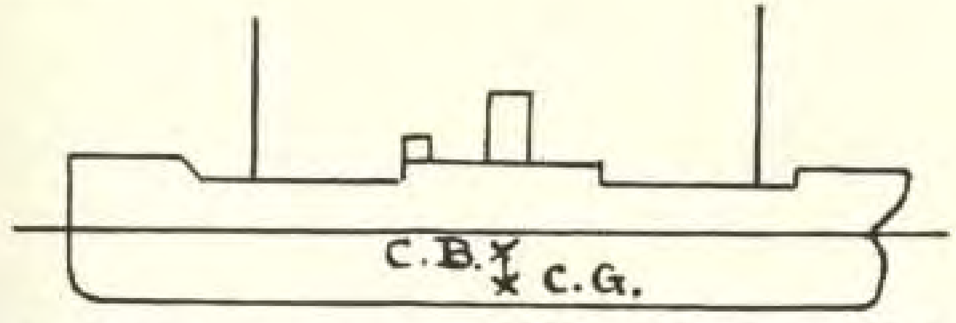



Fig. 5a. On her correct trim with C.G. and C.B. in same vertical plane.

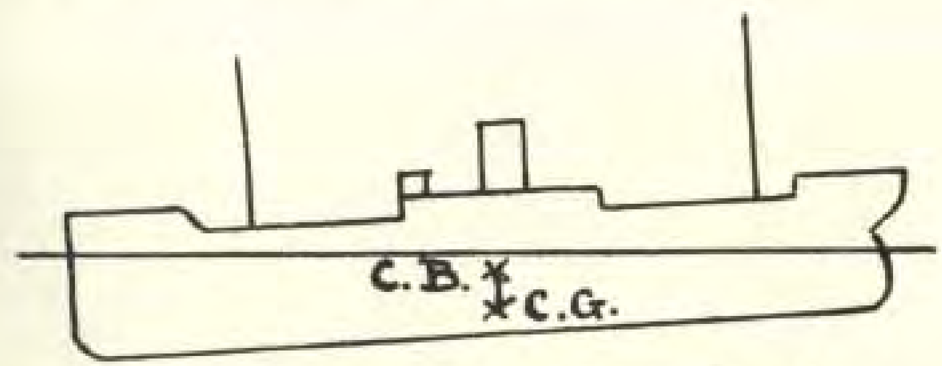



Fig. 5b. What happens when C.G. moves forward.

When a vessel is floating the forces of buoyancy and gravity equalise each other when the ship is at her line of flotation. If additional weight is put aboard the force of gravity is increased and the vessel sinks further into the water until the point is reached when buoyancy and gravity are again equal. Therefore in order that a model shall float at the waterline intended by her designer, she must weigh neither more nor less than the figure given.

The fore-and-aft trim of a vessel depends entirely on the relative positions of the C.B. and C.G. The C.G. has a tendency to place itself in the same vertical line as the C.B. Thus if the C.G. is forward of the C.B., the vessel will trim by the head to a point when the C.G. is in the same vertical line as the C.B. (*see Fig.* 5). It is, therefore, very important for the builder to get the C.G. in the same fore-and-aft position as shown for the C.B. on the design. This is not a very difficult matter, however, in a model which can easily be balanced to find the relative positions of the various weights.

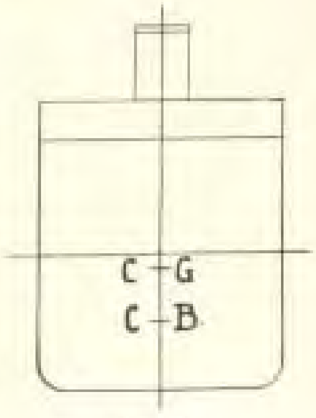



*Fig.* 6.

In a somewhat similar manner the ability of a vessel to right herself depends entirely on the relative positions of the C.B. and C.G. In a sailing vessel the C.G. is always placed below the C.B. to give a powerful righting moment and thus enable the vessel to carry her canvas. In a steamer which has not the steadying influence of sails, the vessel is apt to have a jerky motion if the C.G. is too low. In order to get an easier motion the C.G. is placed higher than in a sailer, but in some steamers the C.G. has been placed dangerously high and actual losses have resulted from this. In the case of a model the comfort of passengers has not to be considered, and it is desirable for the boat to have an ample margin of stability, so the weights should always be as low as possible, and preferably the C.G. should be well below the C.B. The reason why a vessel capsizes can easily be understood.


*Fig.* 7.

When a vessel is upright both C.B. and C.G. are on the centreline, as shown in *Fig.* 6. When she heels a part of the underbody is lifted out of the water on the windward side and a corresponding piece of the topsides is submerged on the leeward side. The submerged shape alters accordingly, and the C.B. moves to leeward.

In *Fig.* 7 the same vessel is shown heeling. The force of buoyancy acts vertically upward through the point B which represents the C.B. The force of gravity is acting downward through *G*, the C.G. It will be seen that both Buoyancy and Gravity are working together to cause the vessel to right herself.

In *Fig.* 8 it is assumed that the vessel has a light cargo below hatches and a heavy cargo on deck so that her C.G.



has risen to *G*. In this case it will be seen that the forces of Buoyancy and Gravity are again working in unison but this time to capsize the vessel.

A vessel is said to be in stable equilibrium when she has a tendency to right herself, and in unstable equilibrium when she has a tendency to capsize. It will be seen from the diagrams that a vessel is in unstable equilibrium when she is heeled to a point that the C.G. is to leeward of the C.B. The higher the C.G. is, the sooner is this point reached. While these matters form the subject of much elaborate calculation in the case of a full-sized vessel, it is not advisable for the modeller to cut matters fine in this respect, and an ample margin of stability will always be assured if the C.G. is kept below the C.B., and in fact all heavy weights should be kept as low as possible in the boat.

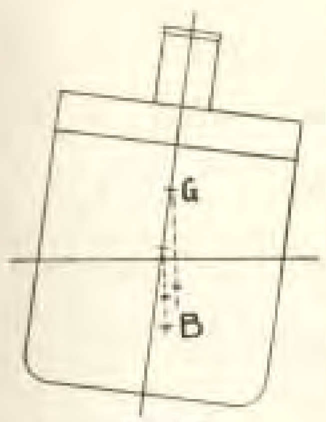



*Fig.* 8.

This is very important in the early stages of the model's construction as it is surprising how tophamper alters a boat's trim and detracts from her stability. This is, of course, quite understandable when one considers the leverage of weight aloft. It is, therefore, essential to put all weights in the bottom of the boat.

From these facts it will be seen that one of the great points to consider in the selection of a plant is the height of its C.G. The second point is its power output. For a model of a prototype vessel this must be adequate but not too great. Prototype models entirely lose their effect if overdriven, and far more models are spoilt this way than by being under-powered.

Actually the hulls of vessels are designed in consideration of the speed at which they are intended to travel. Once this speed is exceeded they cease to run well and make a tremendous fuss in going through the water. Thus a tug's hull is of an entirely different shape to that of a destroyer, yet one on occasion sees model tugs that are being driven at speeds that would not disgrace a model destroyer with the result that any pretence at realism is lost and the model simply looks ridiculous.

The deciding factor in the amount of power required for any given model is the speed at which she ought to be driven to give her scale speed. The nautical unit of speed is the knot, and if we say that a vessel's speed is 15 knots, we mean that her speed is 15 nautical miles per hour. In passing it may be mentioned that one never speaks of "knots per hour," nor of a place as being so many knots distant. Knot simply means nautical miles per hour and is only used in connection with speed. The nautical mile is 6,080 feet as against the landsman's 1,760 yards (5,280ft.), but as most of my readers are used to the land mile I will speak of speed in terms of land miles per hour.

In considering the scale speed, or relative speed of vessels of different sizes, the basis of comparison is their length, and the speed-length ratio.

The speed-length ratio is :—

M.P.H. divided by the square root of the length.

The design of "Brunhilde" represents a yacht of 100ft. to 120ft. long, let us call this 100ft., and she would have a speed of about 18 m.p.h. at the outside. The square root of 100 is 10, so her speed-length ratio would be 18/10ths or 1.8.

To get the relative scale speed for the model we want the square root (in feet) of her length. The length is 40in., and for an approximate calculation let us call this 4ft., so the square root is 2. Her exact scale speed would, therefore, be 1.8 multiplied by 2 = 3.6 m.p.h. This hull being specially designed for a model will, however, stand being over-driven and she would not lose her appearance up to about $4\frac{1}{2}$ or even 5 m.p.h.

There are three forms of propulsion that can be used for a model of a prototype craft. These are electricity, petrol and steam.

If the modeller's main interest lies in the hull of the vessel and her fittings, it is possible that, for his first boat at all events, he may select an electric motor. Electric motors have the advantage of being very clean but their scope is limited by the capacity of the accumulators. The motor itself is light but the accumulators are decidedly heavy, but the whole plant has the further advantage of concentrating the weight low in the boat which, of course, makes for great stability.

There are a number of suitable plants of this nature on the market. Of its kind Messrs. Bassett, Lowke's "Nautilus" Motor can be recommended, and is made in a number of sizes to suit different sizes of boats.

There is little to be said about the installation of an electric plant except that it should be carefully protected from water and that the controls should be arranged in an accessible position on deck. Sections of the deck and upper works will have to be made to lift off to permit access to the motor and accumulators. As with any other plant, the various weights must be arranged in such a manner that the fore-and-aft position of the Centre of Gravity of the complete vessel comes in the position indicated by the designer on the plans. This is important as otherwise the vessel will trim by the head or by the stern, and, besides looking unsightly, this is very detrimental to good running.



One point that the modeller must not overlook is that if he chooses a petrol engine, he must allow for the weight of the petrol. Similarly in a steam plant he must allow for the water in the boiler as well as the fuel.

If a petrol motor is installed, this must be water-cooled, as in a prototype model the upper works make it impossible for air cooling. A further point is that unless the motor is arranged to lie down in the boat, it is too high for most prototype models. Though it may be possible to instal it in a position where the cylinder head is under a high part of the superstructure, this in itself does not get over the real difficulty which is the amount of weight high in the boat. This, of course, raises the Centre of Gravity of the whole vessel and is liable to impair her stability and render her excessively tender (liable to capsize).

There are a number of 15 c.c. engines on the market, but at the time of writing none of these has been put out as standard with water-cooling. There are water-cooled 30 c.c. engines to be had, but this size of engine develops *far* too much power for a metre or 40in. model. In fact it is difficult to tame one of them down sufficiently to give satisfactory results in a 6-footer, and their proper sphere is the racing hydroplane.

Even a 15 c.c. engine is decidedly too powerful for a 40in. prototype model such as the yacht whose building has been described in the preceding chapters, and probably 10 c.c. would be ample.

From the foregoing it will be apparent that the writer is not particularly partial to electric plants. Petrol engines are decidedly more attractive, but have their disadvantages. Chief amongst these is their high Centre of Gravity which must be considered in relation to the total stability of the model. Internal combustion engines for prototype models are a totally different proposition to those for speedboats, as in the latter the sole object is to get the greatest possible power from a limited cylinder capacity. For a prototype model, a petrol engine must be water-cooled; it must be flexible and silent, easy to start and reliable. This means lower compression ratios, different valve timings, etc. If the builder decides on a petrol engine, he must make certain that it is suitable for the boat and the work it has to do.

For prototype models the writer favours a steam plant. This is far more interesting to run than an electric plant and possesses many desirable qualities that are absent from a petrol plant. Chief amongst these are silence, great flexibility and smooth running. Great reliability is also a characteristic of steam plants.

There are a number of suitable plants on the market which can be bought in all stages of finish from the rough castings to completed engines all ready for installation. Whether the builder buys his engine completed or not will largely depend on the toolkit available and the amount of work he wishes to put into this part of his craft.

If unmachined castings are purchased a lathe is essential, but sets of machined castings are available for certain engines. Many of the smaller engines, however, are only available finished, but most of these are very reliable and quite reasonable in price.

## CHAPTER IV.

### *Steam Engines for Models—General Hints on Building an Engine from Parts.*

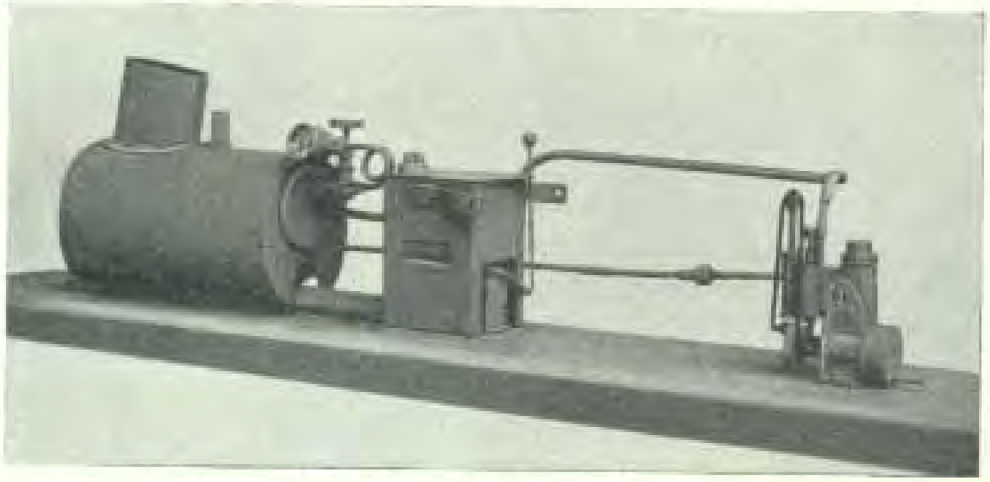
STEAM engines are either single-acting or double-acting. Of these, the former have a power impulse on the down stroke only, but the latter have power impulses on both down and up strokes, the steam being admitted above and below the piston alternately. If there are several cylinders the impulses are arranged to take place in rotation, so that a single-acting twin-cylinder engine would give much the same effect as a double-acting single.

There is, however, one essential difference in the characters of single- and double-acting engines. The single-acting engine is at its best when turning over fast. In consequence it may be desirable to gear down considerably, particularly if using a biggish propeller in a comparatively slow type of model such as a tug or trawler. On the other hand a double-acting engine will have plenty of punch at lower speeds and direct drive can usually be employed.

A small digression may be pardoned at this point. Some of the earliest steamships were paddlers with single-cylinder beam engines. The single-cylinder engines of early vessels were found very extravagant in the use of steam, and this led to the development of the compound marine engine, in which the exhaust steam from the small high-pressure cylinder was used over again at lower pressure in a large low-pressure cylinder. This was carried further in the form of triple and even quadruple expansion engines. The latest ships are in most cases driven by turbines which may be geared down or occasionally used in conjunction with dynamos and motors in turbo-electric machinery.

Modellers who are capable of building compound, triple or quadruple expansion engines are few and far between, and I do not expect any of these will be numbered amongst the readers of this little handbook. Miniature turbine machinery is also beyond all but the most skilled craftsmen. In actual practice the average modeller, for whom this book is written, will be well advised to select a simple single or twin engine of suitable size as this will give every satisfaction in use and make a good, sound, practical job for a prototype model.

When choosing an engine, the main points to remember are the size of the boat, the power of the plant, its weight and the position of its Centre of Gravity. The size and weight of the boat of course governs the amount of power required. When considering the weight of a steam plant, the normal weight of water and fuel carried must also be taken into consideration. So also must be certain necessary fitments. The main of these are water and pressure gauges for the boiler, water pump and lubrication arrangements. There are many other additional refinements that can be added, but it should be remembered that these all add to the total weight of the vessel. If the builder is within the limits he can advantageously add additional features, but if he is liable to exceed the



THE BASSETT-LOWKE No. 94 ENGINE.
Complete with Boiler and Lamp.

total designed weight, he is advised to omit all superfluous gadgets. If weight is added without thought the builder may make his model so heavy that she floats like a half-tide rock instead of being on her correct designed waterline.

In prototype boats it is an important point in favour of any engine if its internal parts are made of non-rusting materials. At the same time many plants with cast-iron cylinders give excellent service provided their owners take the precaution to flood them with oil after running. Gunmetal cylinders will not stand the heat of flash steam but are excellent for use with the pot type of boiler. At the same time a slight amount of superheating is an advantage even with gunmetal cylinders as it dries the steam and makes for better running.

One advantage of selecting a well-known commercially-



produced engine is that spare parts are always available when required.

Steam is such an elastic motive power that any of these engines covers a considerable range of sizes of boats. The necessary variation in power is obtained by varying the steam pressure at which they are worked. The owner must, therefore, have a suitable boiler as well as a suitable engine, and the lamp and main steam cock must be adjusted to give a suitable steam pressure.

If a very small model, say, 24in. or 30in. overall is contemplated, the only engines available are the oscillating cylinder type with a pot boiler fired by a methylated spirit lamp. Although these little engines are often regarded as toys, in practice they can give good service in the little vessels they are intended for. Oscillating engines can be had either single- or double-acting, and are very cheap and light in weight.

A more elaborate installation is provided by Messrs. Bassett, Lowke's No. 94 engine, which has a fixed cylinder with piston valve and a banjo connecting rod. This is a decidedly unorthodox design but is cleverly thought out. The valve timing is arranged in such a manner that the engine is extremely economical in steam. It is well made of non-rusting materials, and can be relied on to give good results. The engine is light and has a low Centre of Gravity, both of which are strong points in its favour. It is made in several types and is suitable for boats from 24in. to 36in. long according to their weight and design. This engine has a very long stroke. It can be obtained separately or complete with a specially-designed boiler and methylated spirit lamp with automatic feed.

When it comes to bigger engines the Stuart range are as good as any. Of these the "Meteor" is an excellent little engine of $\frac{7}{16}$in. bore and stroke. It is non-rusting as regards its internal parts, and is fitted with a piston valve. It is suited to boats up to about 36in. overall provided the displacement is moderately light.

The Stuart "Star" is a twin-cylinder, single-acting, vertical engine of $\frac{5}{8}$in. bore and stroke. It is a totally enclosed engine, fitted with piston valve and displacement lubricator. It is suitable for boats up to about 48in. overall, and is a fast-running engine.

The Stuart "Sun" is a similar engine, but a size bigger, being $\frac{3}{4}$in. bore and stroke. This is a good engine for hard work in big boats, but is more suitable for dry steam, as it has cast-iron cylinders.

Another powerful engine is the Stuart "Double 10," which is suitable for big, hefty models up to about 7ft. overall.

There are a number of other engines on the market, but the above have been mentioned as they are well-tried and popular patterns that are stocked by almost every model supplier.

For such a craft as the yacht "Brunhilde" or any similar model of about 40in. overall, a very suitable engine would be either a "Meteor" or a "Star."

Smaller engines are mostly sold in a finished state, but when one gets to about a $\frac{3}{4}$in. x $\frac{3}{4}$in. engine, these are supplied in any stage from rough castings to a finished engine. If the builder wishes to start with the rough castings, he must have access to a suitable lathe.

THE STUART "METEOR" ENGINE.

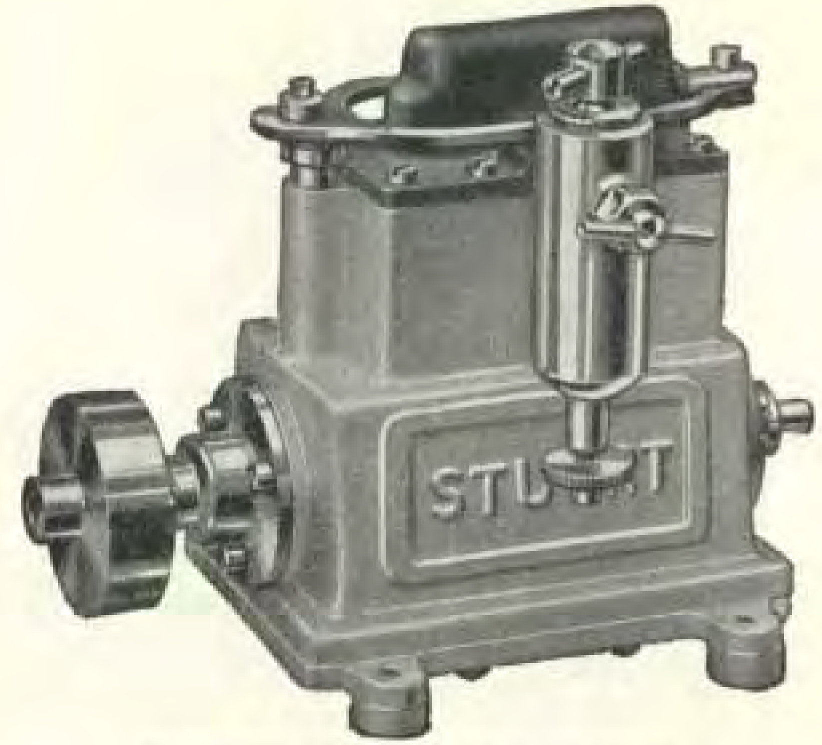
Before the cylinders can be bored out the worker will have to decide how the casting is to be held in the lathe, and this will largely depend on the design of the engine. If it is a single-cylinder job with a convenient valve chest on the side presenting a flat surface, the cylinder casting can be bolted to the face-plate of the lathe by means of an angle plate. In the case of a mono-block twin engine, such as the Stuart "Sun," the flat base of the casting can go against the face-plate, and the whole be clamped firmly in position. In the case of this engine, the block can be slid across the face-plate to deal with the second cylinder, after the first is finished. If further holes, parallel to the cylinders, are required, such as those for valve spindles, they should be drilled immediately afterwards.

Whatever type of cylinder is being dealt with, the first step is obviously to face off the part of the casting that is being used to work from. This facing off is preferably done in the lathe, although the surface could be filed down. In the latter case a sheet of plate-glass can be used as a surface plate. If a little colouring matter, such as red lead and oil or prussian blue, is *thinly* smeared on the surface plate, it will at once reveal any high spots. The colouring matter must



be very thinly spread or it will touch everywhere and impair the value of the test.

In clamping to the face-plate for boring, a piece of paper should be put under the casting. This will obviate slipping, and to a certain extent protect the metal. The casting should be mounted as nearly as possible concentric, but the worker must not expect a rough casting to be dead true. It will assist the centring in the case of a twin mono-block casting if, before mounting, the cylinders are plugged with wood; a longitudinal line and cross-lines can then be scribed to show the centres of the cylinders. Before starting to bore, a careful




THE STUART "STAR" ENGINE.

inspection should be made not only at the front but at the back end of the cylinder also, to ensure the casting running reasonably true to the axis of the lathe.

The castings supplied by model specialists are invariably metal that machines nicely, but there is no guarantee of this being the case if ordinary foundry castings are employed. The machining of the cylinders should, therefore, not present much difficulty once the work has been set up. If the top slide is being used, care will, of course, be taken that the bore is parallel. The final cut should be very light, and made with a sharp tool.

Before removing the casting from the lathe, face off the top. If the other end requires facing off, turn up a mandrel to fit the cylinder and finish the end of it as required.

The ports have next to be cut and the amateur will probably find the most convenient way is to use a little end mill mounted in the chuck. The steam passages have to be drilled out, and here the worker has to rely on his eye, so care should be taken. The cylinder wall will have to be cut away to a certain extent so that the cover does not close the orifice. The passages should not be too small or they will stop a proper flow of steam.

The exhaust passage has also to be drilled, and if there is a choice the builder should consider which side of the engine is more convenient.

As these instructions are more or less general, and intended to cover any type of engine, the builder will have to be guided mainly by the instructions and blue prints supplied by the makers, so that anything said here must be regarded as supplementary and intended simply to clear up any difficulties that may arise.

The cylinder bore is finished by lapping. The easiest way to do this is to make a lead stick. Take some scrap lead and melt up. Find a short piece of tube a size bigger than the cylinder bore and three times the length. Use this as a mould to cast the lead stick, but be sure the tube is dry inside as moisture causes molten lead to spit dangerously. The lead is mounted in the lathe and turned down until it is just a fit for the cylinder. There is no difficulty about this if a sharp tool is used and kept lubricated. The lead should be finished to a good surface.

The lead is left in the lathe and smeared with flour emery and oil. The cylinder is held in the hand and run up and down on the lap until the desired finish is attained. When the lapping is finished, great care must be taken to eliminate every particle of abrasive.

If piston rings are being used, this lapped finish is all that is required, but if a packed piston is being used, a final finish has to be given. This is done with what is known as "French Paper," obtained from watchmakers' suppliers. This is really an extremely fine grade of emery paper many times finer than flour emery, and it leaves a surface like polished glass. The French paper is wrapped round a wood mandrel during the polishing.

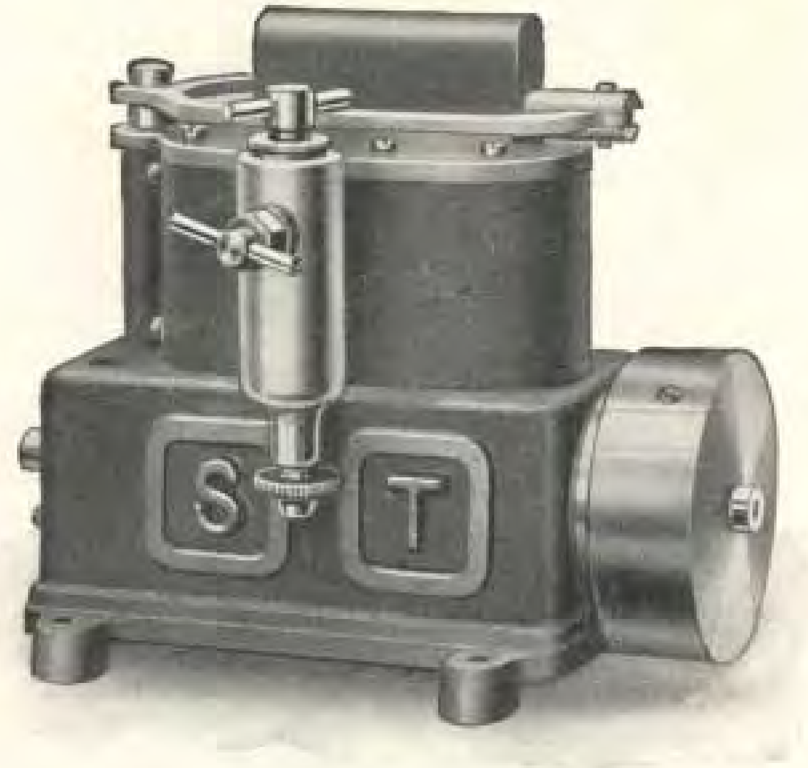
The pistons must be a good fit and it is useless to rely on the packing making good defects in this respect. The packing should be regarded as a supplementary measure to stop the steam blowing past.



In the same way cylinder covers, valve chests, etc., should be faced off properly and reliance not placed on gaskets to make steam-tight joints. If this is done, very thin packings can be used and there is no need to set everything down excessively hard.

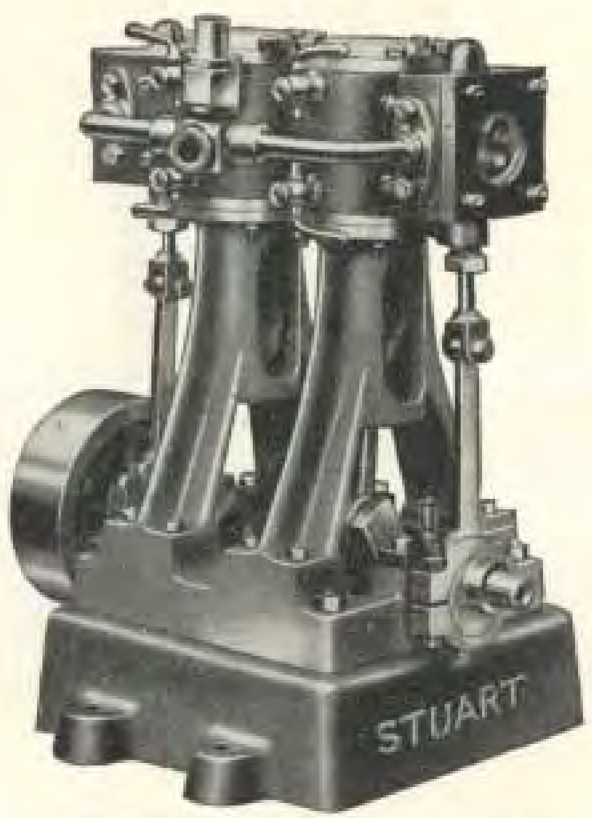
Care must be taken in lining up piston guides with the cylinder. The crankshaft must also be dead square. If these points are not attended to, the engine can never run smoothly.

Returning to the question of fitting pistons, it will be apparent that if the piston rod is the slightest bit off centre in the piston, the engine will not run true, as the piston will




THE STUART "SUN" ENGINE.

press on one wall of the cylinder. The way to get over this difficulty is to cut the piston rod to length, allowing for the screwed ends which go into the piston and crosshead respectively. Shoulder and screw both ends. Centre one end with a Slocombe drill or graver. The middle of the rod must be left oversize. Remove the piston rod from the chuck and mount the phosphor-bronze rod (or whatever material is being used) for the piston. Sufficient metal must be left projecting from the chuck to permit the piston to be turned up. Turn the piston to the correct diameter, which can be checked by offering the cylinder to it as the work progresses. Next turn the packing grooves, and face off the bottom. Centre, drill and tap the hole for the piston rod. Screw this home and support the other end on the back centre. The piston rod is now turned down to size. The back centre can be pushed back from time to time and the size tested against the hole in the bottom cover. Finally part off the piston. This method will ensure the piston and piston rod being truly concentric. In order to screw the piston rod into the crosshead it will be necessary to either put a slot for a screwdriver, or two little holes to take a two-prong key, in the top of the piston itself.




THE STUART "DOUBLE 10" ENGINE.

In the case of a twin engine with the cranks set at 180°, the two pistons should be of the same weight. Likewise the two connecting rods should be of equal weight. As the two cranks are set at 180° this will balance the engine and ensure even running.

Crankshafts as supplied with sets of parts are usually forgings, though they can be built up as described later in this book in the Chapter dealing with Engines for a Model Paddle Steamer. If a forging has to be machined up, it will prove one of the most difficult parts for the model builder to tackle.



The crankpins have to be truly parallel with the shaft, and in the case of a single this means two settings in the lathe, and three settings for a twin.

Some forgings for crankshafts are supplied with pieces of metal at either end to act as temporary end plates during machining. If these end plates are not supplied, it will be necessary to fit them. The centres for turning the shaft and crankpin must be carefully marked on the end plates according to the designed throw of the cranks. As the crankshaft is slender in proportion to its length, it is desirable to support it with packing pieces. If these are used care should be taken not to ram these in so tight that they bend the shaft, or the cure will prove worse than the disease. Owing to the variety of crankshaft patterns it is impossible to give exact instructions and the builder will have to be guided by circumstances. With some patterns it is almost impossible to use packing pieces, and in any case the shaft should be turned down with light cuts. It is no good trying to hurry this job, and the builder must go carefully throughout.

The alignment of bearings is even more important than their actual fit on the shaft. Many commercial designs of engines do not provide for bushes on the crankshaft bearings, but in some cases it is a very simple matter to alter the design to take these. If bushes are being fitted the crankshaft is left slightly thicker in the way of the bushes. The fitting of bushes must be considered as a little refinement that is well worth while. If plain journals are used there is no provision for wear and after a time the shaft must get more or less out of alignment whereas it is an easy matter to slip in a new bush and thus compensate for this. The best materials for bushes are either phosphor-bronze or gunmetal, but a brass bush will give good service if lubricated properly.

It is impossible to give comprehensive instructions that will cover the machining and assembly of every different pattern of engine. The builder will, therefore, have to rely largely on the blue prints and instructions issued by the makers of the castings. The above hints will, however, serve to point out some of the pitfalls and difficulties of the job, and will supplement the particular instructions given with the sets of castings.

## CHAPTER V

*Selecting a boiler—Finding position for plant—Stern-tubes and Tail-shafts—Propellers.*

HAVING decided on the engine, the next consideration is the boiler. Whatever the size or cost of the engine, it is essential to have a good boiler, as a cheap, badly-made boiler can be decidedly dangerous.

Brass boilers are not to be recommended, as this metal has a propensity to disintegrate, and a copper boiler should be selected. Any boiler that depends solely on soft-soldering is liable to explode, and no reputable firm would sell one. Riveted boilers are often soft-soldered, but in this case the soft-soldering serves the purpose of caulking and the rivets hold the boiler together. For preference, however, boilers should be either brazed or silver-soldered.

Model boilers made by good firms are tested to pressures far in excess of what they are likely to be run at, so that the builder need have no fears about any boiler purchased from reputable sources. A good boiler is, however, fairly expensive, so the modeller must expect to pay a good price for this item of his vessel's outfit.

The most important thing about a boiler for marine use is the height of the centre of gravity, which should be as low as possible. There are two main types suitable for our work—the centre-flue marine boiler and the drum boiler with external tubes. There are a number of slight variations of these types but really they can all be classified under one or other of these headings. Of these, the centre-flue has the lower centre of gravity, but the drum-type is faster steaming.

Provided the builder can afford the weight, it is better to have too large a boiler rather than one on the small side, as it is easy to cut down the steam in a big boiler, but impossible to maintain steam pressure in a boiler that is not large enough for its work.

A boiler with a steam dome has its advantages, provided there is sufficient height for its installation. The dome safeguards the engine from feeling the effects of the water surging. This is particularly prone to make itself felt as the result of starting and stopping when the sudden jerk causes the water in the boiler to surge violently, with a result that it gets into the steampipe. Many boilers have baffle plates to obviate the effects of surging, but the provision of a dome ensures



a supply of dry steam. In any case the steam should be taken from the centre rather than the end of the boiler.

The suppliers of the engine will always be pleased to advise the builder as to a suitable boiler and lamp for the installation. It is impossible to give a complete table of engines, boilers and lamps here, as so much depends on the design and size of the boat, but if the builder will take the trouble to study the engine-makers' catalogues he should have no great difficulty in selecting a suitable plant for any boat he wishes to build.

Messrs. Stuart Turner, Ltd., makers of the Stuart range of engines, recommend the Twin-Drum Minor for use with their Meteor engine, and the Twin-Drum Major for the Star

THE STUART "TWIN-DRUM MINOR" BOILER

engine. If it is desired to get greater power out of a Star engine, their No. 491 boiler can be used. This is of the centre-flue type, and will also steam the Sun engine.

This firm has two larger boilers, Nos. 492 and 493, which are of exactly similar type and appearance. Of these, No. 492 can be used when it is desired to get full power from a Sun engine, and No. 493 suits the powerful Double 10.

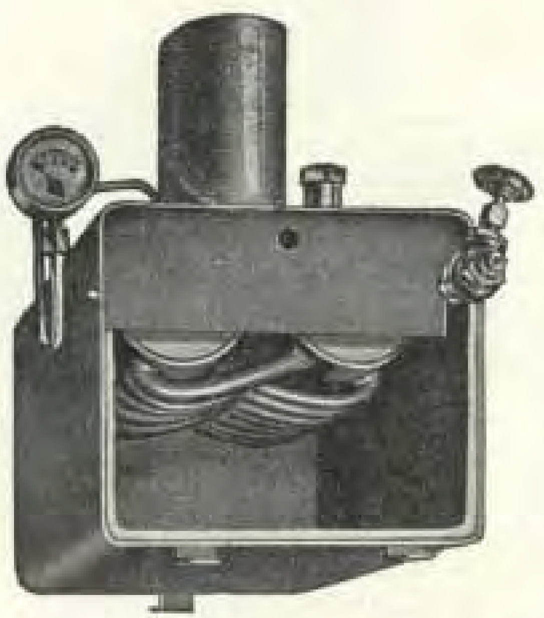
The Twin-Drum Minor boiler is made to be fired by a methylated spirit lamp, but with the Twin-Drum Major either a methylated spirit lamp or a small blowlamp can be used. The other boilers referred to are all fired with blowlamps.

There are other good boilers on the market, but the above are specially mentioned, as they are made by the makers of the engines I have mentioned, and specially adapted for use with them.

The Twin-Drum Minor and Major can be fitted with pressure gauges, but not with water gauges. In any case, the latter would not be reliable with such small drums. In both of these the containers of the spirit lamps and the contents of the boiler are arranged in conformity with each other, so that the lamp goes out just before the boiler is run dry. The bigger boilers are fitted with water gauges and can also be fitted with pressure gauges. All boilers are supplied with safety valves.

It is an advantage for any boiler to be fitted with a superheater as this ensures dry steam to the engine. The degree of superheat used is not excessive.

A useful boiler fitting is a hand force-pump for filling, and in many more elaborate boats a steam-operated pump is fitted as well. A blowdown cock for emptying the boiler is often fitted also.



THE STUART "TWIN-DRUM MAJOR" BOILER

One little point to observe about the main steam valve is that the stem is sufficiently long to enable it to be controlled from a convenient position, preferably on deck, so that the boat can be stopped without lifting part of the deck each time.

In the choice of an engine and boiler, the modeller should bear in mind what has already been said about selecting a plant to suit the boat, neither too powerful nor too small. It is also emphasised that steam is such a flexible motive power that the output of any given engine can be greatly varied by increasing or decreasing the steam pressure.

Either the Meteor or Star engines with a Twin-Drum Boiler would be quite suitable for the yacht "Brunhilde." A

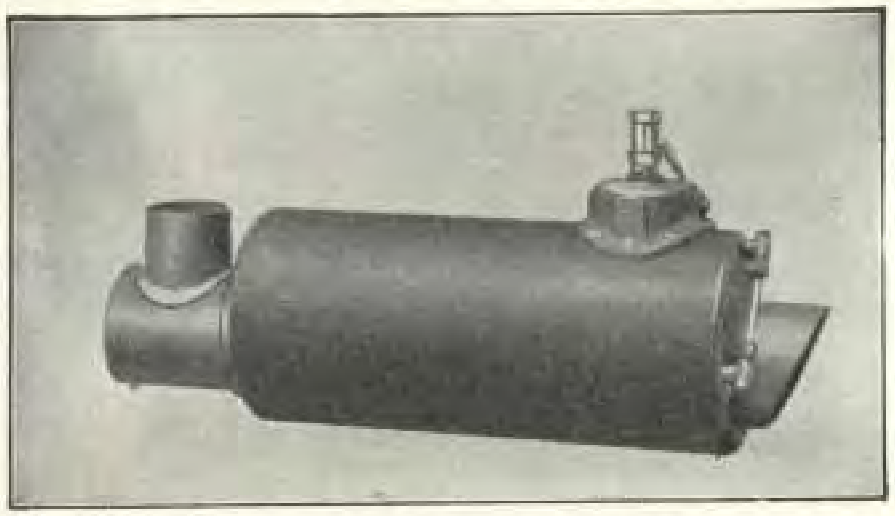


Star with a 491 Boiler would suit "Zingaro." In "Brunhilde" the Star would make the better outfit, of course, and this is shown in the installation plan given later in the chapter.

Blowlamps can be either petrol or paraffin burning, but the latter are more suitable for these prototype models. One point to observe is that the regulating valve has a sufficiently long spindle to be easily handled from deck like the steam-cock, and also that it is sufficiently insulated to save the operator's fingers.

Having selected the plant the next step is its installation. In a wooden hull it is possible that the bottom of the vessel is thick enough to dispense with engine bearers, but in a metal hull they have to be fitted.

Engine bearers run fore-and-aft and, when fitted, should be as long as possible to distribute the weight and stresses



THE STUART "491" BOILER

over the hull. They should preferably be oak if of wood, and, in a wooden hull, can be glued to the bottom and screwed through from the outside. In a metal hull wooden bearers should be well luted on the underside before being screwed into place from the outside of the hull.

It is advisable to get the engine as low as possible in the hull, but the flywheel should clear the bottom by a good ½in., otherwise the flywheel will churn up any bilge and throw it round the interior of the boat. There is always bilge in a boat from condensation, and a certain amount of oil is sure to drop.

The boiler should also be placed as low as possible in the hull, but when the engine is forward of the boiler it will be necessary to allow room for the shaft to pass underneath.

The fore-and-aft positions of the engine and boiler must now be given a practical test. The plans show the fore and aft position of the centre of gravity (C.G.) or centre of Buoyancy (C.B.), which coincide. Mark this on the outside of the hull. Fill the boiler and lamp container, and place the plant in its approximate position in the hull. Balance the boat on a piece of round rod, and shift the weights until the C.G. is as nearly as possible correct. Do not forget, however, that there is the tophamper to be considered, and make a little allowance for this. If the builder has managed to keep his weights below those given by the designer, he will have something in hand for trimming ballast.

In some designs it will be impossible to get the boat on her proper waterline without the use of trimming ballast, but there is one thing to remember, and, to explain this, I will instance the game of see-saw which most of us played as children.

Now the other little boys were not always the same weight as you were, so in order to get a balance you moved out or in on the plank. Put more scientifically, you adjusted the length of the lever arm until an exact counterbalance was obtained.

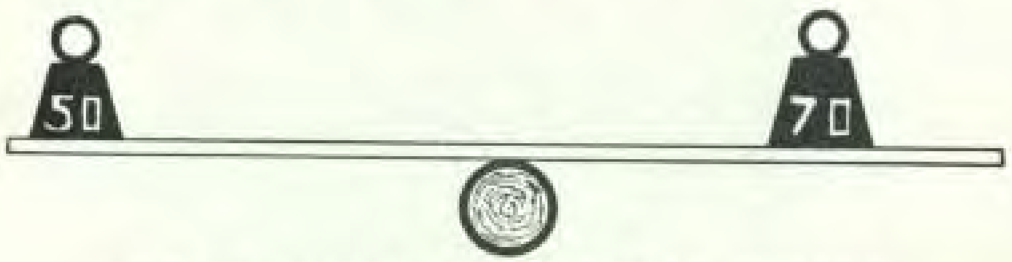



*Fig.* 9—THE PRINCIPLE OF BALANCE WEIGHTS

In Fig. 9 a plank balanced on a log is shown with two weights of 50 lb. and 70 lb. respectively, and the plank is 16ft. long. The 50 lb. weight is 7ft. from the fulcrum (or balancing point) and therefore exercises a force of 50 x 7 (=350) foot pounds. The 70 lb. weight is 5ft. from the fulcrum and, therefore, exercises a force of 70 x 5 (=350) foot pounds. In other words the two weights are arranged to balance exactly.

This principle is very useful in getting a boat on her proper fore-and-aft trim, as a very small weight put right up in the end of a boat serves to correct a much bigger weight that is only a little out of position. It may, therefore, be found that though it is impossible to dispose the plant to balance the boat just right, a very small weight added at one end will put matters to rights quite easily.

Having settled the position of the plant, make marks on the bearers showing the exact position of the holding-down screws. If the plant was never going to be removed from the boat, it would be satisfactory to hold it down with ordinary wood-screws. In practice, the wood at the screwholes becomes worn after the plant has been in and out of the boat a few times. The holes get enlarged and the wood soggy with water and oil until it is a matter of difficulty to get screws to bite properly. This can all be avoided if the builder will take the trouble to make holding-down studs. This is very easy. Cut little oblong brass plates with three screw holes. Take a small bolt and nut of suitable size, and solder the bolt, point upwards, into the middle hole on the plate. Recess the wood of the bearer for the head at the required position. Lute the wood well under the stud-plate, and screw into position with two wood-screws. The screws into the wood are never touched again, and the nuts keep the engine down. The stud is shown in Fig. 10.



By the way, all wood-screws used in boat work should be brass, and any pins or nails either brass or copper.

Before removing the plant from the boat the question of shaft-line should be considered. The position of the after-end is known, and the engine shaft can also be seen. It is desirable to immerse the propeller at least its radius (half the diameter) below the water. Put another way, the shaft should be at least the diameter of the propeller below the waterline. Further, it is desirable for the propeller to have its shaft as nearly as possible horizontal so that the thrust is forward, rather than forward and upward.

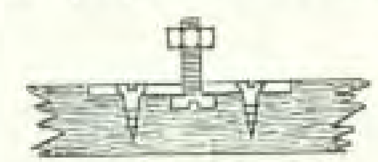


*Fig.* 10—FORM OF HOLDING-DOWN STUD FOR USE IN A WOODEN HULL

It will almost certainly be necessary to introduce a universal joint of some kind into the shaft line and possibly a floating shaft may be desirable.

For the benefit of those who do not know the term "floating shaft," I may mention that this is a shaft that is not supported by separate bearings. It acts as a connection between two other parts of the shaft, as, for instance, the engine shaft and the tail shaft. It is arranged to have a slight end-play, and thus counteracts undue rigidity. Although a thrust block should be introduced into the shaftline, the floating shaft acts as an additional precaution to prevent the propeller thrust being transmitted to the engine. It will, of course, be obvious that end-thrust on the engine is detrimental both to the running and life. A further advantage is the slight universal action obtainable through the couplings.

The modeller who has taken the trouble to make a full-sized profile drawing will be at an advantage at this point, as he can now plot his exact shaft-line. This should be carefully marked on both sides of the skeg or after-deadwood, and the position for the stern-tube can also be marked inside the hull.

The thickness of the skeg requires building up in the way of the stern-tube. Fix suitable strips of wood on each side, using casein glue, and cramp-up to dry. For a boat like "Brunhilde," these slips would be $\frac{3}{4}$in. wide by $\frac{1}{8}$in. thick. These are not carved to shape until after the stern-tube has been fitted. The shaft-line is marked on these to act as a guide when boring.

For making the hole for the stern-tube, a long boring bit is needed. These vary in pattern somewhat, but most of them have a screwed pip on the business end. This pip is apt to follow the grain of the wood and pull the hole off to one side, and, provided the hole is started with another bit, the tool works better without it. These bits are obtainable at most good toolshops, but if the worst comes to the worst and the builder cannot get one, he can (as a last resort), burn the hole through with a red-hot wire. It is by no means an easy job to get the hole through at exactly the correct angle, but the worker should pause frequently to sight his drill with the line. It is really best to start by putting an undersize pilot-hole through. The outer end must be a good fit in any case, and there should be no difficulty about the first inch or so. If the hole is out, it will have to be drawn over to the correct position at the inner end.

Propeller shafts and stern-tubes of various patterns are sold by model shops, but if the builder prefers to make his own, this can be very simply done. The best material for the shaft itself is rustless steel, and the size must be proportionate to the boat and plant. For a Star engine $\frac{3}{16}$in. would be ample. The stern-tube can be ordinary brass tube about twice the diameter of the shaft. This will give plenty of space for grease between the shaft and tube. The ends of the tube are fitted with bushes of suitable length, say, three to four times the diameter of the shaft, to form the bearings. The holes in the bushes must be carefully reamered out so that the shaft is just a free-running fit. They are placed on the shaft, which is passed through the tube. The bushes are then sweated into position in the ends of the tube, when the shaft should run freely. A greaser must be put into the tube at a suitable point just inside the hull. The space between the tube and the shaft is packed with grease by means of a grease-gun similar to that used for lubrication on motor cycles. Any good motor grease will answer the purpose and will act as an efficient seal,



and the tube should not require repacking with grease more than once or twice a season.

It will make a better job and ensure a watertight joint between the stern-tube and the hull if the tube is fitted with a brass plate or washer, just as is described for the rudder-tube later in this book. This, however, is not shown in the Installation Plan (*Fig.* 11).

Now for the actual fitting. After the stern-tube has been made and the plate soldered to it, if the hole has been enlarged at the upper end, it should be filled either with plastic wood or white lead filling. The wood round the hole and under the plate is well luted, and the stern-tube put permanently into position. The extra pieces that have been glued on the skeg can now be carved down to shape.

If twin-screws are being fitted, the positions for the holes and the shaft angles will be determined in a similar way. Here is a useful wrinkle for forming the skegs for twin-screws. Instead of carving the skeg out of a single piece of wood, use two pieces glued face to face. Cut two pieces of wood of half the thickness of the skeg to the required profile. On the inner faces of each mark and carve a groove to half the depth of the stern-tube. Glue and cramp-up, and leave to dry. Finally, carve the outside to shape. The skeg is fixed to the hull by gluing and screwing. Use four tiny screws for this purpose, staggering the screws clear of the glued joint in the skeg.

It may be mentioned that if the builder doubts his ability to bore the hole for his shaft on a single-screw craft reasonably correctly, the same procedure might be employed as that mentioned above for making the bosses on the hull (or skegs) for the twin-screws. The after-deadwood can be built up from two pieces glued face to face after the grooves for the stern-tube have been carved out with a gouge. The builder need have no fear about this making a strong job, since, as mentioned previously, a properly-made joint with this glue is actually stronger than the wood itself.

The majority of prototype craft have large propellers running at comparatively low speeds, and the model should do likewise in order to be true to type in appearance and performance. If the engine is of the light, fast-running type, this means a reduction gear. Similarly, gears can be used to enable two propellers to be driven off a single engine.

This in turn leads us to the consideration of suitable propellers. The propeller is directly related to the speed of a vessel and the work it is called on to perform. High-speed craft use small propellers driven at a high rate of revolutions, but these would be entirely out of place on a prototype craft for a number of reasons. The screw propeller works on the


*Fig.* 11—MACHINERY INSTALLATION, WATERTIGHT BULKHEAD CONSTRUCTION, STERN-TUBE AND RUDDER-TUBE

A—Deckbeams.
B—Bulkhead.
C—Fillet supporting Bulkhead.
D—Watertight Door faced sheet rubber.
E—Kingpost alongside door opening.
F—Half-beam under removable deck.
G—Ledge supporting Half-beam.
H—Main Steam Valve arranged to be accessible from deck.
K—Inner funnel fixed to Boiler Casing.
L—Safety Valve blowing off above deck.
M—Shaft Coupling.
N—Bracket supporting Boiler.

O—Journal Bearing for Floating Shaft.
P—Sleeve with liner on end of Floating Shaft.
Q—L-shaped Thrust Bracket.
R—Washer forming Thrust Block.
S—Fibre Thrust Washer.
T—Thrust Collar on Tail-Shaft.
U—Bearing in end of Stern-Tube.
V—Bracket supporting Boiler.
W—Stern-Tube with Tail-Shaft.
X—Greaser for Stern-Tube.
Y—Rudder-Tube.
Z—Fixing Plate for Rudder-Tube.



principle of drawing a stream of water from ahead of the boat, and projecting it astern. Directly the propeller is driven at too high a rate of revolutions for the forward movement of the vessel, the feed stream, drawn from ahead, becomes inadequate to supply the screw. The propeller is then in the position of sucking at a vacuum and cavitation occurs. This is, of course, when the propeller is working in a cavity (or hollow) instead of in solid water. Torque is the twisting force exercised by a propeller on the vessel itself as against the propulsive effort exerted. Directly the propeller is over-driven, torque asserts itself. Hence the bad listing and steering effects so often seen on models fitted with unsuitable propellers.

One does not see many four-bladed propellers nowadays, and the most usual are three- and two-bladed. Speedboats usually have the two-bladed variety, but most prototype models use three-bladed screws. Tugs, however, often have four-bladed propellers, and so do some liners.

The three dimensions which measure a propeller are its diameter, blade area, and pitch. Obviously a large, slow-running propeller must be a good diameter, and have sufficient area to transmit the power. The question of pitch is, however, a stumbling-block to many novices. Pitch is measured in a curious way, and means the distance the screw would advance for one revolution if working in solid material. Thus a propeller with a 6in. pitch would advance 6in. per revolution if working in a solid medium. Actually slip occurs, and the boat does not advance anything like this distance.

If a propeller has insufficient pitch, it lacks grip on the water, and the engine revolutions rise rapidly. What happens then largely depends on the type of plant installed in the boat, but in all probability the engine buzzes round until the steam pressure drops. If the pitch is too great, the tendency is for the screw to churn the water round without imparting propelling energy to the vessel. The correct propeller strikes the happy medium between these two extremes. Whilst it is impossible to lay down any hard and fast rule, owing to the different types of hull and plant that may be used, a proportion of about 1 to 1 is usually about correct for most prototype models. In other words, if the diameter of the propeller is 2in., a pitch of about 2in. will probably be fairly suitable. This is only intended as a very rough guide to enable the beginner to find a suitable screw for his boat, and no doubt he will have to experiment a little before this desideratum is arrived at.

The efficiency of the propeller depends largely on an unimpeded path for the water both ahead and astern of it. Hence, deadwood should be carefully streamlined and cut down to a minimum, shafts kept within reasonable bounds as regards size, etc.

## CHAPTER VI

*The Transmission—Thrust Blocks, Journal Bearings, etc.—Twin Screws—Lubrication for engine and transmission.*

If the builder is fitting a stern-tube of the type described in the last chapter to a model of "Brunhilde," he may find the greaser on the stern tube inclined to be in the way of the lamp reservoir. The greaser can be lowered sufficiently by filing away part of the bottom until it fits over the tube like a saddle, when it can be soldered into position.

The thrust-block is the next consideration. Whilst this can be of simple construction, it must be efficacious. The simplest form consists of a collar on the shaft held in place with a set-screw. This collar takes against a thrust bearing suitably anchored to the hull. For a small engine such as the Meteor or Star the thrust might be taken by a plain bearing with a fibre washer between the faces. This arrangement is not ideal, however, and even for these small engines a ball-bearing is a great improvement, and is a necessity in larger ones. Nevertheless if any difficulty is experienced in getting such a small ball bearing, the plain bearing described will be found quite efficient provided it is kept well lubricated.

In any case the thrust must be either combined with an ordinary journal in what is known as a "semi-thrust" bearing, or placed as close to a journal as convenient. In the case of the lay-out shown in *Fig.* 11, the thrust is close to the after bearing of the stern-tube and there is only a short overhang.

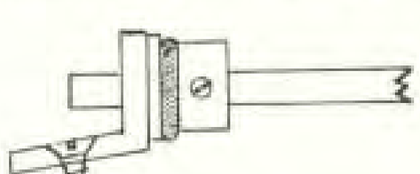


*Fig.* 12—A SIMPLE THRUST BLOCK

The fittings on shaft from right to left are: collar, fibre washer, steel washer and angle piece

The arrangement of the thrust block is shown in *Fig.* 12, which is an enlargement of the thrust shown in the lay-out plan. Forward of the thrust collar on the tail shaft is the fibre washer. Next comes a steel washer which in turn bears against the thrust block anchorage. The latter consists of an angle piece with a long base securely screwed to the bottom of the boat. This angle piece should be of generous width to



admit of at least four screws being used. The hole through the angle piece must be over-size for the shaft, which must be able to take its own line without touching. The angle piece is not intended to act as a journal but merely takes the end thrust of the propeller. If it is found that the steel washer tends to revolve it can be soldered to the angle piece, but in that case the hole should be the same size as the one in the angle piece.

The part of the shaft between the engine and the tail shaft is a floating shaft, that is to say, its end is not supported by a journal bearing but simply by the coupling to the tail

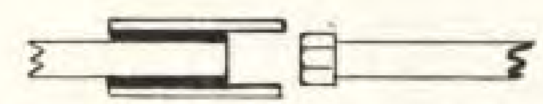


*Fig.* 13—AN EASILY-MADE UNIVERSAL COUPLING

The two halves are shown drawn apart

shaft. This coupling is of the nature of a mild universal joint and is introduced into the shaftline at this point to allow for any slight differences in alignment. It will also be noticed that this floating shaft has a slight amount of end play which obviates any risk of end thrust on the engine.

Although more elaborate forms of coupling can be made or purchased, the one illustrated is very suitable for this installation as it takes up very little room (*See Fig.* 13) and it has the additional merit of being easy to make. The forward end of the tail-shaft is screwed and fitted with a nut, thus forming the male end of the coupling. This fits into a sleeve on the end of the floating shaft. The sleeve consists of a short length of stout brass tube of appropriate size. The hexagon end is easily formed by hammering the tube over a nut of the same size as the one on the tail-shaft. It will need a liner inside the sleeve to pack the space between this and the floating shaft. If a piece of tube of appropriate size is available it will save having a liner turned up specially. The whole is sweated together. The coupling is shown in the diagram with the two ends separated for the sake of clarity.

There is one point to watch when making this coupling. If the nut has an ordinary right-hand thread and is used in conjunction with a right-handed propeller, the rotation of the engine will unscrew the nut. If this is the case it should be sweated on, though it would make a still better job to use a nut with a left-hand thread.

The reader who has a lathe will, of course, be at an advantage, but there is nothing that the builder cannot do without except the one or two minor parts, which have been indicated, and there should be no difficulty in getting these made at any model shop.

By the way, propellers are known as right- and left-handed, in accordance with the side on which they would go in a twin screw ship, where the screws should be out-turning. The right-hand propeller, viewed from astern, turns clockwise, and the left-hand anti-clockwise.

Most engines can be reversed quite simply so as to turn either way, and the engine must of course turn the correct way for the propeller. It may be mentioned that the correct propeller for a yacht like "Brunhilde" is a three-bladed one,

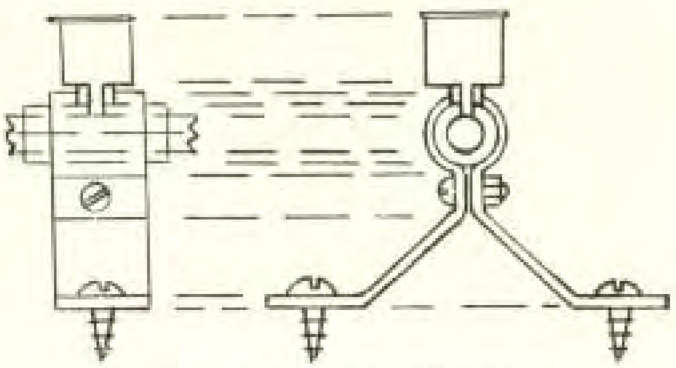


Fig. 14—JOURNAL BEARING
for forward end of Floating Shaft with lubricator and housing made of strip brass

for the cargo steamer "Zingaro" either a three-bladed or a four-bladed, and for the tug "Boadicea" a large four-bladed one of rather low pitch.

The fore end of the floating shaft is supported by a journal bearing which can be quite simply made from a strip of brass bent to shape in the vice. Its height can be adjusted by bending the legs open. The actual bearing can be turned up at the same time as the end bearings for the ends of the stern tube. The bearing should be kept long and only a little end-play given to the shaft. The bearing is shown in *Fig.* 14, and it will be noticed that a small lubricator of motor-cycle type is fitted.

When a twin-screw installation is desired, suitable skegs have to be formed on the hull, and these can be made up as described earlier in the book. As regards the machinery installation, twin screws in the prototype vessel are always driven by separate engines running independently. In the prototype, however, each engine is fitted with a tachometer, and any unevenness of thrust is counteracted by the helmsman. In the model, however, twin screws can only be used successfully if the shafts are geared together so as to ensure the same



power being applied to each. In practice twin screws in a model are frequently driven off one engine by means of gearing. A very good type of gearing is the one made by Messrs. Bassett, Lowke, which is illustrated.

GEARING FOR DRIVING TWIN SCREWS FROM ONE ENGINE
Made by Messrs. Bassett, Lowke, Ltd.

Having completed the installation of the plant, a few words on the subject of lubrication will not be out of place. All lubrication can be considered as being either internal or external. The former consists mainly of the lubrication of the cylinder walls and the only way this can be done is by the introduction of oil into the main steampipe so that it is carried into the cylinder with the steam. For this type of engine the simplest and best method is by the use of a displacement lubricator, which will be seen in front of the engine in the installation plan (*Fig.* 11).

As the reader may not be familiar with the principle on which displacement lubricators work, it may be as well to explain this. The body consists of a strong steam-tight container with an oil filler on top and a drain cock at the bottom. Towards the top is a stout pipe which forms the connection with the main steam-pipe and is fitted with a needle valve which serves to regulate the action. The filler should be fitted with a washer to keep it steam-tight.

The action is as follows:—The container is filled with oil. When steam is admitted to the container by opening the needle valve, the pressure in the container becomes equal to that in the main steampipe. The steam admitted to the container condenses and becomes water. Being heavier than oil this sinks to the bottom and, as more water accumulates, the amount of liquid becomes too great for the container and some of the oil is forced back into the main steam-pipe, where the steam carries it forward into the cylinder. In other words, the condensing steam gradually displaces the oil in the container so that it seeps through into the steam-pipe.

The amount of oil given is regulated by the needle valve. This continues until the container is full of water and the oil exhausted. When it is desired to refill the container, the steam-cock is closed and the drain-cock opened. When the water is completely drained, any residue of oil will show at the drain-cock, which is then closed and the container refilled. If the steam-cock is left slightly open when the drain-cock is opened, a slight pressure will continue which will serve to blow the water out quickly. One point to observe in fitting a displacement lubricator is to place it as near as possible to the engine. A displacement lubricator is illustrated in *Fig.* 15, and its construction will be apparent to those who have a lathe and wish to make their own.

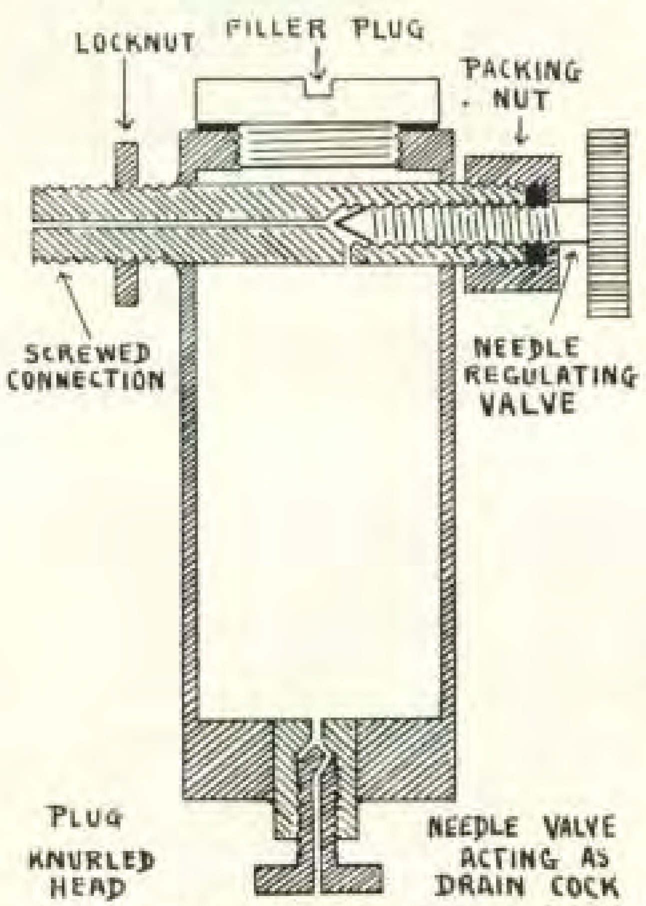



*Fig.* 15—A DISPLACEMENT LUBRICATOR

Some engines have an enclosed crankcase, which acts as an oil-bath, and the other parts of the engine are lubricated by splash. The only drawback to this type is that any steam that finds its way past the piston condenses, so that water accumulates as well as oil, and this is liable to cause rust. In spite of this, the enclosed crankcase type of engine is popular and seems to give satisfaction.



If the engine is of the open type, the bearings will require lubrication, and occasional applications of the oilcan are totally insufficient, so that some oiling system is required.

Pressure systems are complicated for the beginner to instal and involve the fitting of oil-pumps, etc., so the system recommended, which is simple to make and instal, will probably find favour with most builders, especially as it is absolutely satisfactory and reliable.

In *Fig.* 16 will be found a sketch of a wick feed oilbox. This consists of a trough, preferably fitted with a hinged lid. Through the bottom are a number of pipes rather like the draw-off pipes of an ordinary house cistern. The inner ends of the pipes project a little above the surface of the oil. Threads of cotton wicking twisted together pass through these pipes, and their ends are spread round the pipes and hang down into the oil. The oil is drawn up the wicks by capillary attraction, and passes gradually down into the pipes.

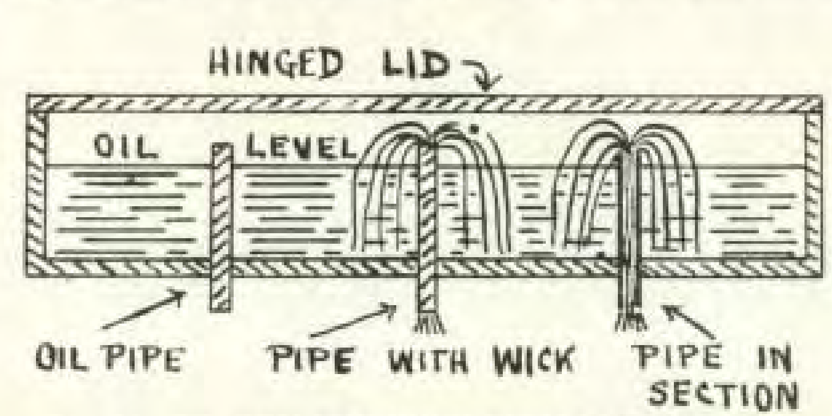



*Fig.* 16—OIL BOX FOR WICK FEED LUBRICATION

The lower end of a pipe can be continued right down to a bearing, in which case it provides a nice steady drip-feed lubrication. In certain cases the wicks may be brought through the pipes and the lower ends allowed to project, so that they are brushed by moving parts of the engine, which should be fitted with a little scoop or tongue of metal which picks up a drop of oil each time it touches the wick. The big end of an open-type engine would be a very suitable subject for this type of lubrication.

Although the particular lubricator illustrated is in the shape of a long, narrow trough, a wick feed lubricator can be any convenient shape. One point to observe is that it should be fitted in a warm position to ensure the oil flowing freely. This will render the lubricator almost automatic in action, as more oil will flow as the engine gets warmed up, and it will practically cease when the engine is shut off and cools down. In order to ensure enough oil getting to the engine when starting up, all that is necessary is to fill the lubricator a little more than usual.

Besides the engine bearings, the shaft bearings require lubrication, and for these suitable lubricators can be obtained. These are shown in the installation plan, but it would also be advisable to fit an oil pipe leading to the thrust and universal joints, as these are difficult to get at under the boiler.

One point which will be observed in the installation plan is that the safety valve projects above deck. This has the advantage of not filling the boat with steam when the boiler blows off, but it has the disadvantage of being somewhat unsightly. If the valve is below deck level some arrangement could possibly be made to trap the waste steam and turn it up the funnel, or a fiddley could be arranged over the safety valve to let the steam escape into the open air instead of condensing inside the boat. In the case of a valve being above deck, as in this instance, possibly a suitable fitting, such as a ventilator, might be arranged to conceal it, but if this is done care should be taken that it does not interfere with the proper functioning of the valve. This is one of those things the modeller must either accept as it is or exercise his ingenuity to overcome by some means suited to the particular model in question. When the model is actually running, there should not be much trouble on the score of blowing off if the lamp is properly adjusted so that the boiler provides the correct amount of steam for the engine.

There are many additional " gadgets " that can be fitted in the engine-room, such as hand and steam pumps for filling boilers, oil pumps, bilge pumps, blow-down cocks, etc., but these can all be added later as the builder gathers experience. The main thing for the novice is to make a good, straightforward job, that functions satisfactorily. To this end the simplest installation that will give satisfaction has been described, and all complications avoided. If the builder is tackling one of the larger boats described in this book, he would be well advised to add a water-gauge and a hand-pump to his equipment, and, possibly, a blow-down cock.

The main secrets of success in model building are to look ahead and use plans. The drawings given by the designer have not only to be enlarged full-size, but must also be supplemented by the builder. Without intimate knowledge of the individual builder it is impossible for the model designer to give every constructional detail on his plans. With the best will in the world he cannot estimate the skill and resources of the individual model maker, nor can he guess how much time and money will be expended on the model, or what detail work will be included. He is even ignorant of such major considerations as what type of plant will be selected. Therefore



all the designer can do is to give the lines and indicate the main points of the design, leaving the builder to fill in the final details to suit his own special requirements.

Possibly this is a good thing as, if the designer was obliged to specify every detail, the plans for a model would be nearly as complicated and expensive as those for a full-sized vessel.

This, of course, leaves a good deal to the individual builder, but the planning of this detail work is one of the most fascinating parts of the whole thing, and gives great scope for ingenuity in thinking out all the fittings above and below deck. Plans, rough sketches and notes should be made so that nothing is overlooked.

Often the careless or inexpert builder gives himself extra work and trouble by omitting to do things at the right time. For instance, a great deal of work that is easy before the deck is put on becomes most awkward and difficult afterwards. The writer has tried to point these things out as far as possible, but it is also highly desirable for the builder to think carefully about these things for himself.

The next thing is to finish off the internal fittings of the hull. The most important of these is the rudder-tube, but before the builder can instal this he must decide how he is going to fit his steering gear. Two steering gears are described elsewhere in this book, and, although both are highly practical and eminently suitable for a prototype model, neither is a really sightly fitting, and they have no counterpart in the full-sized vessel. Some model builders put the steering gear brazenly on the after-deck, but it is really better to fit it out of sight.

The neatest way to dispose of the gear will depend on the deck lay-out of the vessel being modelled. In the case of a steamer having an after deckhouse, the gear can be concealed in this, and arrangements made for access either by lifting the top of the house or some other convenient way. In the case of the yacht " Brunhilde " there are several alternatives. A sunk watertight well in the deck might be used, but in this case it is very desirable to have a really watertight hatch cover. A second method is to use a raised hatch on top of the deck, which could represent the afterpeak or a companion-way. If an after watertight compartment is being fitted it might be considered advisable to put the hatch for this compartment over the steering gear. This, however, is not recommended, as the hatches of the watertight compartments are best fitted with clips which would prevent ready access to the steering gear when running.

Whichever of these alternatives is being chosen, it will be necessary to decide beforehand as not only is the length of the rudder-tube affected, but beams and carlines have to be arranged under the deck round any openings. If the steering gear is being arranged in the after watertight compartment, the rudder-tube will have to be carried well above the waterline, and arrangements made not only for supporting the gear, but also the top of the rudder-tube. One great disadvantage of this arrangement is that the gear will block up part of the hatchway and thus hinder free access to the inside of the watertight compartment.

Having decided how the steering gear is to be arranged, the rudder-tube can be made and installed. The stock of a 40in. boat can be $\frac{5}{16}$in. light gauge brass tube, and that for a 60in. boat $\frac{3}{8}$in. As the stock must be a good fit for the rudder-tube, which is also light gauge brass tube, the builder should buy the two pieces of tube at the same time, otherwise he is sure to have difficulty in getting just the size he wants, and the fit of the rudderpost (or rudder stock) in its tube is a matter of great importance. The rudderpost must fit its tube really well in order to prevent shake, but not so tightly that it binds. Put the piece of tube for the rudderpost away carefully so that it does not get bent until ready to make the rudder, as described elsewhere in this book. This will be a nice little job to fill in time while coats of paint are drying.

Cut the rudder-tube to length allowing for its projecting about $\frac{1}{8}$in. above the deck, floor of well, or as the case may be, according to the method of installing the steering gear that has been decided. Drill the hole in the hull, and insert the tube temporarily. Cut out an oval brass washer about $1\frac{1}{2}$in. by 1in. Drill a hole in this to fit the rudder-tube. This washer will be soldered to the tube and lie on the bottom of the boat. As the tube is not at right angles to the bottom, the hole in the washer must be opened out longitudinally with a rat-tail file to an oval. When this has been done, drill two holes for the holding-down screws. Clean up the bottom of the tube and the washer round the hole. Put the washer in place on the bottom of the tube, and solder to it. Remove the tube with the washer fixed to it. Coat the bottom of the tube and the underside of the washer with luting, and replace in the boat, and screw into position. The rudder-tube is shown in *Fig.* 11.

The mast-step (or steps, according to the number of masts the vessel has) must now be put in place. The simplest method is to square the bottom of the mast to fit into the step which consists of a slip of oak or other hardwood $\frac{1}{8}$in. thick with a square hole in it. Glue the steps into place with casein.

The ports in the vessel's sides should be inserted before the deck is put on. These can be made as described in the Chapter on Fittings, or bought ready-made. The holes for



these have to be carefully spaced and bored, and after the wood has been well luted the ports are fixed in place.

Hawse-pipes are the next consideration. These are easy fittings to make, and are also described. The main difficulty is to get the holes in the hull at the correct angle so that the top end comes out at the correct spots on deck. By the method of making that is described, a little latitude is given in this respect. The position where the hawse-holes come through the deck is governed by the type and width of the anchor windlass that is being used, as the chains lead from the hawse-holes on deck back to the windlass, and thence down through the chain-pipes to the cable lockers. The builder will, therefore, want to know the width of his windlass over the cable drums to determine the positions of the hawse-holes.

Before passing to other subjects, one small but important point might be mentioned. When I was describing the purpose and installation of the floating shaft, I omitted to mention that this member of the transmission should have a little end-play so as to avoid any risk of the thrust being conveyed to the engine.

The coupling at the fore-end of the floating shaft consists of a disc with two slots to take the pins on the engine shaft coupling. This will be clear on reference to *Fig.* 11.

## CHAPTER VII

*Watertight Compartments—Deckbeams and Decks—How to make Watertight Hatches—Ruling Planking-lines on Decks—Painting a Hull—Striking a Waterline.*

A POWER-DRIVEN model is more liable to be swamped than a model sailing yacht, owing to the large openings in the deck, which are necessarily left for access to the power plant. To safeguard against losing the boat, many model powerboat owners either carry a special float, or have part of the superstructure arranged so that it will float off if the craft sinks, and thus form a buoy. A strong line, coiled away under the float, has its lower end attached to a strong part of the hull, so that the craft can be easily salvaged if she sinks. This is not a bad arrangement on comparatively shallow lakes, but it is more satisfactory to make the craft herself unsinkable.

In the majority of cases the power plant only takes up the centre of the vessel, and there is nothing to prevent the builder fitting watertight bulkheads and dividing the interior of the vessel into three compartments. The forepeak and afterpeak will thus be watertight and render the craft unsinkable. (See *Fig.* 11.)

If possible it is a good thing to make the bulkhead coincide with one of the breaks in the deck, as it will then serve to stiffen the deck at this point.

The bulkheads themselves can be made of $\frac{1}{16}$in. plywood. It will facilitate fitting these to the hull if a pattern is made of stiff paper or thin cardboard. The bulkhead is fixed in place by being butted against a stop consisting of a thin batten fixed inside the hull and the top goes against a deck-beam. A strip of wood $\frac{1}{4}$in. by $\frac{1}{8}$in. is boiled until it is pliable. It is then bent to shape inside the hull, pinned and allowed to dry out. In case of difficulty in bending, the strip can be in two parts butted on top of the keel. When dry, the strip is glued to the inside of the hull, being pinned into position until the glue is dry, when the pins are withdrawn. The bulkhead is then glued into position, and its top glued to the deck-beam next it, when this is fitted. As it is desirable to fit this deck-beam simultaneously, I will now explain how to fit these.

The structure of a vessel is really a sort of box girder, so the deck is a very important part and stiffens the hull immensely. Some builders simply tack the deck on top of the sides, but this is not recommended.



If the deck is merely put on top of the sides, the deck, being a separate piece of wood with its grain in a different direction, will not expand and contract evenly with the hull, and, though the joint may be concealed when the hull is new and freshly painted, it will show up very soon. Also this form of construction lacks the strength of a dropped-in deck. The builder is, therefore, advised to go to the extra trouble of cutting out a chamber all round the gunwale, as shown in the section of "Brunhilde" (see *Fig.* 2).

The deck for a model of this size (40in. overall) can be $\frac{1}{8}$in. pine. Some builders like to use three-ply for a deck, as it is less liable to split. Three-ply can now be obtained that is absolutely waterproof, but in any case its edges must be very carefully protected. Three-ply $\frac{1}{8}$in. thick is infinitely stronger than $\frac{1}{8}$in. pine, but it is also much heavier, so if it is decided to use a three-ply deck the thickness must be reduced. In fact, ply $\frac{1}{16}$in. thick will be ample.

Whether the deck is pine or three-ply, it will not stand to the deck camber without the support of deck-beams. The deck-beams for a model of this size can be made of $\frac{3}{8}$in. pine. The ends of the deck-beams are let into notches cut in the gunwale with the top of the beam flush with the bottom of the chamber into which the deck drops. These notches are $\frac{1}{4}$in. deep, so the depth of the ends of the beam will be $\frac{1}{4}$in. Its depth in the middle will be $\frac{1}{4}$in. plus the amount of camber.

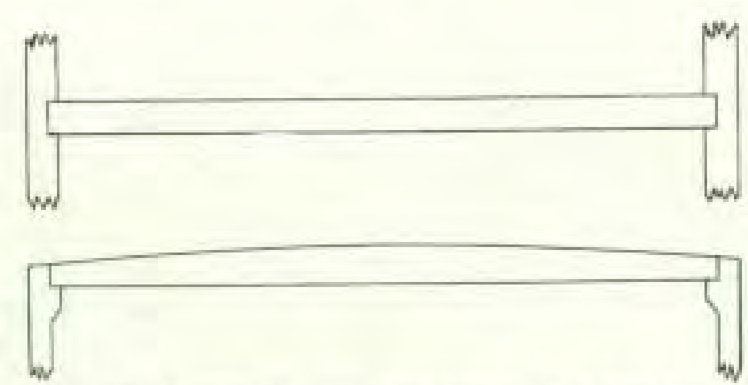


*Fig.* 17—METHOD OF FITTING DECKBEAMS

The underside of the beams *must* be straight. On no account attempt to bend a deck-beam to the required camber, or hollow out the underside. If either of these things is done, the beam will gradually fall in the centre, losing its camber. As the beam straightens out, its ends will force the sides of the boat apart, and all sorts of further complications will probably occur. A deckbeam is shown in *Fig.* 17.

The ends of the deck-beams are mortised and glued into notches cut in the gunwales. On no account saw the notches out of the topsides, as if this is done the ends of the beams will always show as ugly scars on the topsides in spite of all efforts to hide them. The diagram will make this matter perfectly clear. In marking out the top of the deck-beams use the flexible batten so as to get a true curve.

Whether $\frac{1}{8}$in. pine or $\frac{1}{16}$in. plywood is being used for the deck, the thickness is insufficient to provide proper holding for the screws used to fix the fittings in place. The positions of the deck fittings should be ascertained from the plans. As far as possible all of the more important fittings should be arranged to fall on deck-beams, as these give the best holding for the screws. Deck-beams must, however, be arranged to come at the breaks in the deck, particularly at sections which lift off to give access to the machinery. These points should all be carefully thought out before the deck-beams are spaced out, as by so doing the modeller will save himself much unnecessary trouble. In any case the approximate spacing for deck-beams in a boat about 40in. overall will be about 6in. apart.

Having fixed the deck-beams in position, the deck has to be shaped. Even if the vessel is flush-decked, the deck will have to be made in several parts, owing to the sections that lift off.

Cut a suitable length of wood, allowing a little for fitting, and draw a centreline lightly on its upper face. Now suppose the after-deck is the first to receive attention. In the case of " Brunhilde " we shall have to make allowance for the steering well or rudder-tube if the steering gear is above deck. Start with this as a fixed point. Turn the deck over and glue to the underside a piece of thin calico or similar material in the position the deck has to be cut or drilled. The object of this is to prevent splitting, either while making the hole, or afterwards. It should extend about an inch beyond the edges of the hole. If a hatch opening is being cut, make the thwartships cuts before the longitudinal ones, as this also helps the worker to avoid splitting the wood. A sharp knife and a steel straightedge are the best implements for this job. By the way, the glue holding the calico should be allowed to dry before cutting.

Offer the wood to the boat, and tack lightly in position with small tacks, leaving the heads protruding, so that the tacks can be withdrawn later. Take a sharp pencil and mark the outline of the boat on the underside of the wood.

As the thickness of the gunwale left round the deck chamber is known, cut the wood this amount inside the marked lines. Offer to the boat and ease, as required, until the deck drops nicely into place without forcing.



Remove the deck and mark out any openings for deckhouses, hatches, etc. Glue pieces of calico on the underside, and cut out as before. If any carlines are required, now is the time to fix them.

In case the reader is unaware what a carline is, it may be explained that these are longitudinal deck-beams, and are used to brace the walls of deckhouses, etc., and take any special strains. In the model it is unnecessary to mortise these into the deck-beams, and they can be glued and screwed through the deck-beam. This means putting a screw into the end-grain of the carline. Generally speaking, this is very bad practice, as it not only tends to split the wood but gives poor holding. This is one of the occasions, however, when it cannot be avoided. It is possible that some of the deckhouses come where there are beams, and, unless these interfere with the machinery installation, or are visible, they are better left as they strengthen the structure. If deck and deck-beams have to be cut away, the inside edge of the deck will be supported by a carline running between the nearest whole beams. The short deck-beams, between the side of the ship and this carline, are known as " half-beams," and should have their ends glued and screwed to the carline.

The portions of the deck that lift off with their appropriate deck-beams will need a little further explanation, but had better be left until we have got all the permanent decking in place in order to avoid confusing the reader.

If the inside of the hull has not yet been varnished, this must now be done, including the deck-beams and undersides. Start by giving two filling coats of a mixture of half varnish and half turpentine. It will probably be best to paint the part of the hull that houses the machinery, but the bow and stern can be given three good coats of varnish. The centre of the boat can now receive three coats of paint on top of the varnish filling. Do not make these coats too thick, as you will add a lot of weight to the hull.

Whilst this is in progress, the deck can be carried on a stage further. Whether pine or three-ply is being used, something must be done to provide holding for the screws to fittings that do not fall on deck-beams or carlines. This takes the form of gluing reinforcement pieces on the underside of the deck. In the case of a deck of $\frac{1}{8}$in. pine the reinforcement pieces can take the form of slips of $\frac{1}{8}$in. mahogany. If the deck is $\frac{1}{16}$in. three-ply, they had better be $\frac{3}{16}$in. thick. The underside of the deck should have one coat of varnish priming and two good coats of varnish.

At the commencement of the Chapter instructions were given for making watertight compartments so as to render the model unsinkable. The larger these are the more effective they will be, and there is no reason why they should not occupy all of the inside of the vessel with the exception of the centre space required for the machinery.

At the same time it is very bad practice to seal any portion of a boat off permanently. Even if there is no leakage whatsoever, there is bound to be a certain amount of condensation. This dampness in an unventilated part of the boat is liable to cause rot, cause decks to buckle, and do other damage.

The proper thing to do is to have hatches in the deck which are really watertight or else openings through the bulkheads themselves, with hatches of a suitable nature. These are put in place when the boat is running, but opened when she is lying idle.

There is no great difficulty in making a really watertight hatch. This is shown in *Fig.* 18. The hatch cover consists of a piece of $\frac{1}{8}$in. mahogany with a piece of $\frac{1}{4}$in. sheet cork glued on to the bottom of it with casein glue. The coaming

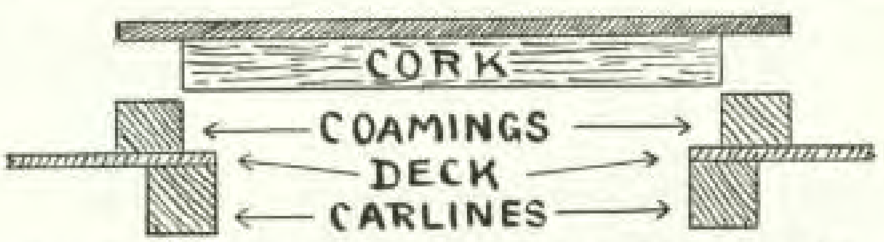



*Fig.* 18—HOW TO MAKE A WATERTIGHT HATCH

consists of $\frac{1}{4}$in. square mahogany and is set $\frac{1}{4}$in. back from the hatchway opening, so as to form a rim on which the bottom of the cork rests. If this is well fitted, not a drop of water should penetrate. It will be seen from the diagram how the deck is supported by carlines round the hatchway. This is preferably made before the deck is fitted. If a really good job is made there should be no need of clips for this hatch, but if the builder thinks it advisable they can be fitted, but should be small and neat. It is advisable to make the hatchway sufficiently big to put the hand through as this will allow the use of a sponge if any moisture finds its way into the compartment, and will also prove an advantage if repairs have to be effected at any time.

If it is not convenient to put hatches in the deck, there is no great difficulty in making watertight doors for the bulkheads, but the bulkhead itself will have to be strengthened by a frame round the opening, with uprights going from the bottom of the ship to the deckhead (underside of deck). The door itself can be $\frac{1}{8}$in. or $\frac{3}{16}$in. mahogany. The four corners can be arranged to pull up tight with studs and milled nuts. The latter can be taken from old dry batteries. If there is



any doubt about the door being watertight, a little groove can be cut round it and a piece of thin, round rubber glued into the groove, so as to act as a seal. An alternative method is to use a piece of rubber sheet (say, a piece from an old inner tube) to form a grommet. The construction is shown in *Fig.* 11.

The reader should mentally note both these methods, as neither is difficult, and both may have a number of applications on a working model. In arranging the deck and deck openings, everything depends on the relative positions of the machinery and deck erections, and what applies to one model will not apply in its entirety to another craft. Once the modeller grasps these various points, however, he will be able to arrange matters to suit whatever ship he is modelling. Half the interest in building a model lies in thinking these points out and in overcoming minor difficulties.

The deck should be marked out in planks before it is permanently fitted, as it is far easier to deal with off the boat. The deck-planks of a yacht are curved, following the sheer and butting on a king-plank amidships, but in a steamer they run fore-and-aft. The first thing is to put in the planks that surround openings for houses, hatches and the like. These are usually about twice the width of the ordinary deck-planks.

In a full-sized steamer there are usually scuppers round the deck-edge, but it is not likely the modeller will reproduce these. Inside the scuppers is another wide plank, called the covering board, following the shape of the deck-edge. This is the same width as those round the deck openings. In the model it is usual to make this extra wide, and let it take the place of scuppers and covering board. If an actual strip of mahogany is being put on the model's deck-edge, this takes the place of the covering board, and no notice need be taken of this in marking, as this edge of the deck will be covered.

The covering board of a model like "Brunhilde" can be $\frac{1}{4}$in. by $\frac{1}{8}$in. mahogany, where there are no bulwarks, and $\frac{3}{8}$in. by $\frac{1}{4}$in. in the way of the bulwarks, which are $\frac{1}{8}$in. thick. This will make the inner edge of the covering board a continuous line round the ship. An additional advantage of the covering board is that it prevents moisture penetrating the seam along the deck-edge.

Deck-planks on a full-sized vessel are about 4in. wide, but it is impossible for the modeller to scale this down and put lines on his model. How close they are will depend on the modeller, but they look inferior if too far apart. At the same time a poorly lined-out deck looks very bad, and it is better to put fewer lines and do them properly, or even omit them altogether. About $\frac{3}{16}$in. apart would look well in a model like "Brunhilde."

Before lining, the deck must be glass-papered to a high finish. Give two coats of clear size, rubbing down lightly after each.

I hear that if sycamore is used instead of pine for the decks, it is unnecessary to size it, and that the varnish stands heat better without the size. Sycamore is, however, heavier than pine, and I recommend decks of $\frac{1}{8}$in. pine, with closely-spaced deckbeams, and, if proper protection is provided, there is no fear of damage from heat.

The actual lining is done with a draughtsman's ruling pen and waterproof drawing ink. If you are not used to ruling with this implement, have a little practice on a piece of paper before starting on the deck. Do not put too much ink in the pen, but avoid running dry in the middle of a line, as it is difficult to join up neatly. If you do make an error, let it dry thoroughly and then scrape off with a sharp knife. Do not forget to resize the wood before touching up afterwards, or the ink will run.

Clean the pen *frequently* during ruling. Test on a piece of paper each time after recharging. If the ink gets cloggy, clean the pen at once. Always clean the pen very thoroughly after use. A draughtsman's pen can be reset on a fine oil-stone, but this needs great care not to leave a sharp point. It can also be stropped on a piece of leather.

Start with the lines round the deck openings and the covering board. After that, tackle the fore-and-aft planks. Start with the centre (or king) plank, which lies half on each side of the centreline. Work alternately one side and the other. This will give the ink a chance to dry, and also help you to get the planks even. Do not trust to your eye but mark each plank carefully at both ends and the middle.

There is one point to watch very carefully. The planking on the different parts of the deck must be aligned absolutely correctly, so that the lines run true from end to end of the vessel. If this is not done the effect will be spoiled.

After ruling the planks give the deck a coat of varnish to protect it during handling.

It may be mentioned that if dummy panelling has to be put onto the doors of deckhouses, etc., it can be done with drawing ink in a similar fashion. It is advisable, however, to do this before the house is assembled, as it is far easier to rule on the flat.

The parts of the deck that are being fixed permanently should be bedded down in white lead paint and screwed with $\frac{1}{4}$in. by No. 0 brass screws, putting a screw about every three inches or so. Also put a screw into the centre of each deck-beam. If marks are put on the gunwale before the deck is dropped into place, no difficulty will be found in locating these. The deck should also be screwed to any carlines.



The strips of mahogany for the covering board can be fitted temporarily. They are then taken off and varnished, including the underside. After varnishing, the strips are hung up to dry. A small screweye put into the end of each will facilitate their being hung on tacks in the edge of a shelf.

This, by the way, is how masts and spars are hung up to dry after varnishing.

When the covering boards are dry they can be fixed into position, being bedded down on wet varnish. To hold the covering boards, use tiny copper pins. Drive each pin nearly home, and nip off the head. When the headless pins are driven home they will be practically invisible in the mahogany.

Give the whole deck another thin coat of varnish to protect it during the time the outside of the hull is being painted. When dry turn upside down and chock up firmly.

There is one great point to remember during all painting and varnishing. Dust must be avoided, and so it is unwise to leave the work during drying in a room that is liable to be swept and dusted.

Any varnish used for boats must be special boat varnish as ordinary varnish blooms in water. Rylard is particularly recommended, as it is British, and as good as anything made.

Similarly, any paint or enamel must be good quality. For first coats there is nothing to beat good white lead paint as a protection for the wood. For undercoating under enamel, it is recommended that the undercoatings supplied by the enamel makers are used. Finally, when one comes to the question of enamel, it is best to use one that is specially made for boat work, and here, again, Rylard can be thoroughly recommended.

An alternative to enamelling is to use ordinary flat paints, and varnish on top. This is very inadvisable when light colours are used, as the varnish darkens them. In any case, the writer recommends enamelling, but as far as dark colours are concerned, this is only a matter of opinion, and not vital.

Good brushes must be used, and kept clean. All coats of paint must be thinly applied, and the boat rubbed down after each, using waterproof glasspaper. In rubbing down with this paper, use plenty of water.

The first essential to get a good finish is to have a good surface to work on. It is no use thinking that paint will cover up roughnesses, and if the surface of the hull is not absolutely perfect it had better be rubbed down before starting to paint.

Some sticklers insist that it is wrong to enamel model steamers, as the prototype is not enamelled. If these gentlemen will take a magnifying glass and examine a finely enamelled surface they will find it unexpectedly rough, the inequalities being more than scale size to any in the painted hull of the prototype ship. A good surface is less porous and, therefore, better protection. Also it lessens a model's friction through the water.

Some modellers these days like a cellulose paint. The ordinary brushing cellulose has not the penetrative power to key into the pores of the wood, and therefore forms a surface skin that is easily chipped. When such chips occur the water has a nasty habit of creeping underneath, which not only causes peeling but is detrimental to the wood. If a spray gun is available, better results are, no doubt, obtainable, but the average amateur does not possess one of these implements. In any case, however, for marine work, good lead paint, enamel and varnish remain unsurpassed.

Paint in either stern-tube or rudder-tube will be detrimental to smooth working, so before it is forgotten put a small screw of paper into each of these holes.

Nothing looks worse than a waterline badly put on. Yet one sees any number of models disfigured in this way. It will be found very simple to get a good, sharp waterline, especially on a bread-and-butter hull, if the instructions are followed out.

The first thing is to stop any holes or blemishes in the boat's hull. A serious blemish can be filled with plastic wood, but if this material is used, be careful to see that it has sufficient key into the surface, and, if necessary, make a hole with a bradawl to act as one. Plastic wood shrinks a lot, so any filling should be left standing proud for at least 24 hours, and then rubbed down. For ordinary small scars the best filling to use is whitelead powder mixed with gold-size.

For filling the grain of the wood, give the boat a coat of filling made with varnish and turpentine, mixed half and half, but before doing this take a sharp-pointed copying pencil. The waterline falls at the junction of two of the layers, and, whilst painting, we have to keep the position of this marked so that the line will be available when required. Go round the line with the copying pencil, and make a series of dots two inches apart. These dots will show through the paint, and are renewed before each successive coat is applied.

When the filling coat is dry, the boat can be primed. For this, use white-lead ground in oil with a dash of varnish, and mixed with best turpentine. After this is dry rub the boat down, using waterproof glasspaper. Renew the pencil dots round the waterline, and then give a second coat of priming.

Next give two coats of white-lead paint, rubbing down and renewing the dots after each. Use the paint fairly thin, apply thinly, and give plenty of time for drying between coats.



The hull is now ready to receive the undercoats, and, as the topsides are to be a different colour to the bottom, arrangements have to be made to keep the colours apart and get a sharp, straight division at the waterline. In order to facilitate explanation, we will assume that the model being painted is the yacht "Brunhilde," and that she is to have a green bottom and white topsides.

Take a sheet of good quality, non-porous paper and cut into slips a few inches long and about ¾in. wide. The yacht is being painted upside down, and, as paint runs downward, we will start with the bottom. With gum or paste stick slips of paper round the waterline, using the dots as a guide. Cover the edge of the topsides but leave the bottom uncovered. Give two coats of the green undercoating, rubbing down between each.

Now for the green enamel. Enamel is applied like final coats of varnish. It must not be applied thickly. Just enough to flow is put on, *using light strokes all one way*. As the edge is protected by the paper, the worker need not worry if the paint goes over the edge, but should be careful to see that he gets it right up to the line.

After enamelling, a damp chamois leather is used to rub down, with a little very finely ground whiting.

Damp the paper strips and remove from the hull. Put on a fresh band of paper strips on the other side of the waterline to protect the finished bottom. The white topsides are painted and enamelled in similar fashion, the paper strips being removed at the finish. If good paint has been used and care taken, the final finish of the hull should be something to be proud of.

If the boat's hull is of metal, or for some reason the waterline has been lost, it will have to be marked out again. This entails the use of a surface block and face plate. The reader is unlikely to have a spare sheet of plate-glass big enough to stand the boat on and leave a margin all round to use the surface block.

If the lady of the house is of kindly nature, her permission can be asked, but otherwise it is as well to wait until she is safely out of the way. Then borrow one of the wardrobe doors in which there is a large mirror. Put this on the table and with a spirit level chock up absolutely horizontal, checking longways and crossways. Place the boat on the mirror and chock up to her correct fore-and-aft line of flotation. Using a plumb bob and checking the stem against the line, get her on an even keel. Moving the surface block round the boat, proceed to put in a row of dots right round the waterline.

Mention is made above of the use of a surface block, but it is quite possible that the reader does not possess one, and these are rather expensive things to buy, but the reader can easily rig up something that will answer the purpose for this job. Two pieces of fairly thick wood are screwed firmly together at right angles, and a hole for a pencil made at the right height. This can be slid round the boat, keeping the pencil against the hull, and dotting in the waterline.

Replace the wardrobe door, and proceed to paint the boat as previously described.

Some boats have a coloured stripe along the waterline. The correct name for this is a "Boot-top." It can be put on in a similar manner, getting sharp lines by using strips of paper as described.

One point to remember is that paint is heavy and adds considerably to the weight of the craft. In any case, however, thick paint does not mean a good finish, but usually the contrary, and thin coats, properly applied and rubbed down, give the best results.

## CHAPTER VIII

*Ventilation—Accessibility of Controls—Lift-off Parts of Decks —Protection from Heat—Making Rudders.*

THE question of decking over the machinery is one that requires some consideration. Part of this must be removable to give access to the plant, but at the same time it must provide adequate protection from water and yet admit sufficient air for ventilation. On the other hand the deck itself must be protected from heat so that the finish is not spoilt, and also the parts that lift off must not look as if they did. A further point is that controls must be arranged so that they can be operated without removal of the lift-off parts of the deck.

In order to afford adequate protection the size of the portions to lift off should be kept as small as is consistent with being able to get at the plant comfortably. Further, these openings should not extend right to the gunwale but be kept in the middle of the ship and as narrow as possible. This means that the side decks will be permanently fixed and the lift-off portions constitute the middle.

There are a number of ways in which ventilation can be obtained. Deckhouses with their portholes and windows provide useful openings in the deck; fiddley gratings over the engineroom and ventilators are even more obvious means. In any case, however, all these openings should be as near the centreline of the ship and as high up as possible.

In order for the lamps to work well, a good supply of air is absolutely necessary. A good circulation of air also helps to keep the underside of the deck and sides of the ship cool, and thus preserves them. On the other hand, boilers and steam-pipes lose in efficiency if heat is dissipated, so that these have to be very adequately lagged. By conserving heat in this way, more steam is obtained from less fuel, which means that a less hot lamp can be used, which in turn assists to preserve the deck and sides of the model.

The hottest part of the deck is round the funnel and this usually needs some additional protection. The funnel itself should always consist of an inner and an outer funnel, with a good air space between which will keep the outer funnel at a reasonably low temperature and save the paint from being burnt off.

In order to conceal the junction between the lift-off decks and the permanent deck, the break should be arranged to come where there is an actual break in the deck, such as a different top deck level, or the side of a house, hatch, or the like. Failing this the break should fall on a deck-seam, where the ruled planking is. If properly done, it should not be noticeable unless one deliberately looks for it.

It is necessary for the owner to be able to control his boat from the deck. The water-gauge and pressure-gauge can be arranged so that they are visible through a skylight. Steam-cock and blow-lamp regulator can be placed just under a skylight or hatch, or just inside a deckhouse.

It is impossible for the writer to give an exact lay-out, showing just how these various points must be arranged, but, having pointed them out, it is a nice exercise for the builder's ingenuity to make a suitable lay-out to meet his requirements. There is no great difficulty about this, and problems solve themselves quite easily when one has the actual boat before one. The only thing is that one must have a clear idea of what is being aimed at before starting the job.

In like fashion although many of the various processes in building a model overlap, it has been necessary for the writer to make his explanations continuous, but in practice in order to make the work as easy as possible the builder has often to turn from one part of the boat to another.

Having decided exactly which portions of deck are to lift off, the permanent side-decks in this part of the boat can be fixed, or rather, the deck-beams and carlines arranged. Deck-beams must be put across the boat to support the ends of the permanent deck. Between these, carlines are put, supporting the inner edges of the permanent side-decks. To support the latter firmly, half-beams must also be put, as requisite, between the carlines and the side of the ship. The method of installing all of these has been explained already. When this has been done, the builder has the complete framing to support his permanent deck with a hole in the middle for the lift-off section of the deck. Cut two strips of $\frac{1}{8}$in. mahogany the width of the carlines, plus $\frac{1}{8}$in., and glue to the underside of the carlines, so as to form a ledge all round the hole on which the lift-off deck can rest. These strips can extend across the beams to which the carlines are fastened, and will strengthen the joint between the carlines and deck-beams. Put two similar strips across the underside of the deck-beams at the ends of the hole so that the ledge is continuous all round the hole.

Now for the framing of the lift-off portion of the deck. Make the deck-beams for the forward and after-ends of this the full width of the opening. Then make the side carlines and fix to the beams.

Some additional deck-beams are required to stiffen the deck, and these should be closer than those supporting the



permanent part of the deck, say, not more than 4in. apart. These are fixed between the carlines in the usual way.

In fitting the framing for the lift-off part of the deck to the opening, do not forget that both of these have to be varnished. If the fit is too close the deck will stick instead of lifting off easily. The thickness of a visiting card should, therefore, be left all round. The wood for the deck for the lift-off part can be the piece cut out of the middle of the wood being used for the side-decks. If a nice, clean knife-cut is made, using a steel straightedge, only the width of the cut need be lost, and this will not be more than the slight allowance that must be made for the varnish. Start by ruling a centreline and cutting the hole. Then fit the side-decks. The order in which this is done makes the work easier for the builder. Having fitted the decks temporarily, mark the positions for the planking lines on the wood, so that they join up with those on any other parts of the deck already fitted. Remove them and proceed to size and rule, as before. Fit the lift-off deck to its framing by gluing, and also screw to the deck-beams and carlines. Tiny screws are used and the heads touched over with a spot of paint. The whole lift-off portion of the deck (top and bottom) is then well varnished. Before putting the side-decks in place, varnish all the deck-beams and carlines thoroughly. Use white-lead paint round the gunwale and varnish round the opening, when setting this in place.

Now any hot part of the plant is bound to come under the lift-off part of the deck, so that is all we need protect from heat. In any boat it will be desirable to protect the underside of the deck round the funnel, but in a very hot boat the whole deck over the plant may need protection.

The best material for this is light gauge aluminium. Aluminium corrodes with salt water and deteriorates with salt air even, and it is inadvisable to use it for important parts of a boat. There are a number of aluminium alloys which have excellent non-corrosive qualities and, if they can be easily obtained, it might be better to use one of these. However, these shields are not difficult to replace so it is not worth going to much expense or trouble about them. Generally speaking, aluminium is not a good metal for marine work and, whenever possible, any parts made of it must be well protected with paint. The object of using aluminium is, in this case, of course, to avoid weight so high in the boat.

In passing, it should be mentioned that all screws used in the boat itself should be brass, and all pins or nails either brass or copper.

The hole in the deck shield, under the funnel, should be larger than the inside funnel, but less in diameter than the outside one. It is inadvisable to screw the shields directly on to the underside of the deck-beams, and spacing pieces should be put on the screws to keep the shields at least $\frac{1}{8}$in. away from the beams, so as to allow space for air to circulate. If the plant permits it would be better to give $\frac{1}{4}$in. or more.

While on the subject of ventilation, something might be said about ventilators. If these merely come through the deck they serve to let warm air out as warm air always rises. If

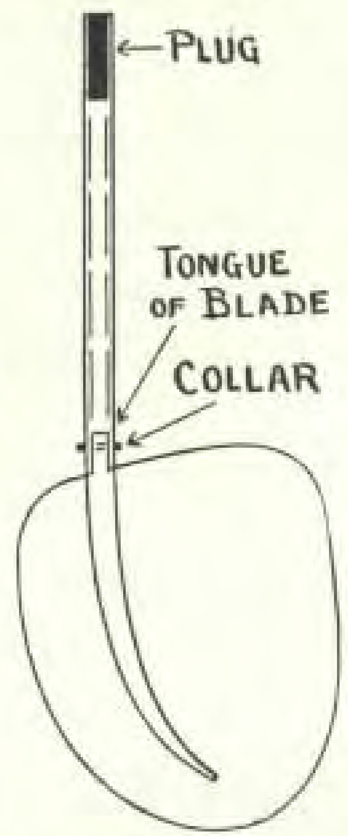



*Fig.* 19—CONSTRUCTION OF A BALANCED RUDDER.

the stems are carried right through the deck to a point low down in the hull, they tend to introduce a current of cold air and thus promote a good air circulation. This is advisable when the ventilators are forward in the vessel.

If the rudder has not been made this can now be attended to. How this is made will depend largely on its pattern. That of "Brunhilde" is a balanced hanging rudder (see *Fig.* 19), and will, therefore, have to be all metal. The lower part of the tube, forming the stem, will have to be split up with a jeweller's saw. This is a little metal fretsaw and used exactly like a fretsaw. After cutting, anneal the bottom of the tube, which is to form the fork between which the blade of the rudder will be held. Bend the blades gently to the required curve. Put a piece of metal the same thickness as the blade of the rudder between the fork and flatten the sides in the vyce. Be careful not to fracture the metal as you do this. Then remove the metal and file the taper on the two sides of the



fork. Take a short end of the tube that was used for the rudder-tube (i.e., the rudder-tube, *not* the rudder stock) and cut a little collar about $\frac{1}{16}$in. wide: this will presently be fixed on the stock, just below where it emerges from the rudder-tube, and will thus prevent the rudder being knocked up by a blow. It will also strengthen it. The rudder-blade is cut to shape from sheet brass of a moderate gauge. On no account make this too heavy. At the top of the blade leave a little tongue about $\frac{1}{4}$in. long to go up inside the stock, which it should just fit. Two little slots are filed in the top of the blade, alongside this

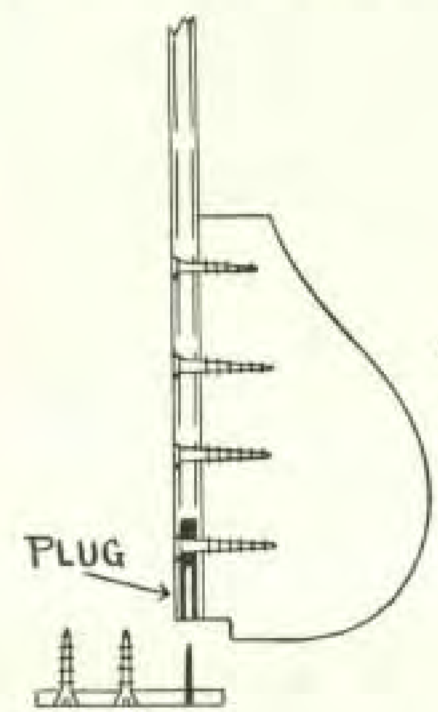



*Fig.* 20—ORDINARY TYPE OF RUDDER WITH PINTLE.

tongue, for the collar, if required. The whole can be securely sweated together. This finishes the rudder with the exception of the rudder-head, which is dealt with as described later. If a metal rudder is used, please do not leave this bright brass, as some builders are inclined to do, but paint the same colour as the underbody of the hull.

The ordinary type of rudder, hung on a sternpost, is quite simple to make. The blade is cut from mahogany, and the rudderpost made of brass tube. Cut the tube to length. Take a piece of brass rod that will fit inside the tube, and sweat into the bottom to form a plug about $\frac{3}{4}$in. long. Bore a hole in the bottom to fit the pin of the pintle. Up the forward side of the blade make a groove to take the tube. The tube should then have the holes drilled and countersunk for the screws that hold it to the blade. A similar plug is then sweated into the top of the rudderpost. The groove in the blade must be well luted before the tube is screwed on. This is all clear in the drawing (see *Fig.* 20).

This type of rudder has a pintle at the bottom, which must be long enough to lift the rudder itself just clear of the pintle plate. The pintle is a piece of hard brass wire soldered into the plate. There is little to say about the making of this except to warn the builder to get his pin absolutely vertical so as to be in line with the rudder stock. This is also shown in the diagram.

The most difficult type of rudder to make is the balanced rudder supported on a pintle. The dimensions of the various parts will, of course, vary with the size of the rudder, but for the sake of explaining the method of making we will presume that we are making a rudder of this kind with a 7/32in. stock. The bottom of the tube is plugged, as explained above. Now drill a hole through the tube just above the plug. With a

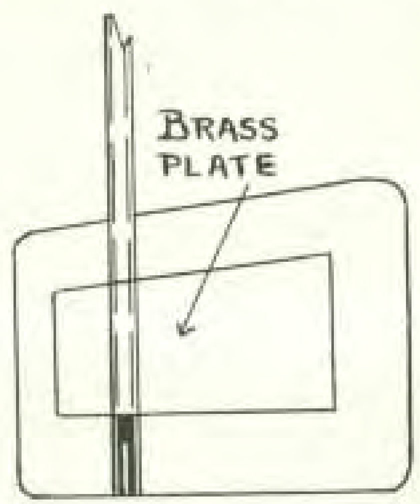



*Fig.* 21—BALANCED RUDDER WORKING ON A PINTLE.

jeweller's saw (which is similar to a metal fretsaw) make a slot up the tube. A cross-piece of fairly stout brass is put through the slot and soldered into place. The top of the tube is then plugged. For the blade you will require two pieces of ⅜in. mahogany cut to shape. With a small gouge make a groove in each half of the rudder deep enough to take the rudderpost to half its depth and exactly fitting it. Then recess each half to take the brass cross-piece to half its depth. The two parts of the rudder will then fit exactly round the rudderpost. Glue the two halves together with casein glue and clamp up and leave to dry. When dry, drill right through the blade and brass cross-piece, and rivet all together. With a file, proceed to shape the rudder in section to good streamlines tapering off at the back to a fine edge. This type of rudder is shown in *Fig.* 21. The pintle is made as previously described.



The two steering gears described below, although different in construction, are the same in principle. Either of these works equally well on straight courses or small angles of helm, but the first is to be recommended when the owner is likely to want to steer his boat in a circle on occasions.

Both of these gears fasten to the rudderhead in the same way, and entail the use of a small tap to put a thread in the hole through the collar and rudderhead.

The first gear consists of a quadrant with a curved slot fixed to the rudderhead and a clamping screw fixed to the deck. This gear is shown in *Fig.* 22. Cut the quadrant out of brass sheet just thick enough not to bend. This is best done with the jeweller's saw. Make a "pop" with a centre-punch for drilling the hole for the rudder stock. Put the leg of a

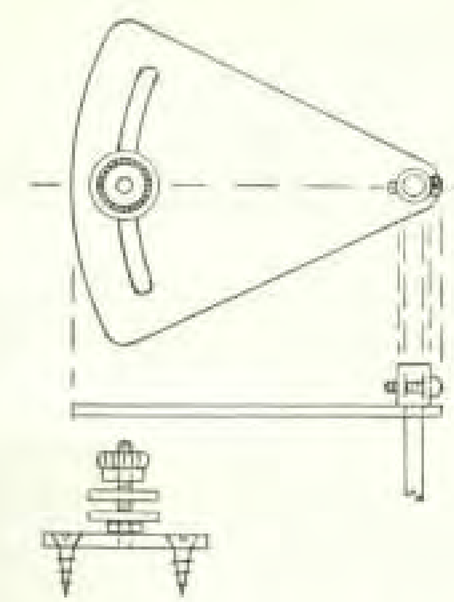


*Fig.* 22—QUADRANT STEERING GEAR.

The top drawing shows plan view of complete gear, and bottom drawing shows side view of quadrant and clamping screw separately.

pair of compasses in the pop and mark the circular slot for cutting out. Drill the hole for the rudderhead of a size to fit tightly on the stock. The circular slot is cut out with the saw, drilling holes at each end to start and turn the saw. Take a short piece of the same size tube as used for the rudder-tube and solder this onto the top of the quadrant, taking care that the holes register exactly.

The quadrant is fixed to the rudderhead with a small round-head screw. To line up the quadrant with the rudder, the rudder must be held in the vyce by the stock, and, as it is important not to damage this with the jaws of the vyce, wood "clams" must be used. Take a piece of inch wood and drill a hole that exactly fits the rudderpost. Then split in two with a saw. The size of the hole will then be diminished by the width of the saw-cut, and the rudder can be held firmly but without damage. Adjust the post so that the collar and rudderpost come level when the quadrant is put in place, resting on top of the jaws of the vyce. Line the quadrant and rudder up nicely, and run a drill through the collar and post. This should be the correct tapping size for the screw that is being used. The hole can be threaded with a taper tap of the correct size and thread for the screw being used. A small B.A. screw with a round head is very suitable for this job. If the builder thinks that it is beyond him to put a thread through this hole, a bolt and nut can be used, but this does not make nearly such a neat job.

Now for the clamping screw. Get a wireless terminal complete with screw and a spare nut to fit. These can be obtained for a penny or two from any wireless shop. Cut a small brass plate for the deck and drill three holes in it. The centre one should fit the screw, while the outer ones are for the two screws holding the fitting to the deck. Cut the head off the screw, and put the nut on it, leaving just sufficient length beyond to go into the deck-plate without projecting through it. Solder the lot together. The method of using this gear to hold the rudder at any required angle is, of course, apparent to the reader.

The second gear is more elaborate and possibly gives a little finer adjustment for those who go in for steering competitions where very straight running is essential. This gear is shown in *Fig.* 23, but a few words of explanation as to its making are required.

A sort of tiller is used instead of a quadrant, but is fixed to the rudderhead exactly as described above. The end of the tiller is bent over to form a loop, which goes round the screw of the adjusting rack. The loop should have sufficient length to permit the tiller to move freely on the rack.

The rack consists of a length of screwed brass rod carrying two large nuts with milled or knurled edges. The rod is mounted on two simple angle brackets made of sheet brass into which it is sweated. The nuts should be of large size, as mentioned, for ease of handling when the fingers are wet and cold. If the builder has a lathe, he will have no difficulty in making these nuts for himself and he can bevel the inner faces off at the same time, to allow for the tiller not always being square to the rod. The screwed rod can easily be bent to the required arc.

In the case of the quadrant gear the collar is put on top of the quadrant, so as to keep the quadrant low. It will add to the gripping power of the clamping screw if washers are put above and below the quadrant, as shown in the diagram.

In the tiller gear the collar can be either above or below the tiller, according to the height of the rack, and the latter



is governed by the size of the nuts. In any case, however, it is quite easy to bend the tiller up and down, as required.

It will be of assistance in fitting the gear on the actual boat if a little cut is put with the saw right across the top of the rudderpost and collar with the saw, as this will enable the builder to see when the holes are properly in line.

Either of these gears can be fitted either ahead or astern of the rudderpost, according to what suits the deck lay-out of the model. It is advisable to have the quadrant or tiller a good length, as this makes it easier to get a fine adjustment

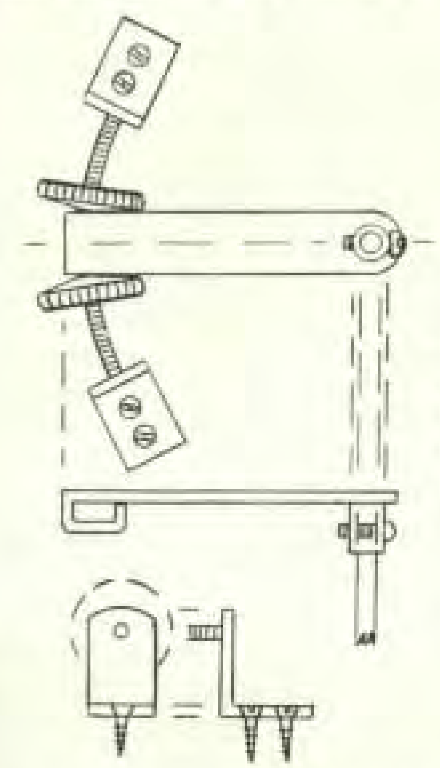


*Fig.* 23—
TILLER STEERING GEAR.
The top drawing shows plan view of complete gear. Below this is side view of tiller showing loop. The bottom drawings give end and side views of angle plate.

of the amount of helm. This may seem a minor point, but in steering competitions it is a very important one. If the builder wants to go to a very fine point he can mark out his helm angles in degrees, but all that should be required is a mark to indicate when the helm is dead central.

It should be mentioned that neither *Fig.* 22 nor *Fig.* 23 is exactly to scale. With regard to actual sizes, the rudder stock should be as large as convenient. On the length of the quadrant or tiller depends the fineness of the helm adjustment one can get, so this also should not be cut down unduly. In order to save weight in the quadrant gear, it might be considered advisable to cut or drill some of the metal out of the centre of the quadrant.

## CHAPTER IX

*The properties of Metal Hulls—Notes on Designs—Building Metal Hulls—How to make the Former—Plating-up.*

SOME of my readers may be more at home with metalwork than others, and prefer to build a metal hull, but metal hulls are more difficult to get true to shape unless proper methods are used. Metal hulls can be built of sheet brass, zinc or tinplate. There is one great advantage that zinc and tinplate hulls have in comparison with wood, and that is the cost, which is under a half of that of a wood hull, and when one comes to a boat of 5ft. overall or thereabouts this saving is quite appreciable.

As far as the brass and zinc hulls are concerned they have the advantage of being non-rusting, but tinplate hulls will give very good service if looked after and well protected with paint.

The method described is applicable to all of these metals, and although my description is primarily intended to apply to tinplate, a few preliminary remarks on brass and zinc hulls will make the instructions applicable to all.

Brass is the most difficult of the three to work but will make a beautiful hull. If used it must be annealed to soften and facilitate shaping. This is done by heating to a moderate red and allowing to cool. Brass is expensive and unless the reader is an expert metal-worker, he is advised to try either zinc or tinplate for his first venture at a metal hull.

Zinc is very cheap and a soft metal that works easily, but conversely hulls of this material are more prone to dent easily. The metal can be softened by heating, but care must be taken not to burn it as zinc melts at a comparatively low temperature.

The third and fourth plates given at the end of this book give the designs of two larger boats of which the particulars are as follows:—

"BOADICEA."—Length 60in., beam 14.5in., draught 7.5in., weight 77¾ lb. This model is based on the design of a powerful, modern, sea-going tug, and there are several noteworthy features in the design. The deep heel and well-immersed propeller would make her a very able vessel for work in a heavy seaway, and this in the model would also make for straight running. With her generous beam and freeboard, coupled with the really beautiful set of sections that the designer, Mr. H. B. Tucker, has given her, this model should be most suitable for work on open waters where seaworthiness is important. It will be noticed that the superstructure is far forward on this vessel,



a feature of large, modern tugs, the object of which is to get the tow bar as far forward as possible as this increased the manœuvrability and handiness of the craft. Another interesting little point is that the tug's boat is carried on top of the fiddley, and is served by two sets of davits to permit her being lowered on either side of the ship, as desired. If built to five times the size of the reproduced drawings, the displacement would be 45 lb. for the 50in. model, and four times 23 lb. for the 40in.

"CORONET."—Length 60.5in., beam (without paddles) 9in., beam (over paddles) 17.0in., draught 4.0in., weight 49½ lb. This model is a typical paddle excursion steamer of the latest type, and her prototype would carry about 1,200 passengers. The plans give the method by which the paddles are made to feather and some further particulars of this are given in the Chapter on Engines for Model Paddlers. If built to five times the size of the drawings the weight would be 28½ lb., and four times 15 lb.

In deciding how big to build a model several points have to be considered. One of these is, of course, the cost, but there are other considerations.

In this connection I should like to mention some most extraordinary phenomena. If one has to carry the boat to the water, one knows when one leaves the house that she weighs about 35 lb. By the end of the street the weight has increased to ½ cwt., and after half a mile it is about ½ ton! Even more remarkable is the question of length. When building, the footrule assured us that the boat was, say, 4ft. long, yet when one essays to take this into a crowded tram one finds the vessel is over 8ft. long, but when one finally arrives at the lake and sends her on her first journey, her size shrinks until when half-way across the water she is an insignificant little thing not more than 2ft. overall!

Because of their apparently diminished size afloat it is advisable to select a reasonably big size to work to, but one must not overlook difficulties of transport to and from the water. The reader who has a car solves this problem easily, but in any case it is a good thing to join a club, if possible, so as to gain the convenience of the use of a boathouse near the water.

Now with regard to a metal hull, if the builder has a notion to make a real scale job fully plated up in proper style, my advice is to save that sort of work for a glass-case show model, as it is wasted on a working model, which has to stand hard knocks and rough usage. Even the most careful owner cannot prevent an occasional collision, either with another craft or the sides of the pond. If a full-sized ship gets into collision with another vessel or runs full-tilt against a concrete pierhead, she retires hurt to dry-dock. Yet our models are expected to come through such incidents unscathed. In consequence, hulls of working models have to be proportionately stronger than the full-sized craft and different methods of construction are desirable.

Whether hulls are wood or metal, it is highly desirable to make the component parts of the boat as light as is compatible with strength. This applies particularly to tophamper though even below there is no need to make things disproportionately heavy.

In fitting additional deck details—and in the engineroom, too—the question of stability should never be overlooked, and even if the additional weight is low in the ship, it should not be forgotten that extra weight puts the boat down below her marks, and an overloaded vessel is bad in a seaway. Where additional weight is added, it can be compensated by lightening other parts. If, on the other hand, a boat already lacks stability, it may be a question of either adding ballast or reducing the weight of the tophamper. In any case the modeller should be careful to make the total weight of his boat agree with the figures given by the designer.

In building a metal hull a wood former is used, over which the hull is shaped. Without this it is impossible to build a model hull in metal and get a satisfactory shape.

The wooden former can be built up solid by the bread-and-butter method, if desired, although the layers can be screwed together instead of gluing and there is no need to hollow out the inside. This, however, uses a lot of wood and is, therefore, pretty costly. Of course the wood need not be as good quality as that for a wooden hull, but inferior wood makes the carving more difficult.

An alternative is to build up the hull of thin wood by planking it onto moulds (or frames). The moulds can be common deal and the planking cheap, thin wood, so this is quite an inexpensive method. As the planking is merely to serve as a former over which the plating is laid, it need not be close and small gaps do not make any difference. In planking a boat properly, planks have to be a good fit along their edges to make them watertight, and great care has to be taken in shaping, but for our purpose all that is required is to get the form of the vessel.

The third method, which is the one recommended, consists of a combination of the bread-and-butter and the planking systems of making the former. The parts of the former that it would be difficult to plank are made up either from the solid or by bread-and-butter, and the remainder by planking. The solid parts are the bottom as far as the turn of the bilge and the extreme ends.

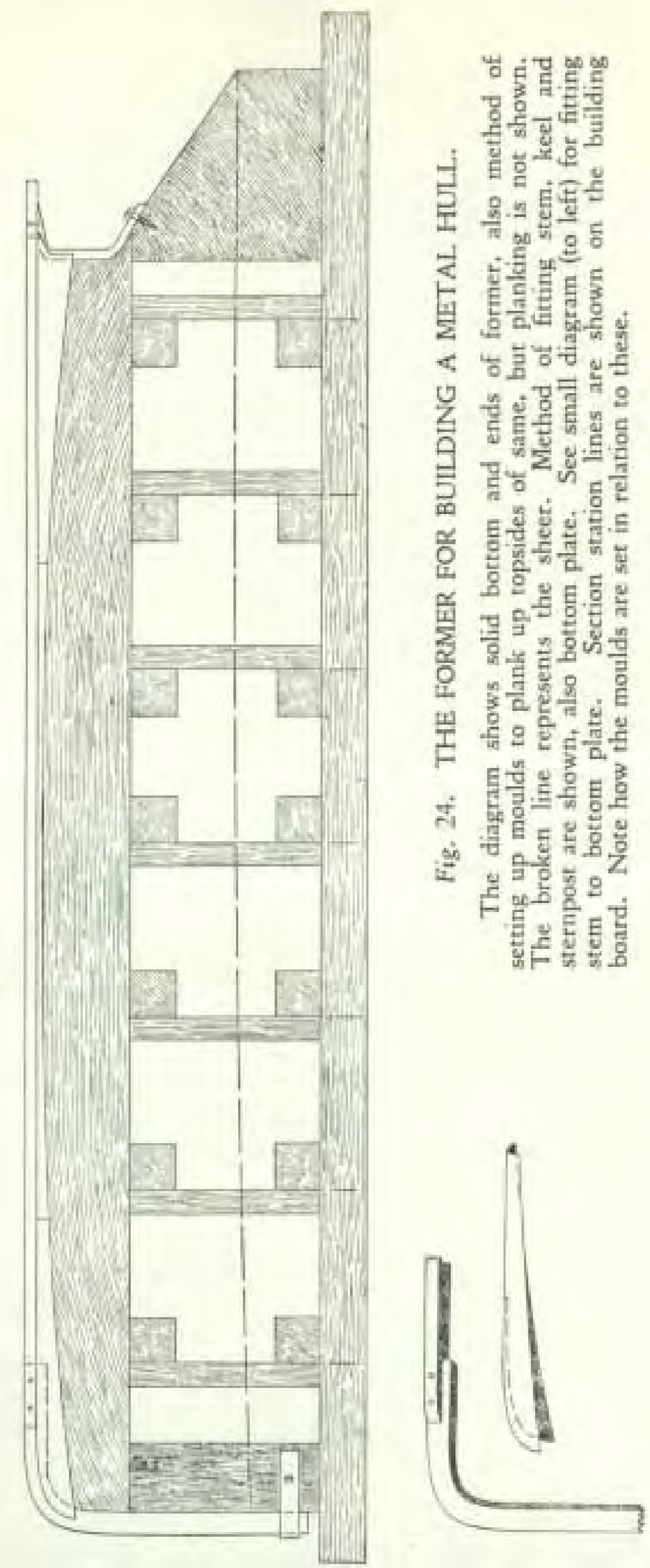


*Fig. 24.* THE FORMER FOR BUILDING A METAL HULL.

The diagram shows solid bottom and ends of former, also method of setting up moulds to plank up topsides of same, but planking is not shown. The broken line represents the sheer. Method of fitting stem, keel and sternpost are shown, also bottom plate. See small diagram (to left) for fitting stem to bottom plate. Section station lines are shown on the building board. Note how the moulds are set in relation to these.

The bottom can either be carved out of a single thick plank or built up in layers bread-and-butter fashion. If the builder has to buy his wood this is easier and possibly lends itself to greater accuracy in following the design, but if the builder has a piece of thick board in hand, it is not worth the expense of buying special wood.

The bottom must be carefully carved to shape, special attention being paid to getting the two sides exactly alike. When this is finished, the topsides have to be added. A glance at the sketch which accompanies this article will make the matter absolutely clear.

The diagram (see *Fig.* 24) is not to scale, and is merely to show the method of making up the former and laying the keel strakes. In order to make this clear certain of the parts have been exaggerated slightly. Also it is really desirable to use more transverse section moulds. The solid ends to the former are, of course, recessed to take the ends of the battens which are used to plank up the sides.

It should also be added that although dimensions are given, these apply to a boat the size of "Boadicea," and must be varied if necessary for other sizes. In building to other sizes and designs the builder will have to judge for himself to a certain extent, and make such minor modifications as are required.

The section moulds are erected on the solid bottom and then planked over with thin wood, say, ⅛in. thick. Obviously if the moulds were made full size like the bottom, the planked-up part would be ⅛in. full all over. The moulds for the planked part must therefore be reduced by ⅛in. (or whatever the thickness of the planking wood may be) all round to allow for planking.

Before starting to carve the bottom, mark on the top of the wood a centreline and the station lines for the erection of the section moulds. The moulds can be cut out of any wood about ½in. thick, and are secured to the solid bottom by setting them against cross-pieces of wood about 1in. square.

It will be seen from the diagram that the boat is built upside down on a building board. The section moulds have to be made sufficiently long to come down to the building board, and a line to represent this should be struck on the plans.

Now there is one most important point to remember in connection with setting up the section moulds. *Those in the fore part of the boat must have their after faces on the section stations, and those in the after part must have their forward faces on the station lines.* The reason for this will be apparent in due course.

In setting up the section moulds screw the cross-pieces of



1in. square wood to the bottom on the far-side of the station line. Then, when the moulds themselves are screwed to the cross-pieces, they will come in their proper positions.

The screws holding the moulds to the building board must be put through from the underside of the building board, and it will facilitate this if similar cross-pieces of 1in. square wood are used.

When the moulds have been set up, take a batten of the ⅛in. wood and offer to the moulds. It will be seen that owing to the curvature of the sides the batten does not take right across the moulds but only on one edge. Rasp the moulds down until the batten takes firmly right across them. It will now be obvious that if the moulds had not been correctly placed with regard to the station lines the hull would not be the correct shape as the moulds would be too small.

It is obviously necessary to put a sort of inner stempiece at the fore-end of the former in order to fasten the planking together and support the stem. The fore-end of the former is accordingly carved from the solid. As it would be an extremely difficult job to get the planking round the tuck of the counter, this is best carved out of the solid also. These ends of the former are screwed to the building board in their correct positions.

Before starting to plank the former, check again to see that all is fair and true. Then plank up with strips of ⅛in. wood. It will be seen that these have to be wider in the middle than the ends, and also that they have to be cut with a curve that varies with the position of each plank on the boat. In order to avoid distorting the frame, it is advisable to put strips on each side alternately.

The builder has not got to get his planks up absolutely tight, as all that is being done is to make a former for the plating. At the same time the way the planking falls is something of a guide for later work. If much difficulty is found in getting the shape of any planks, paper patterns can be cut. If necessary, the planks can be in several lengths.

Having finished the planking, rub the former down with medium glasspaper to take out any humps or bumps. This completes the former, and the plating can now be started. For a medium-sized model **X** (Single Cross) tinplate is suitable, and for a larger boat such as "Boadicea" **XX** (Double Cross) tinplate. Thinner plate is inadvisable, as it tends to buckle while being soldered, but the above is thick enough for strength without being unduly heavy.

The method really consists of building the hull up in metal strakes, which are soldered together where they overlap. As the largest size sheets usually obtainable are 28in. long, the strips forming the strakes will have to be in at least two parts. It is inadvisable, however, to have more joins than are absolutely necessary, as these add to the weight of the hull. When the hull is finished, the metal is so thin that it can easily be built up in the painting until the laps of the strakes disappear entirely, leaving a smooth-skinned hull.

The first step is to make up the keel, stem and sternpost. The keel for a medium-sized model can be a piece of $\frac{1}{4}$in. square brass. The stem is $\frac{1}{2}$in. by $\frac{1}{8}$in. brass. The wide way of this is, of course, set fore-and-aft. To bend this, anneal the brass by bringing it to blood-red heat, and allowing to cool. It may be necessary to re-anneal before the bend is complete. The keel has a slot cut in the fore-end, to take the foot of the stem, which is riveted and sweated in position. The whole is filed down fair.

The construction of the sternpost and **A**-bracket will largely depend on the design of the vessel. However, this can be made of a piece of $\frac{1}{4}$in. square brass like the keel. The sternpost will have to be opened out in order to get the stern-tube through it. This is done by putting a fairly sharp bend in the brass at the required spot and then cutting down the back of the bend with a hacksaw. After the metal has been straightened, a pointed tool, such as a marline-spike, can be inserted, and the sides of the cut opened out until it will take the stern-tube. Find a piece of brass rod, about the size of the stern-tube, and insert temporarily in the hole and squeeze the slot together above and below the hole. There will still be little gaps above and below the tube, but these can be filled up when the stern-tube is finally inserted and soldered into place.

The keel and stem can be assembled before being put on to the former, but the beginner will probably find it easier to leave the sternpost until he has got the keel in position on the keel strake. Be sure to get keel, stem and sternpost aligned correctly on the hull.

Owing to the sharp bends in the ends, the keel strake must be made in three parts—bow, stern, and middle. In the middle this strake goes over the centreline and forms the lowest part of each side, the actual keel being soldered on outside it. At the bow and stern the keel strake laps the stem and sternpost. This will be clear by the diagram showing the forefoot and plating (see *Fig.* 24).

Start by bending the middle of the keel strake over the former. Cut and bend the forward part, leaving the fore-end open to take the stem. Solder these together. Then make and solder on the stern part. There may be a little difficulty in bending the end parts of the plate, but it will be found that the tinplate can easily be worked down into shape by means of a piece of wood.



Drop the keel and stem into place, and solder to the plates. The sternpost is then fitted. The lower end of this should be pinned before being soldered to the keel and its upper end can, if required, be screwed temporarily to the wooden after-end of the former. The plates lap this in the same way as they do the stem.

The next strake can probably be made in two parts. As the girth of the boat is greatest in the middle the strips of tinplate for the strakes will have to be widest in the middle. How wide the builder can make his strips will depend on the shape and size of the boat, but he should get them as wide as he conveniently can in order to save work. Cut a brown paper pattern first to get the shape, and use it to make a pair of strakes, one for each side of the boat. When the strakes are fitted they can be soldered into position. Fit the after part of each strake first, so that the fore part laps it.

The strakes overlap about $\frac{1}{8}$in. or slightly more. One point that must be very carefully watched is that the strakes lie flush on the former and do not spring away, as any error in this respect is intensified with the next strake.

It will help the builder to get his plates down flush while soldering if he has a strip of thin wood, say, 6in. long, and holds this on top of the plate he is soldering, parallel with the overlap.

The remaining strakes are put on in the same manner. There are one or two little points that will help the builder in his work. In order to hold the plates in position until they are soldered, the worker can wind a cord round the boat, using wedges where there is a hollow. An alternative method is to use tintacks, which are driven in just far enough to hold and subsequently withdrawn. The holes for the tacks must be started with the point of an old scriber, or something of the kind. When the boat is finished these holes have to be filled with solder. The main disadvantage of using tacks is that it leaves little burrs on the inside of the hull. It is useless to try to hammer these out as it will spoil the hull, and they have to be filed off sufficiently to prevent the danger of scratching the hands when handling the boat.

As the builder approaches the sheer, he should watch the shape of the strakes so as to get the top strake a nice, wide one, with its upper edge properly shaped to the curve of the sheer.

When the boat is plated up, take the building board off and take the moulds out. If there is any part holding, the moulds must be persuaded out. The planking strips and ends follow and the bottom of the former should then come out without difficulty. This is easiest in a boat with straight sides, but should present no difficulty even in a boat like "Boadicea," which has a slight tumble-home.

At this stage a metal hull is very flimsy. The best thing to stiffen the boat up is to fit a wooden shelf. This is a wood batten, say, $\frac{1}{4}$in. wide by $\frac{3}{8}$in. deep. The battens are held in place with little brass nails, spaced every 2in. or 3in., and clenched inside by having the points turned over. The points, by the way, should not be turned with the grain of the wood. The back of the batten, where it goes against the hull, should be well luted with a mixture of white lead and varnish, and put on wet. The heads of the nails are well pressed in, and soldered over, and, once the boat is painted, become invisible. If a tin deck is being fitted the top of the shelf is set level with the edge of the sheer-plate. If a wood or aluminium deck is used, the top of the shelf is set the thickness of the deck below the sheer, so that the deck can be dropped in.

In order to support the deck, beams have to be fitted. These are wood, with their ends mortised into the shelf, as described in the Chapters on Wooden Hull Building. The width of the boat should be carefully checked before the deck-beams are fitted, so as to be sure the hull has not sprung.

The deck holds the whole fabric of the boat together, and once it is on, the hull will become strong and rigid. If an aluminium deck is being used, it can be screwed to the shelf and deck-beams. If a tin deck is being used, this can be soldered to the top of the side, in the usual way.

If an aluminium deck is used, it is advisable to protect the under-side with either paint or varnish. At the sides, where it beds on the shelf, and where it beds on the beams, these should be well luted with the white lead and varnish mixture.

One point about the soldered tin deck is, that it can be regarded as a permanent job, and, once on, cannot be taken off to make alterations.

I omitted to mention the great advantage of using a wooden shelf. In a metal hull, this not only adds rigidity, but also a certain amount of elasticity that enables a hull built this way to take a blow without denting.

## CHAPTER X

### *Engines for a Model Paddle Steamer*

IN a paddle steamer the engineroom is a centre of attraction, and there is no reason why the plant of a model paddler should not be equally attractive, as a very good plant closely resembling the prototype can be built without undue difficulty, and the use of standard model locomotive parts will simplify matters, so that the whole thing can be constructed without the use of a lathe and with a very modest toolkit.

Paddle engines are essentially slow running in the prototype, and older vessels ran at about 80 r.p.m. The most modern paddlers, however, have much smaller wheels, and run considerably faster, but even then their speed is comparatively low, and this must be remembered in building a model engine.

The first thing to determine is the size of engine required. For a 5ft. model like "Coronet" a pair of double-acting cylinders $\frac{1}{2}$in. bore by $\frac{5}{8}$in. stroke would provide ample power, but this will depend largely on the steam pressure available. In any case to run the engines too fast will destroy the likeness to the prototype, though the wheels on a model will necessarily be driven at a higher number of r.p.m. than the full-sized ship.

The cylinders used are model locomotive, but nowadays outside cylinders are more easily obtainable than inside cylinders. These can be obtained in all stages from castings to finished cylinders. How far finished the builder obtains his cylinders will depend on the tools he has, and those who have no lathe will be obliged to get finished parts.

An immense variety of these parts is obtainable from suppliers such as Messrs. Bond's or Kennion's, who specialise in these model locomotive parts, so builders should have no difficulty in getting what they want for any size of boat. These cylinders have nothing to rust internally, but other external parts of the engine will require rubbing over with oil from time to time to prevent rust.

You will also require the eccentrics for the valve gear, which will need a little modification. The frame is made of sheet steel, about 16-gauge, as used for model locomotive frames. In addition to these there is a number of small parts to buy, that will be mentioned as we come to them.

When you are getting your cylinders, there is no difficulty in getting the supplier to let you have these with the steam chest put on the reverse way to a locomotive outside cylinder. This will bring the slide valve on what would be the inside in a locomotive, but in our case will be the outside. In a locomotive these cylinders are placed outside the frame, with the machined face against the plate. In a paddler's engine the cylinders are inside the frame so that the machined face is outside, with the valve on top.

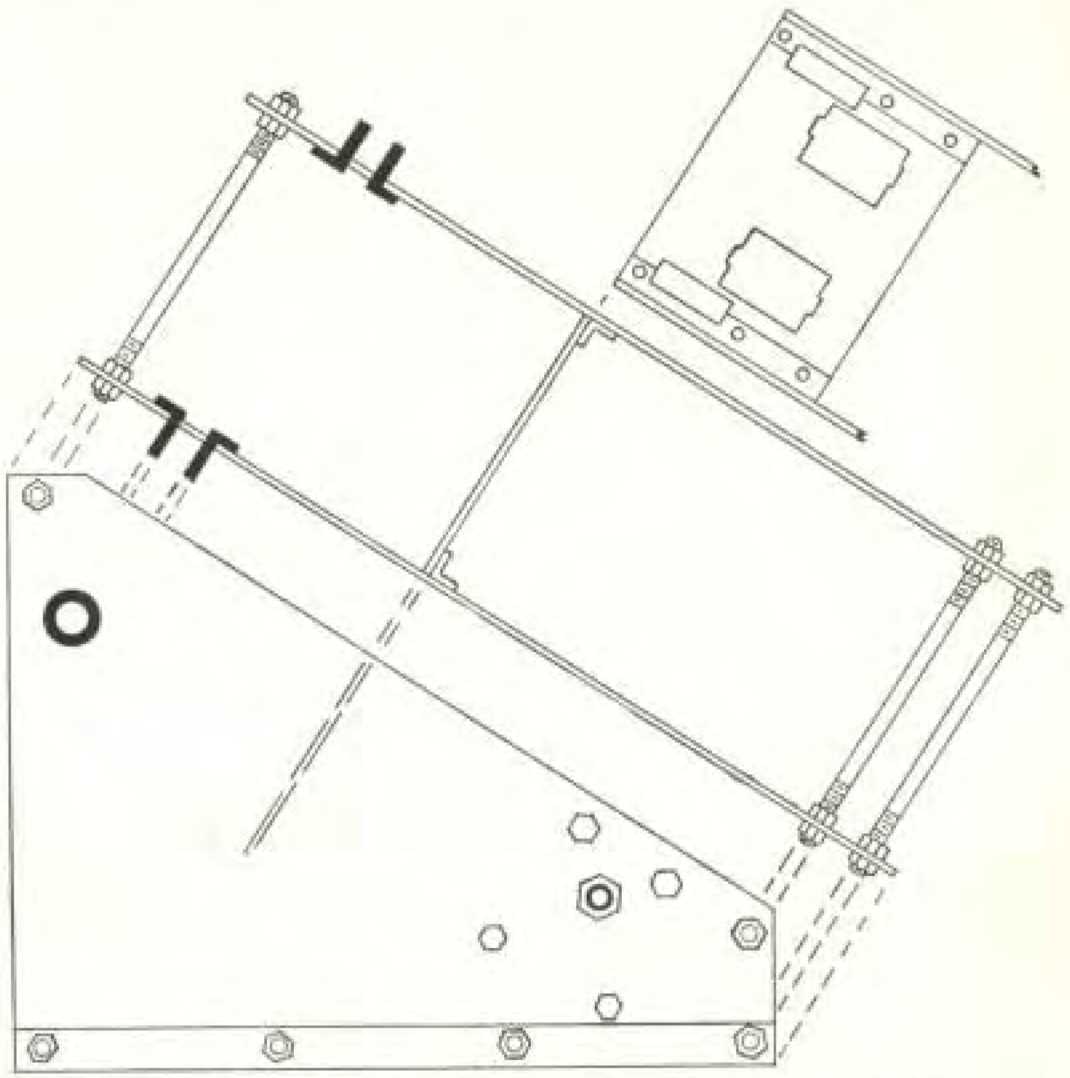


*Fig.* 25—FRAME FOR MODEL PADDLER'S ENGINE

The side frame and angle pieces for holding-down bolts are shown in profile at the bottom of drawing. Above is whole frame, shown in plan. The top drawing shows the motion plate, the actual position of which can be seen in the lower drawings. The crankshaft bushes are shown black, as is also the exhaust pipe.

Start by cutting out the two steel side frames. The dimensions will be determined by the stroke of the engine and the height of the paddle shafts. The cylinders should be kept as low in the boat as possible, as they represent a great mass of metal. The length of the connecting rod can be varied to suit circumstances, but it should be remembered that an unduly



short rod will increase the side thrust considerably, and an overlong rod produce whip. The drawing is not intended to be a hard and fast plan but merely to give the novice a suitable general lay-out, and so cover a variety of different-sized engines.

The two frames should be cut out and drilled at the same time. The best way is to mark out the frame on one piece of metal, together with the holes for the distance pieces, of which seven are shown in the drawing. Start by drilling one hole through the two plates suitable for one of the distance pieces. Fix the two plates together with a bolt and nut. Drill a second hole and put another bolt through. The two plates are now firmly held, and can be sawn out and drilled at the same time to ensure uniformity.

The whole frame is held together by means of threaded rod and nuts. These can be either brass or steel. The plates are held at the desired distance apart by nuts inside and out. Alternatively, plain rod can be used, and the ends threaded. If threaded rod is used, a neat way is to use pieces of brass tube as distance pieces. The only objection to this is that the ends of this tube must be faced off dead true, as otherwise the frame will be distorted.

It is most important to get the two side plates absolutely parallel. The next thing to determine, however, is the distance apart for the two side frames and to ascertain this we have to mount the cylinders, one on each side frame.

Whilst we still have the two side frames bolted together the holes for the crankshaft bushes should be drilled. This will also help to line up the cylinders.

In some types there are two holes in the machined face of the cylinder. The smaller one is intended for the inlet, and the larger one towards the centre for the exhaust. We are going to use the exhaust for the purpose for which it is intended, but the inlet is not going to be used and a fresh inlet will be drilled later through the steam-chest cover. The present hole will be used for one of the four holding-down bolts which fix the cylinder to the side frame and the bolt will also serve the purpose of plugging this hole.

See that the screws holding the cover of the steam-chest are not standing proud, and take a small set-square and scriber. Mark a line lightly across the face from top to bottom, passing exactly through the centre of the smaller hole. Then mark another line from side to side. Take these lines just round the corners so that their position can be seen when the cylinder is laid down on its face. Place the cylinder on the side frame and mark the ends of the lines on it. If the spots are joined up you will have a cross that gives you the position to drill the hole for the holding-down bolt.

Next mark the machined face in similar fashion for the larger hole. In order to get the second hole to register, the cylinder should be put in position and a bolt put through the first hole and screwed up. Now line up the cylinder carefully so that the piston-rod points dead at the centreline of the crankshaft, or rather the position it will occupy when we have made it. Then mark out to get the position of the second hole and drill.

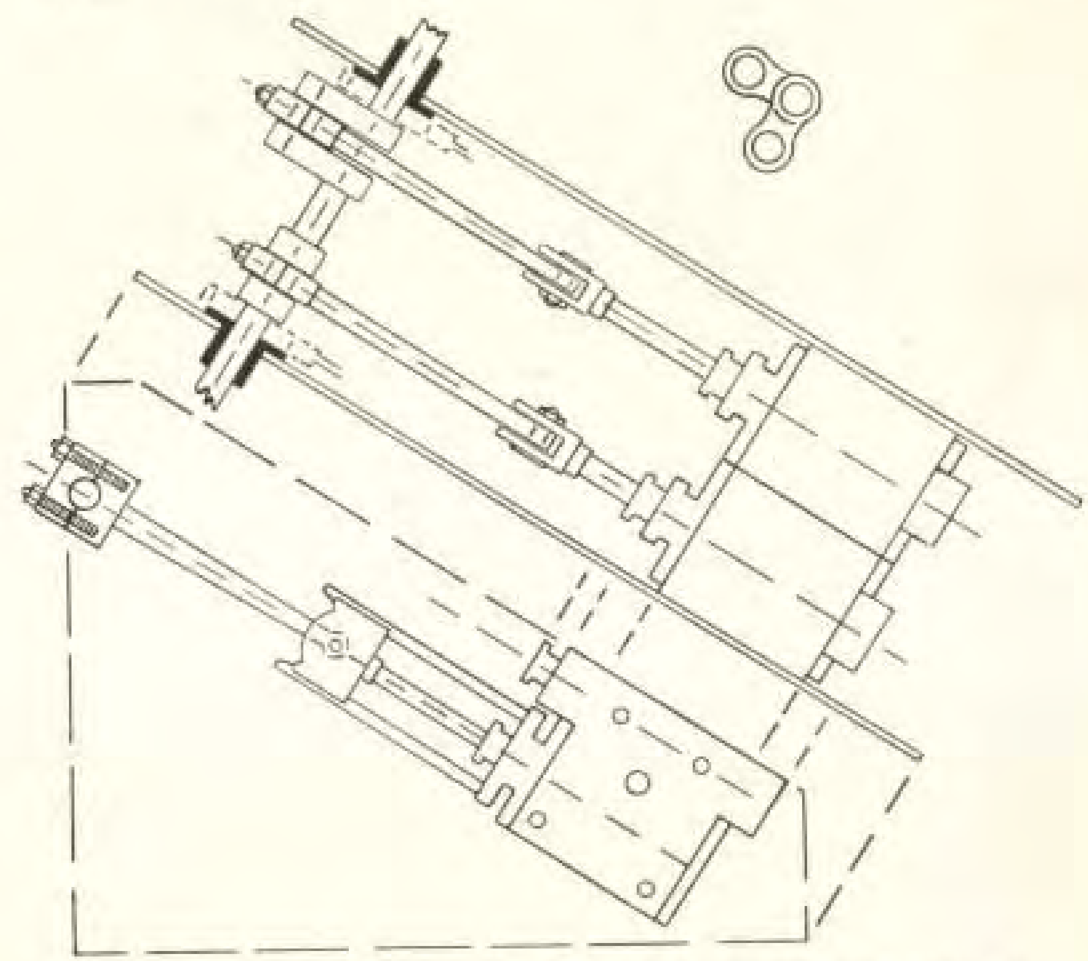


*Fig.* 26—GENERAL LAY-OUT OF MODEL PADDLER'S ENGINE

The two lower drawings show cylinders, pistons, crankshaft, etc. The small upper drawing is an end view of the crankshaft, showing how webs are set at right angles.

The exhaust pipe goes through this hole and the end has to be threaded to suit. A thin nut is put on the pipe outside the frame. Take a piece of suitable copper pipe for the exhaust and thread one end. You can put this on one side and use for the actual exhaust pipe later. Put the holding-down bolt in first and then the exhaust. If the latter does not go in, it may be necessary to draw the hole over slightly. Screw up and then drill for the other three holding-down bolts. You



must space these between the bolts holding down the steam-chest cover. When drilling, use a clearing size drill through the steel, and change to a tapping size for the cylinder. A stop must be put on the drill to prevent the drill injuring the cylinder wall and a good thickness should be left as the metal is soft, and the steel bolts will distort them unless sufficient metal is left. Tap out the holes and insert the remaining bolts.

The other cylinder has to be mounted on the other side-frame, in similar fashion, but there is a little more difficulty in finding the position for the first bolt hole. Cut pieces of the screwed rod approximately to length for the distance rods and put the frames together temporarily but get them parallel. Put the side with the unfixed cylinder down. Having marked the machined face for the first hole, put the cylinder in position and spot for the cross lines. Then proceed as before.

You can now ascertain the spacing of the crank webs by measuring the distance apart of the centres of the piston rods. Having got this the crankshaft can be made. First file and drill out the crank webs. These can be made from a short length of rectangular mild steel. A pretty stout crankshaft is desirable, as the bearings are wide apart, and a slender shaft will whip.

In making, drill one web first, and use as a jig to get the four even. Be careful to get the holes square. When one hole has been drilled in the second web, put a piece of the material being used for the crankshaft through the two pieces to locate them and drill the other hole.

Having made the webs, take two lengths of the mild steel rod which you are using for the crankshaft, and pass through a pair of the webs, putting these in their correct position. Take a third length and put the second pair of webs in position. The webs must be set at right angles. If fairly long lengths of rod are used, there will be no difficulty in lining these up by eye. When they are correctly lined up they must be pinned with a small pin through web and shaft, and soft soldered. The superfluous rod is cut away and, after cleaning up, the crankshaft is complete except for being cut to length.

Take the frame apart and drill holes in the angle pieces that go at the bottom of the side frames and take the screws that hold the engine on the bearers. These holes should be drilled to coincide with the threaded crossbraces so that the nuts will hold the lot together. Also drill the holes for the holding-down screws, but space between the crossbraces.

The next thing will be to get the frame finally lined up. Put the cylinders back on to the frame, and set the frame up. In order to get it true, place on a sheet of plate-glass. Use a set-square to check that the sides are truly vertical. When all is in order, take your soldering iron and put a little solder on the inside of each inside nut, so as to prevent its losing its position on the rod.

The bushes for the crankshaft will have to be turned. If the builder has no lathe, he can get these made very cheaply at the shop where he buys the cylinders, etc. These should be phosphor-bronze. The bushes will have to be sweated into the frames. Put a piece of steel of the same size as the crankshaft through the two holes before you sweat up, so as to keep the bushes in line during the operation.

Take off one side-frame. If the crossheads are not already mounted, these can be put in place. Model locomotive practice is to simply pin these, but it makes a better job if these are screwed. A pin is required, even if they are screwed, to prevent them slacking back.

The present design allows for the eccentrics being put in position after the crankshaft is built up, but if the valves are put inside they will have to be put on as the shaft is built up.

The standard locomotive eccentric will, however, have to be modified for our purpose, as the side boss, with the setscrew, will have to be removed. In order to hold the eccentric on the shaft, it is drilled and tapped for a grub screw. When the eccentrics have been prepared they can be put on to the shaft and their position adjusted later by means of the grub screws.

Be careful the grub screws do not stand proud. If anything, they should be slightly below the periphery of the eccentric.

One side of the eccentric takes against the web, while the outer side bears against the flange of the bush, which should be of a generous width accordingly. Likewise the web and bush serve to keep the strap of the eccentric in track.

The next thing to do is to make the motion plate. This is made from the same material as the frame. If you are not quite sure of the size holes to cut for the crosshead and valve-gear, these can be cut on the small side first, and opened out as requisite later. The brass angle plate is screwed and sweated onto the motion plate. After you have put the screws in, test this in the frame before sweating up, as any slight discrepancy can then be corrected. The screws holding the motion plate to the side-frames should be hexagon-headed, to match the other frame screws. The crosshead guides house in slots in the motion plate, so care is necessary to get these lined up properly.

It will add a nice finish, and save rusting, if the frame and motion plate are painted.

The connecting rods can now be made. There are several ways in which this can be done. The whole thing can be



cut out of bronze rectangular bar, or just the head can be bronze and the remainder steel. In the latter case the small end should be bushed. If you happen to have a little piece of brass tube of the right size, this would not make a bad bush. The end of the steel rod will have to be screwed and sweated into the head.

The rectangular bronze head is made up as a split big end. In making, sweat the two halves together temporarily,

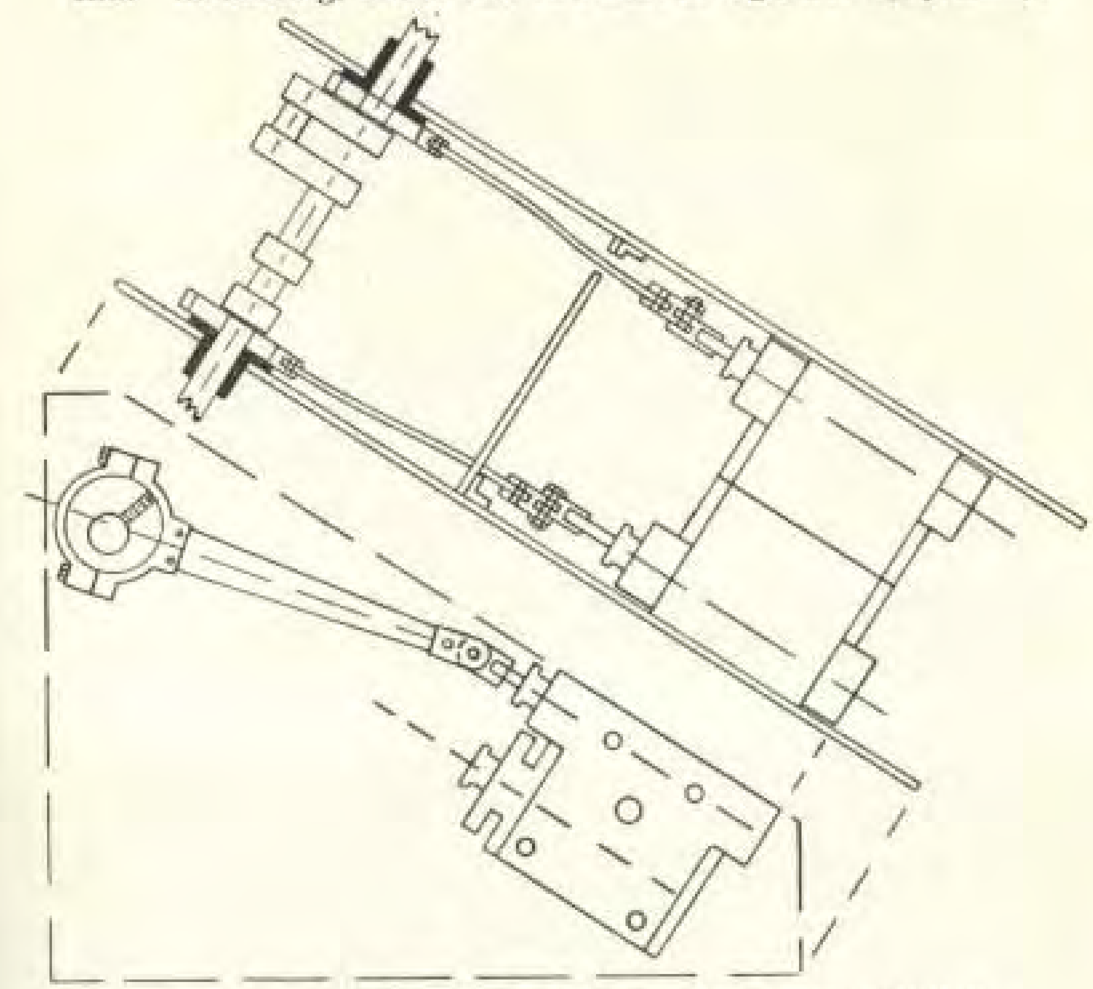


*Fig. 27*—VALVE GEAR OF MODEL PADDLER'S ENGINE

This diagram shows valve eccentrics and rods. The plan view shows motion plate in position, one side being cut away to show the hole through which the eccentric rod passes. Holes for inlets drilled in steam-chest covers are not shown.

while you drill and tap the holes for the studs. The top part, of course, must be drilled clearing size to slip off. The hole for the crankpin has also to be drilled. Be careful to get this just on the line between the halves. The studs should be just far enough apart to clear the centre hole.

In making the connecting rod the length must be arranged so that the piston has an equal clearance in the cylinder at each end of its stroke.

It will probably be necessary to offset the eccentric rod, but this will depend on the parts purchased. In one of the most common types of eccentric which is sold for model locomotives, the rod can be removed from the strap, and a longer rod fitted. This is what is actually shown in the drawing. The rod is flat strip steel, filed to shape, and the two rods should be filed up together. The form of knuckle joint shown can easily be sawn and filed to shape. This can be steel or bronze. On a small engine it is unnecessary to bush the holes. The pin is steel.

When making the eccentric rod this should be made a little too long when filing up. Take the cover off the steam-chest and arrange the length so that equal port opening is given. The rod should be sweated as well as riveted to the strap and knuckle.

The valve timing can now be adjusted by means of the grub screw. The inlet port should open just before the commencement of the stroke. The direction in which the engine runs will depend on which way it has to be installed in the boat, but if there is a choice it is preferable to arrange for the thrust to come on the top guide.

Whilst you have the cover off the steam-chest, the new hole for the inlet can be drilled and tapped for the inlet pipe. By having the two inlets on the top of the engine a **T** union can be put on the main steampipe.

The engine is more or less finished now, but there are some general remarks that must be made, as nothing has been said about lubrication. All bearing surfaces require provision for lubrication. For instance, the crankshaft bushes should have oil-holes drilled. It is not really sufficient to go all over the engine with an oil-can, and provision should be made for a steady feed of oil to all parts that require it. This can be effected either by a wick feed system or a pipe system fed by gravity from a tank placed in a suitable place. Very fine pipes have to be used, and the ends pinched up.

Wick feed oiling is probably the most suitable for this type of engine, and oil-boxes can be placed at suitable spots over the parts that require lubrication. Details of this system of lubrication have already been given. In order to get the oil to a moving part such as the big end, the end of the wick is brought to a position where it is brushed by the part in question each revolution. In order to facilitate picking up the oil a small projecting piece of metal should be left on the top, which will just touch the wick in passing. The main bearings will, of course, be pipe-fed.

One disadvantage of these big engines running at slowish speeds and low pressures is, that there is a liability of excessive condensation. This can be guarded against by lagging the cylinders with asbestos. If the blue sheet-metal cylinder lagging, sold by model shops, is put round the whole, the appearance will be enhanced. There is no difficulty in putting this on, as the cylinders are designed for it. It would also be as well to lag the main steampipe with asbestos string, especially if there is any distance between boiler and engines.



In lagging a steampipe with asbestos string, the two ends of the string can be secured with thin brass or copper wire.

The next consideration is a suitable boiler for the plant. We want a boiler that will keep the weight low in the boat, and it must be of good capacity, especially if a feed-pump is not being fitted. A pressure of 100 lb. is the maximum required, but even then it is desirable to have a well-made boiler, and, if the builder is unable to silver solder reasonably well,

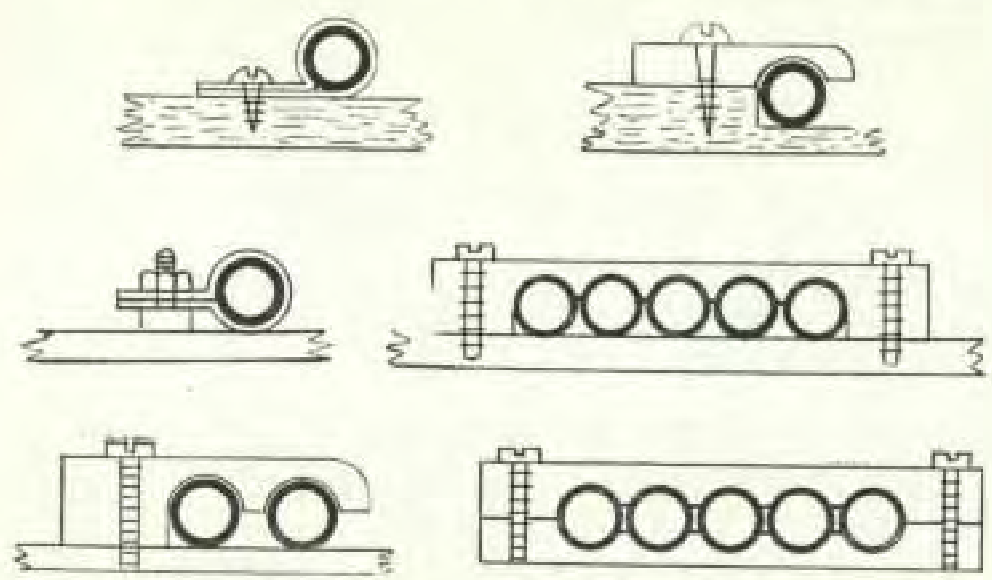


*Fig.* 28—USEFUL FORMS OF PIPECLIPS

he would be well advised to have his boiler made for him, or buy one from one of the well-known firms dealing in model supplies.

The best type of boiler for a job of this kind is the marine with an oval flue. In this kind of boiler it is desirable to have the flue of generous size in order to ensure complete combustion. This is a very important point, as lack of ventilation will prevent the blowlamp doing its job properly, with the result that steam will be difficult to maintain. Also the fumes will be unpleasant and possibly dirty paintwork and fittings.

To assist ventilation it is a good plan to turn the exhaust up the funnel, but in doing this be sure to give the end of the exhaust pipe an upward turn, as otherwise as much steam will blow downward as upward, with the result that things will be worse than ever.

Whilst on the subject of boilers, attention is drawn to the desirability of lagging boilers as well as steam pipes. The benefits of this are twofold. Firstly the heat is kept from the boat's hull and upper works, and secondly the dissipation of heat is prevented. This means that all heat generated is usefully employed and thus less heat is needed to produce the same volume of steam, and the use of less heat is also beneficial as regards keeping hull and upper works in good condition.

Before leaving the subject of engines and boilers, mention might be made of the desirability of arranging the pipework (oil-pipes in particular) neatly. A group of pipe-clips are shown in *Fig.* 28 as used in wood and metal hulls, and their construction, either from strip or from solid brass, will be apparent.

The only points of note are the method of making a stud for a metal hull by soldering a bolt to it point upward, and that the screws or bolts should be close up to the pipes.

When the engine is completed, the modeller will have to turn his attention to the paddle wheels and the method of coupling these to the engine.

The spindles of the wheels are hollow and fit on extension shafts, coupled to the main shaft. For the spindles the modeller will, therefore, require a piece of brass tube that is a good fit on rod, the same size as the engine shaft. The side discs of the wheel are thin sheet brass. Take four pieces of sheet brass and drill a hole through the centre of each, the correct size of the spindle. Mark out one plate with a scriber to the shape of the wheel as given on plans. Place the other three pieces of brass under this and bolt the four together firmly. If there is the least tendency to move, drill a second hole through one of the parts that has to be cut away between the spokes, and put a second bolt through. The reader has probably done fretwork at some time, and will remember the wooden saw-block, with a slot for cutting, that formed a part of the outfit. Take a piece of wood and make a similar sawing-block. For cutting the wheels a jeweller's saw is used, and, as mentioned previously, this is only a metal fretsaw, and used exactly similarly. In fact, if the worker has an old fretsaw frame, all he needs is a packet of blades, which only costs a few pence. Cut close round the circle of the wheel, leaving the finishing to be done with a small Swiss file. In cutting out the pieces between the spokes of the wheel, drill a hole to thread the saw blade through, and holes at each corner to facilitate turning the blade.



It will be seen that the floats are mounted on arms, and the holes for the arm pivots can also be drilled. The four side plates should be entirely finished before being unbolted.

The floats are brass with brass arms soldered to them. If the first arm made is used as a template, be sure to use the same one as a template throughout, as otherwise a progressive difference will be introduced, so that the last one is nothing like the first.

The floats are made to feather by means of the feathering arms shown in the diagrams of the wheel. The bottom arm in the diagram is the master arm. Instead of being pivoted, both on the float arm and the centre disc, it is riveted to the centre disc, and thus rotates the disc and attached arms in step with the paddle. The disc is offset slightly and thus forms an eccentric, which causes the floats to alter their angle as the wheel rotates, and this imparts the feathering motion to the floats. The disc turns on a pin in the outer side of the sponson, or perhaps I might express this better as the outside wall of the paddle well. The amount by which the pin of the disc is forward of the axle of the wheel is roughly half the length of the float arms.

With this explanation the worker should have little difficulty in making up the paddle wheels. One little point is that the float arms should be bent at an angle where they join the float and have a little extra left to form a good joint with the float. It will be seen that the floats are overhung (i.e., project beyond the side discs of the wheel).

To fix the wheels onto the extension shafts (or possibly it would be more correct to call them "drive" shafts), holes are drilled and tapped through wheel axles and shafts, and screws put through.

In order to take the extension shafts, holes are drilled through the sides of the ship and bearing bushes inserted. It is very important that when the job is finished these bearings should be in perfect alignment with the engine bearings so that the whole shaft is in line. Further, as the wheels project such a distance beyond the bearings in the side, these bearings should be as long as possible, and there is no reason why they should not extend pretty well to the wheels themselves.

In order to permit the lining-up to be done easily, the holes through the hull should be considerably oversize for the body of the bush. The latter should have a plate at the end, which will cover the hole, and can be fastened to the surrounding wood or metal by screws or soldering as the case may be.

The coupling between the engine shaft and the extension shafts is effected by means of sleeves consisting of pieces of brass tube through screwed to each shaft with set screws. It is important that this tube should be a good fit on the shaft, and also that the sleeves should be as long as possible. It will make a stronger job if the two shafts are halved (or stepped) into each other at the ends. The plain butted connection is shown in *Fig.* 29.

Now the width of the engine will vary with the cylinders used, but it should not be over about 3in. The internal width of the hull will vary according to how the hull is built, but should not be over 8in. So there will be a minimum of 2½in. each side of the engine. The joints between the shafts should come about one-third of the distance between the engine and sides, measuring from the engine. This is important as the position of the joints governs the length of the sleeves. This will be apparent when the method of fitting up is detailed. By this means a sleeve at least 1½in. long can be used.

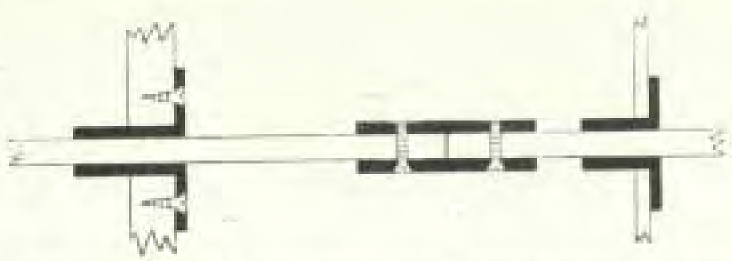


*Fig.* 29—CONNECTION BETWEEN PADDLER'S MAIN-SHAFT AND EXTENSION DRIVING SHAFT

If the two ends are halved and stepped into each other, an even stronger joint will be obtained.

When the various parts have been prepared, remove the engine from the boat. Pass the extension shaft through the bush (which is left unfixed), through the hole in the side and into the paddlewheel. Put the screw through the wheel and shaft. Push the connecting sleeve on the extension shaft as far as possible. Do the same with the other extension shaft. Then put the engine in place and screw down on the bearers. Put the sleeves in position over the joints with the set screws in place. The whole shaft will then take up its own alignment and the bushes can be fixed to the sides. To test the alignment, disconnect the big ends and see all runs freely.

With regard to the bushes for the side bearings, these can be made at the same time as those for the main-shaft bearings and are exactly similar except that they are longer. The bushes can either have a wide flange or be fitted with plates made of sheet brass to cover the oversize holes in the sides, and should have four screw-holes drilled if being used in a wooden hull. The edges of the holes through the wood or metal sides should be protected with paint, and in the case of a wood hull the undersides of the bush plates should be well luted before screwing down. In a metal hull the flanges of the bushes are soldered to the sides of the hull.



These bearings will require lubrication and, as the water is liable to wash oil away, grease should be used. Very small greasers can be obtained suitable for this purpose, and these will have to be arranged so that they can be replenished as required.

Of course the installation must be done before the deck is put on, but if it is properly done, there will be no difficulty afterwards in removing the plant when necessary for overhauling.

## CHAPTER XI

*Funnels; Masts and Spars; Rigging; Rails*

THE funnel is the most prominent feature of the upperworks, and should consist of an inner and an outer funnel. The former is the boiler uptake, and is fixed to the boiler and not attached in any way to the outer funnel, which is part of the superstructure. A glance at *Fig.* 11 will explain this, and all other installations will be similar. In ships with several funnels, some of them are often dummies, and will consist of an outer funnel only.

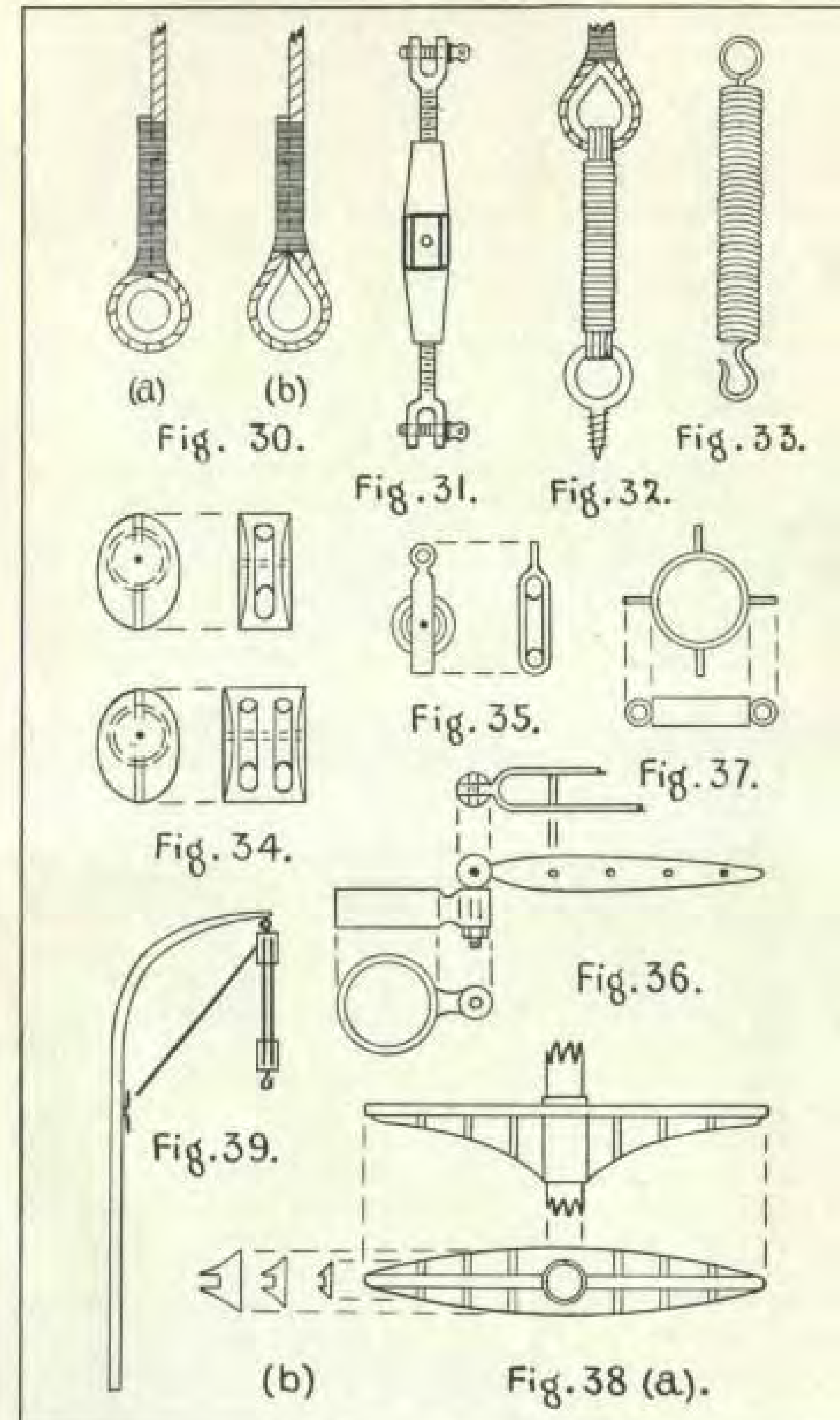
The inner funnel (or uptake) is a piece of light brass tube, or, if tube the right size is not available, can be bent to shape from light sheet brass, and riveted. There should be a reasonable air space between inner and outer funnels, and this should be open at the lower end as well as the top in order to promote air circulation and dissipate heat. By this means the outer funnel should be kept pretty cool so that the paint is not burnt.

Unless the builder is able to braze or silver-solder, he will have to get a piece of light brass tube of suitable size. For an oval funnel this can easily be bent to shape. Any bands round the funnel can be made of half-round brass wire. These are riveted in place with the rivet heads inside the funnel. In order that rivets may be flush on the outside, the holes are slightly countersunk. The butt-joints at the ends of the wire will not be absolutely square, owing to difference in circumference between the inside and outside of the bands. The joints in the bands can be arranged to fall under steampipes, etc. Other funnel fittings, such as steampipes, whistles, eyes for funnel guys, and ladders, can be fixed similarly. Owing to the size whistles and steampipes will have to be dummies.

Funnels should be painted in the usual way, using flat paints. Ordinary paint should stand the heat on an outer funnel, provided the lamp is working properly, and not wasting heat up the funnel.

Now for the masts and spars. These are made from squares of light pine. The taper should be marked on two faces, and the square planed down. This gives a square section spar tapered either fore-and-aft or thwartships. Mark the taper on the other two faces and again plane down. Plane off the corners so that the spar becomes octagonal, and, finally, rub down circular with glass-paper. The thickest part of a mast, or derrick, is usually just below its middle. The heels






SPAR FITTINGS, ETC.—*Not to scale*

of the masts are squared off to fit the mast steps. In fitting these, do not forget to allow for varnishing. The spars are varnished and hung up to dry by means of a small screw-eye put temporarily into the end of each.

Dowel sticks are most unsuitable for making masts. The after-sides of masts are always straight, and the taper taken off the other three sides. Many models are spoiled by inferior masts and rigging, so it is worth while to take trouble over these and use the right materials.

The rigging is divided into two categories—standing and running rigging. The former comprises the shrouds (stays supporting masts on either side), forestays, backstays, funnel guys, etc. The latter, in a steamer, consists of flag halliards and similar ropes, boat falls (tackles for lowering), and derrick rigging. All the standing rigging in a modern vessel is wire rope. The running rigging also, is often largely wire, but certain items, such as flag halliards, are always hemp.

Stainless steel rigging wire is obtainable, and very nice rigging can also be made by twisting several strands of fine phosphor bronze wire together. This can be done on a lathe, or even the flywheel of the domestic sewing machine can be pressed into service.

The upper ends of shrouds are sometimes made with a loop and passed over the masthead, resting on the "hounds," which are stops to prevent the shrouds and stays slipping down the mast. Alternatively the upper ends of shrouds have an eye, and are either hooked or shackled to a lug on a mastband. The lower ends of shrouds and stays have an eye. The upper eyes on stays and shrouds are invariably eye-spliced. The lower ends of shrouds are either eye-spliced or have the end racked to the standing part. The splices are invariably served and tarred.

An eye in the end of a wire rope invariably has a metal "thimble" in it (*see Fig.* 30*b*). Round eyelets are known as "cringles" (*see Fig.* 30*a*), and in the prototype are seldom used in the end of a rope, but for the corners of sails, awnings, etc. The round eyelets are more easily obtainable, and will answer the purpose in a model, and can be made from brass or white metal paper eyelets. These can be transformed into thimbles by cutting through with the jeweller's saw and bending with round-nosed pliers if desired.

When racked together and served, the end of a shroud looks very much like *Fig.* 30. The thimble or cringle is placed in the bight of the wire rope, and the end laid alongside the standing part. Thin brass or copper wire is then served tightly round the two, and the whole sweated together. The splice part is then given a coat of black paint. If desired to simulate a splice, the end of the wire rope is gradually thinned



away to nothing by taking out strands. The serving is continued up the standing part a little above the splice.

Standing rigging is usually tightened with turnbuckles (or rigging screws). The patterns vary slightly, but on ships they usually are very much like *Fig.* 31, which is a good pattern. This has right- and left-hand threads, so that turning the body tightens on both ends. On occasion, screws having a swivel at the top-end are used, but the open-bodied pattern, like one sees on telegraph poles, is incorrect for nautical use. Rigging screws are difficult to make and rather expensive to buy, but a properly made-up lanyard of watercord (*Fig.* 32) looks quite well, and is nautical in appearance. Where shrouds and stays have to be let go frequently, as on the lifting parts of a deck, a spiral spring can be used as a substitute for a turnbuckle. (*Fig.* 33).

Two main kinds of blocks are used for the running rigging. The ordinary wood single and double blocks are used with hemp ropes (*Fig.* 34). In these the sheaves are slightly off-set so that one end only has space to reeve the rope through. To make this clear it is somewhat exaggerated in the diagram. When wire ropes are used metal gin blocks are used (*Fig.* 35). There are a number of patterns of these, but the one shown is very usual.

The inboard ends of derricks are fitted with a sort of universal joint, known as a "gooseneck," which swivels in the eye of a mastband (*Fig.* 36), or sometimes where a number of derricks are carried in a sort of platform affair round the mast. This may be a difficult fitting for the amateur to make, but, at the worst, a substitute can be made from two screweyes interlocked. Generally speaking the derricks on a model will not be required to swing about as on the prototype, but will be kept made fast for sea on their crutches, so the builder will be able to contrive something to suit.

If it is required to open the eye of a screweye or a ring for any purpose, do not bend it outwards or the shape will suffer afterwards. Take two pairs of pliers and twist the eye sideways, when it can be closed afterwards without showing.

The outer end of the derrick is fitted with a four-eyed ferrule (*Fig.* 37). The upper eye is for the "lift," which raises or lowers the spar. This is usually wire rope and led through a gin block on the mast, but in smaller vessels is occasionally hemp. Practically all mast and spar bands are alike, and only differ in size and the number of eyes fitted.

The two side-eyes of the derrick ferrule are for the guys, which trim the derrick round to the desired position, and prevent it swinging. The bottom eye is for the "whip" (or hoist), which is used for hoisting merchandise, etc. When at sea the guys and whip are usually unrigged and stowed away in the Bos'n's Store, so the modeller will be quite correct in omitting these. The derrick itself is usually lowered into a crutch, which is similar to a rowlock with a prolonged stem, or into a chock on the top of the nearest deckhouse. The lift is, therefore, all that is needed on the model and, in fact, it is better without superfluous detail, which would not be found on the prototype's decks when at sea.

The derrick ferrule consists of a band round the spar with a number of eyes silver-soldered into it, but if the modeller cannot silver-solder, he can drill holes and put screweyes straight through into the mast. This has the additional merit of preventing the band slipping. The mastband can be a piece of tube if the modeller has any of suitable size, but if not a strip of sheet brass can be cut, bent round a wood mandril and soldered.

The gin blocks for the derrick lifts are often carried on a sort of crosstrees (or gantry), as shown in *Figs.* 38*a* and 38*b*.

The gantry is made from a piece of brass tube and several pieces of sheet brass soldered up. If any difficulty is experienced owing to already soldered bits coming adrift when a fresh piece is added, the design could be simplified by omitting the three small webs on each side. At the same time it is a pity to do this as the design given is a good one, and can be managed quite easily in the right way. Make the small cross-webs in one, forward and aft of the main web, and mortised into it by halving (i.e., cut half-way down from the top of the main web and half-way up on each of the cross-webs). Assemble upside down and pack up on a piece or two of fire-clay or asbestos, and sweat the lot together with the blowlamp. The cross-webs are shown in *Fig.* 38*b* with the slots cut for the main web.

Boat davits are of several patterns, but the novice will be well advised to fit the ordinary pattern (*Fig.* 39). The double block tackle, illustrated, starts from an eyelet (in the grommet strop) below the upper block, and the tackle, including the fall, has five parts. The fall belays on the cleat shown. Though in the prototype the boat falls must be long enough to permit the boat to be lowered, the modeller is advised to dispense with the long end, as all this line will be a nuisance and can never be kept tidy about the deck.

This pattern davit can be bent up from brass wire tapered off at the top, as shown. To make the cleat, bore two holes right through the davit and insert a piece of thin wire from the opposite side. Bend the two ends to shape, and then solder in position. The superfluous loop at the back is then filed away.



Other kinds of davits are the Welyn and the Gravity. The latter are fitted to the latest liners and consist of carriages running on rails arranged over the side of the ship, so that a boat can be lowered by a single man at any angle of heel. These, however, are complicated fittings and best left until the modeller is very proficient, when he can take particulars from an actual prototype.

Lifeboats are double-ended on most ships, but on some of the smaller vessels, such as trawlers, tugs, etc., square-sterned boats are often used. Boats vary in size from about 20ft. to 40ft. long, in the case of the largest liners, but small ships carry smaller boats suited to the size of the parent ship. Lifeboats in small vessels are very seldom covered with canvas boat-covers, but in bigger ships this is often done, particularly when passing through the tropics. Where a model has a number of boats the canvas cover is a good way to avoid

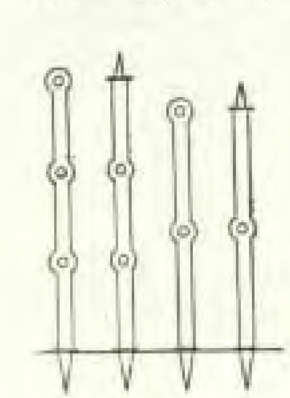


*Fig.* 40.
STANCHIONS

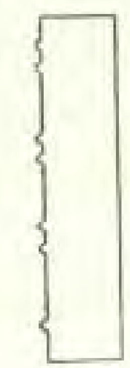


*Fig.* 41.
MARKING TOOL

the repetition of detail work. Boats are usually carved from wood, but they have been made on a wooden former by gluing strips of paper one over the other until the required thickness is obtained. When painted these are quite stiff and satisfactory. This is not a bad way to make a number of boats when they are wanted all alike, as for a model liner.

Rails are often a source of difficulty to model makers, and an uneven rail will ruin the effect of an otherwise handsome model. Rail stanchions can be bought in various sizes from model supply houses, such as Messrs. Bond's or Bassett, Lowke, Ltd., and with the aid of these there is no excuse for inferior rails. If the stanchions are bought, all that has to be done is to thread the brass wire for the bars, and secure at each ball with a touch of solder. In *Fig.* 40 stanchions with two and three balls are shown, also those made to have a wooden rail for the top bar.

If the builder has a lathe, it is a tedious but not difficult matter to turn up the necessary stanchions. Having decided the dimensions, make up a small marking tool (*Fig.* 41). It will be noticed that the little teeth are in pairs, and these mark the top and bottom of each ball on the stanchion. Put a piece of brass wire in the chuck, and make light scores all round with the marking tool. This marks out the full length of the stanchion at once, and its use ensures the stanchions being all alike. Move the wire back in the chuck, leaving the length down to the bottom of the second ball projecting. With a graver reduce the thickness of the shank between the balls as requisite, leaving the balls still cylindrical. Then round off the top ball. Then move down to the next section, and reduce the shank and round the second ball. Proceed in the same way until the stanchion is finished. In turning the stanchions very light cuts will have to be taken and the outer end of the wire will have to be supported suitably.

In order to get the holes through the balls even, a little drilling jig must be made. Cut two oblong pieces of $\frac{1}{8}$in. mild steel about $\frac{1}{2}$in. longer than the actual stanchion. Scribe a longitudinal line down the face of each, and with the marking tool position the holes for the balls. Drill holes through the plates with the same size drill as is being used for the stanchions themselves. Countersink these holes so that when the stanchion is laid on the plate with the balls in the holes, the shank is just clear of the plate. When the whole is clamped up with the stanchion inside, the latter will be firmly held, and can be drilled.

Those who have no lathe, and wish to make their own stanchions, can do so by using brass split pins of appropriate size. The balls are formed on these by bending on a simple jig with two pairs of pliers. The jig consists merely of two (or three) headless nails driven into a piece of wood. When the wires are put in place and soldered, the whole will be held together solidly.

One point to consider is the height of the rails. This does not depend on the size of the ship, but is based on the human frame, and is on an average 3ft. 6in. Thus on a 5ft. model of a 300ft. ship the rails would be 1/60th of 42in.=7/10in. high, and so on. On some types of small vessels, however, the rail is not so high, but the above is a very good general guide.

Other fittings which depend on the size of the crew, and not that of the vessel, are steering wheels, binnacles, engine-room telegraphs, etc.

## CHAPTER XII

### *Deck Fittings for a Model Steamer*

Cables and anchors are important fittings. The cables should be stud-link chain (*Fig.* 42) which can be obtained from the model shops. Only a short length is wanted, as the anchors are never lowered on a model, so all that is needed is the small pieces that show across the fo'c'sle head between the hawse holes and the chain pipes.

The usual pattern of anchor carried in merchant vessels is the Byers (*Fig.* 43), but large naval ships have the Admiralty pattern, which is slightly different. Anchors can be bought, or cut and filed up from solid brass. They should be painted (usually dull black) or bronzed black, and not left bright brass or silver-plated, in the fashion beloved of some showcase model makers. The cable should likewise be bronzed black.

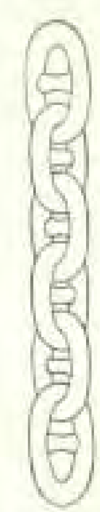


*Fig.* 42
STUD-LINK CABLE

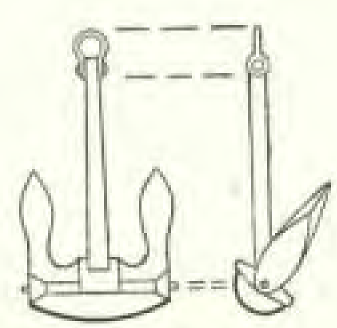
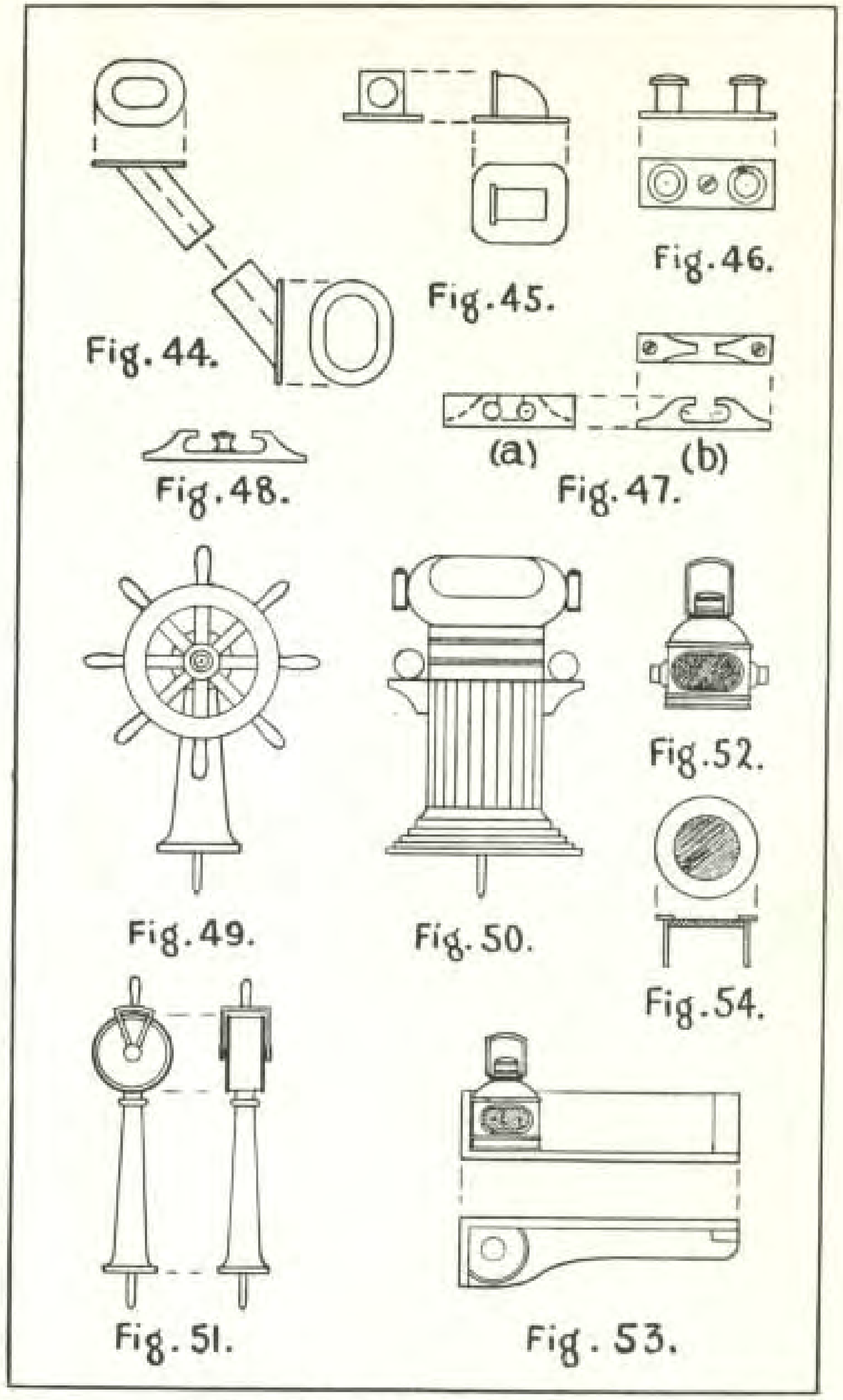


*Fig.* 43
BYERS' PATTERN ANCHOR

The anchors house their shanks in the hawse pipes, and the pipes continue to the deck where the cable emerges from the hawse hole, which is smaller in diameter than the hawse pipe. The cable then passes to the windlass and thence down the chain pipe to the chain locker.

The hawse pipes are easily made from a piece of brass tube and brass sheet. The main difficulty is to get these at the exact angle so that the upper end emerges at the hawse hole on deck correctly. The hawse pipe is shown in *Fig.* 44, but in making a model the same size tube can be used throughout the reduction made by the hawse hole. Chain pipes vary slightly in pattern (*Fig.* 45).

As the anchors will never be lowered, a simple dodge, which saves a lot of trouble in fitting, is to make the tube




MODEL DECK FITTINGS—*Not to scale*



of the hawse hole long enough to house the anchor shank, and plug the top-end. The anchor is drawn up into position with a piece of copper wire threaded through a small hole in the plug. The wire is fixed and the hole stopped with a spot of solder. If this is done the end of the cable is similarly secured into the hawse hole in lieu of coming right down to the anchor. If the modeller is making his own anchors, the shanks can then be shortened and the anchor shackle dispensed with without spoiling the effect of the model in any way.

There are a number of different patterns of anchor windlasses in use on prototype vessels, but the Clarke Chapman is probably the most popular, and the modeller who fits one of these will be absolutely correct. Windlasses are difficult things to make, but a rummage through the local clock repairer's scrap box will probably be productive of some suitable gearwheels.

In the old days, when practically all sailors were bred in sailing ships, most were skilled in the use of palm and needle. In fact, on early steamers, a sailmaker was carried, though in most cases his actual sailmaking was confined to making awnings, weather dodgers, etc. At that time in many smart, well-cared-for steamers, canvas covers were made for windlasses and winches, and put on when the vessel was on passage between ports. These covers usually covered the entire windlass or winch except possibly the outside drums.

In some windlasses the chain pipes are combined with the baseplate of the windlass. Drawings of the Clarke Chapman windlass are given later in the book. These, together with those of the Clarke Chapman winch, were very kindly furnished by Messrs. Bassett, Lowke, Ltd., who make very beautiful models of these deck fittings.

For belaying mooring ropes, bollards (*Fig.* 46) are used. These are not difficult fittings to make. The base is a brass plate with a hole in the centre for a holding-down screw. If there is any fear of the fitting turning, a couple of small pins can be added. The posts of the bollards can be made of small pieces of brass or copper tube, and the heads of small-headed copper rivets or even cheese-head screws with the heads filed down. If the latter are used, they can be dropped into holes in the baseplate and filed flush on the underside. The whole is sweated together. In the prototype, of course, the bollards often have to take a tremendous strain, and are most securely anchored to the frame of the vessel, but in the model the fixing given will be sufficient.

Mooring ropes are led through fairleads (*Fig.* 47*b*). These are quite easily made. Two holes are drilled through a suitable piece of brass to form the ends of the opening (*Fig.* 47*a*). The slot is then cut through from the top, and the metal between the holes sawn and filed away. The outside of the fairlead is then filed to shape and drilled and countersunk for the holding-down screws. Another pattern of fairlead (*Fig.* 48) has a roller in the middle.

Neither bollards nor fairleads should be left bright brass or plated, as they are invariably painted in the prototype.

The bridge fittings consist of the wheel, binnacle and telegraphs. A typical wheel is shown in *Fig.* 49. In very small ships the movements of the wheel are conveyed to the rudder by chains, but in larger vessels the rudder is operated by means of steam or electric steering gear controlled by telemotor gear or other means from the steering wheel on the bridge. The size of the wheel varies a little, and generally speaking a wheel that operates the steering gear by hand is larger than one which simply operates a telemotor or similar gear. In any case wheels are governed in size by the human frame, and are about 4½ft. high.

Besides the steering compass mounted in a binnacle, there is usually a similar compass on the navigation platform, known as the standard compass. Patterns of binnacles vary, but that shown (*Fig.* 50) is very usual.

Telegraphs (*Fig.* 51) comprise engineroom telegraphs conveying orders to the engineroom, and in fair-sized ships docking telegraphs are also fitted to convey the orders for handling mooring lines to the First Officer on the foc's'le head and the Second Officer aft on the poop. In all cases repeating telegraphs are fitted-down in the engineroom, or on the foc's'le or poop, as the case may be.

In case of breakdown of the steering, an emergency wheel—usually a hand-wheel—is fitted aft, together with binnacle.

A binnacle is usually about 4ft. high, and a telegraph much the same.

The navigation lights consist of the masthead light, sidelights and stern light. A small vessel, or one with only one mast, carries her white, steaming light on the foremast at least 20ft. above the water, but when her beam exceeds this figure, the height of her beam up to 40ft. The light is constructed to throw an unbroken light over an arc of 225° of horizon from right ahead to two points abaft the beam on either side (*Fig.* 52). Large vessels carry a second similar white light on the mainmast 15ft. above the one on the foremast. Tugs, when towing, carry two lights one over the other, and, when towing two vessels and the length of the tow is 600ft. or over, three white lights. The pattern of masthead light illustrated has a loop at the top for a halliard and lugs on either side for the guide ropes. This pattern can be hauled up and down, as required. In a fixed lamp the loop and lugs would be omitted.



The port (left side looking forward) light is red and the starboard (right side) green. A sidelight is shown in *Fig.* 53, together with its screen. Sidelights have to be fitted with screens to prevent the light being seen across the bow on the wrong side of the ship. A sidelight must be visible from right ahead to two points (22½°) abaft the beam. The screens are usually wooden and are painted red or green, as the case may be.

The stern light is a small white light, visible from right aft to two points abaft the beam on either side, and is rather similar in construction to the masthead light, but with a more restricted arc of visibility. It is mounted in any convenient place aft.

Portlights (or scuttles) are a conspicuous fitting. These on the prototype can be fixed or opening, according to the position and uses. They consist of a circular brass frame with a thick glass set in it. For model purposes they are never made to open, but when high on the superstructure, may be left unglazed in order to admit air for ventilation.

In very small models they may be purely dummies, and consist of a brass ring fixed to the hull, the space inside that would be occupied by the glass being painted greenish colour to represent the glass. The size of the glass in a prototype portlight usually varies from 12in. to 16in. in diameter, so this will be a guide when scaling down.

If fitting dummy portholes of a small size, short, brass paper eyelets are useful. A little cutter of appropriate size made from a bit of brass tube with the end sharpened will assist in putting these in without distortion. Their shape will make them hold well in a wood hull. On a metal hull a small ring can be soldered on where required.

If proper glazed portholes are being used, they can either be bought or made. If the worker has a lathe he can turn up the brass frame (*Fig.* 54). If the worker has no lathe, he may be able to buy brass washers of a suitable shape to form the flange, but usually the hole is too small in proportion to the diameter of the washers. If the washers are obtainable they can be soldered to short lengths of light brass tubing. The tube forming the body should be long enough to go right through the side of the vessel and leave about ⅛in. projecting inside. The spare bit can be cut down to form little tongues, which are subsequently spread outwards and fix the port permanently in the side.

Take an old photographic plate or similar piece of glass, and cut into strips of the width required. Cut the strips into squares. For this a glass-cutter must be used. With a pair of cutting pliers, nip off the corners until the squares are reduced to circles. As the body has an inner flange, a very exact fit is unnecessary provided the glass completely fills the porthole orifice. The glass is bedded in place inside the body with a touch of white lead luting.

If the worker has a fine emery wheel, and is inclined to spend a little more time on the job, a better fit can be obtained by the following method: Cut a sufficient number of small sticks, like meat skewers, that fit the tubular body of the portlight. Make the glass discs, as above, roughly to shape, but a shade oversize. Stick one of the discs with seccotine (or similar adhesive that is soluble in water) onto the end of each of the sticks and leave till thoroughly dry. Using water and turps as a lubricant, grind the edges of the glass down on the emery wheel until they are the right size. A light pressure against the wheel is used and the glass rotated during grinding. Unstick by soaking in warm water, and insert in the body as before.

Another method of glass-cutting is to use a piece of brass tube held in a drill to cut out the discs with a paste of turps and fine emery powder as abrasive. In order to prevent the drill slipping about and keep the abrasive imposition, clamp a piece of thin wood with a hole the size of the cutter on top of the sheet of glass.

This method of making portlights and the method (given in the next Chapter) of making ventilators by electrolysis were recommended by Mr. A. P. Isard in an article published in MARINE MODELS.

## CHAPTER XIII

*Making Ventilators and Ladders; Windlasses and Winches; Care in Running; Conclusion*

Ventilators (*Fig.* 55) are decidedly difficult to make, but a good assortment of sizes and shapes is stocked by the model shops. If the modeller wishes to make his own there are several ways by which it can be done. Turned or cast metal is too heavy, so these will have to be built up in one way or another. The expert metal worker will probably either beat out his ventilators or press them up, using a male and a female mould. The easiest way for the amateur, however, is by electrolysis.

The stalk of the ventilator will be made of treblet tube (brass) and the part which presents difficulty is the cowl. Carve a wood model cowl, taking care that the bottom is the

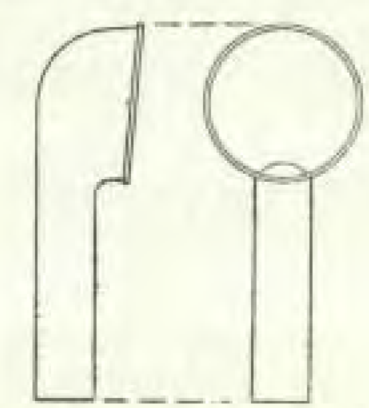


Fig. 55—VENTILATOR

right size to fit treblet tube of a size obtainable. Take a small cardboard box of a size to allow about an inch all round the wooden matrix, and cut down to a depth to take half the matrix plus about $\frac{1}{2}$in. Mix a little Ash's Dental Plaster (which is finer than ordinary plaster of paris) to a consistency like thick cream. Pour into the box. Smear the matrix with vaseline, and, when the plaster has thickened a bit, push the matrix down into the box to half its depth. Let this stand until nearly set, and then smooth off the top flush with the top of the box. Take two small pieces of round wood and push into the plaster at the corners of the box. Let the mould dry stone hard, and then move into another box of the same size, but twice as deep. Make sure the matrix has not stuck. Take an old paint brush, dip in water and then rub on a lump of common garden clay. Paint the half mould with this so that the second half mould will not stick. Vaseline the exposed half of the matrix, and fill up with plaster to make the second half mould. When dry, hold the mould edgewise under a slowly-running tap, and part with a thin knife-blade. Open up the bottom of the stalk to form a pouring hole, cutting the plaster away with a knife. Make a second hole to let out the air at the top of the bell, or rather the bottom, which will be at the top when the lead is being poured into the mould.

Tie the two half-moulds together with string, and heat some lead in an old iron saucepan. Pour into the mould and, when cold, take out the casting. Make as many castings as are required, according to the number of ventilators wanted.

The lead castings are thickly copper-plated, and the lead melted out. Before plating, the castings must be cleaned up carefully. As any blemish in the casting will be reproduced on the ventilator, pains should be taken to get the lead castings absolutely smooth.

The lead castings can be taken to the platers', or the worker can easily and inexpensively do this for himself. Get a zinc rod, as used in a wet battery, and an empty porous pot. Fill the pot with dilute sulphuric acid and put the zinc in it. Stand the porous pot in a large glass jar, and fill the jar outside the pot with a strong solution of copper sulphate. Make a small calico bag and fill with copper sulphate crystals to keep the solution up to strength, and hang it in the jar.

Solder a piece of copper wire onto the bottom of the lead ventilator casting. Connect up with the battery zinc and hang the casting on a piece of stick put across the mouth of the jar so that it is immersed in the solution but touches nothing.

Leave plating for the best part of 24 hours, when there should be a good deposit, but if not thick enough continue the plating after cleaning off the copper with Gospo, Vim or some similar abrasive soap.

When the plating is finished, clean up and file the copper off the mouth, and also the bottom of the stalk. Melt the lead out with a blowlamp. Solder a ring of thin wire round the mouth, and also fix to the treblet tube. Paint the ventilator in the appropriate colour.

The plating method mentioned above can usefully be employed for one or two other fittings, such as the binnacle cover.

Ladders are either wood or metal, and are quite easy to make. The wood ladders are made in a jig, consisting of a piece of wood with slots cut for the treads, which are glued to the sides with casein glue. The only caution is not to get any glue onto the jig, as otherwise the ladder will not come off.



Metal ladders consist of brass strips to form the sides and pieces of wire for rungs. This again is made in a jig, consisting of a flat piece of wood with holes drilled to hold the wire rungs in position during soldering. Cut the pieces of wire for the rungs a bit too long, and then put into the jig, drop the first side over these and solder the rungs into place. Put on the second side, using some slips of wood as distance pieces between the two sides. Solder up as before, and then clean off the ends of the wires. If the holes in the two sides are

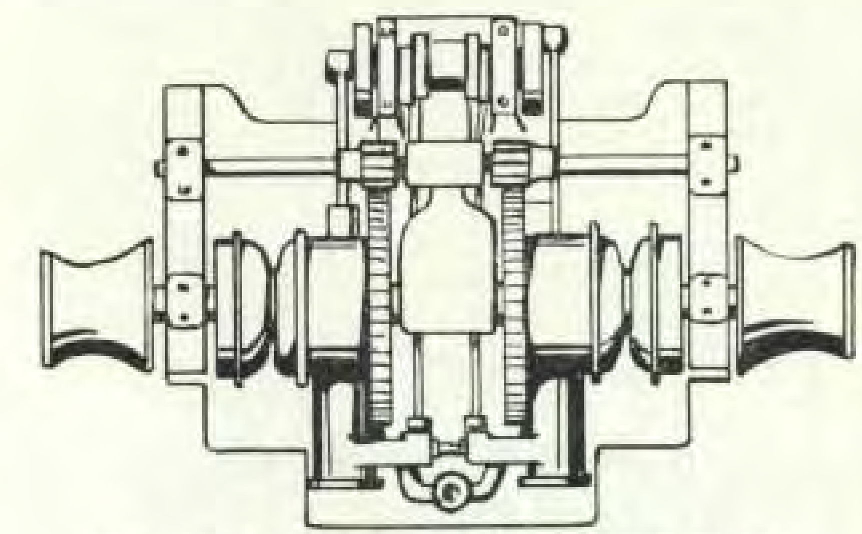


*Fig.* 56—A CLARKE CHAPMAN WINDLASS

drilled together, it will ensure the rungs being horizontal and parallel.

The drawings of windlasses and winches included in this chapter were very kindly supplied by Messrs. Bassett, Lowke, Ltd. These represent what are probably the most difficult deck fittings of all to make—windlasses and winches.

A Clarke Chapman windlass is shown in *Fig.* 56. This is a very usual pattern and will be correct on almost any model. A simplified model winch is shown in *Fig.* 57, and, whilst this is not true to prototype, it will make a very good showing on the decks of a working model.

Cargo winches are also difficult things to model, and usually a number of them are wanted if the deckwork is to be complete. A Clarke Chapman cargo winch is shown in *Fig.* 58, and a simplified form of model winch is also obtainable much on the lines of the model windlass shown.

These model windlasses and winches are really models in themselves, and almost too delicate and costly for the average model builder, but they can, if necessary, be omitted or simplified, on all except the most elaborate models.

When at sea hatches are always battened down and covered with tarpaulin covers, so the tops need not be scribed out in planks or fitted with handles. It is more correct to paint hatch covers black to simulate the tarpaulin covers.

Before installing any deck fitting, the builder should be careful that it is appropriate to the type of vessel being modelled and also that the size is correct in proportion to the scale of the model. Never put in a fitting just for the sake of doing so. If you are modelling by the aid of photographs and there is some fitting in the picture that you cannot make out, do not fit a vague square piece on the deck. It is better to omit than have wrong fittings. Model builders are very fond of putting such things as wire reels about the deck because they are easy to make, but they are not to be found on every ship and at most about two are fitted. The modeller should know the purpose of every fitting and how it works

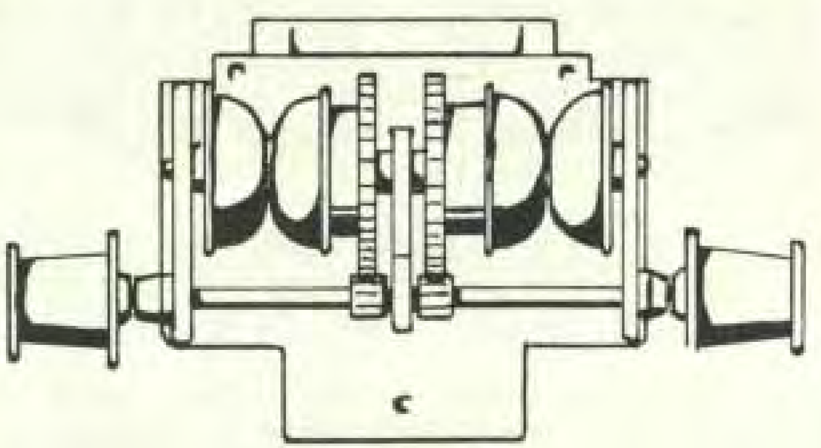


*Fig.* 57—A SIMPLIFIED MODEL WINDLASS

so that he can give a realistic representation of it. It is not necessary that every fitting on a working model should work. In fact, over-elaboration is a waste of time, as the minute detail work required is lost. Those who have the time, patience, toolkit and skill can, of course, indulge their fancies in this respect to their hearts' content, but it is quite unnecessary to go to this extent in order to make a good working model, and the beginner is advised not to attempt it, but to concentrate on getting the correct general effect. Elaboration can come when the requisite skill and knowledge are acquired.

One little point which might almost be considered as belonging to the fittings is the question of flags. The White Ensign is never used except by Navy ships. The Blue Ensign is flown by H.M. Customs, Trinity House and certain other public bodies and services. For all other ships the Red Ensign is the only correct national flag. The sole exceptions



are certain yacht clubs, which are permitted by Admiralty Warrant to fly the White or Blue Ensigns.

The Ensign is carried on a flagstaff in the stern. Vessels which have two or more masts sometimes have a small gaff on the aftermast, specially to carry the ensign. Merchant ships fly their house flag at the truck of the mainmast, and yachts carry their club burgee in the same position. Some excursion steamers fly a name pennant at the foremast head. The Union Jack is never used on a ship except by H.M. ships, which fly it on a staff in the bows when at anchor, usually striking it when they get under way.

A most useful accessory, which should be in the kit, is a little syringe, to take out any bilge water. A length of fishing line with a lead sinker, such as is used for a sea fishing

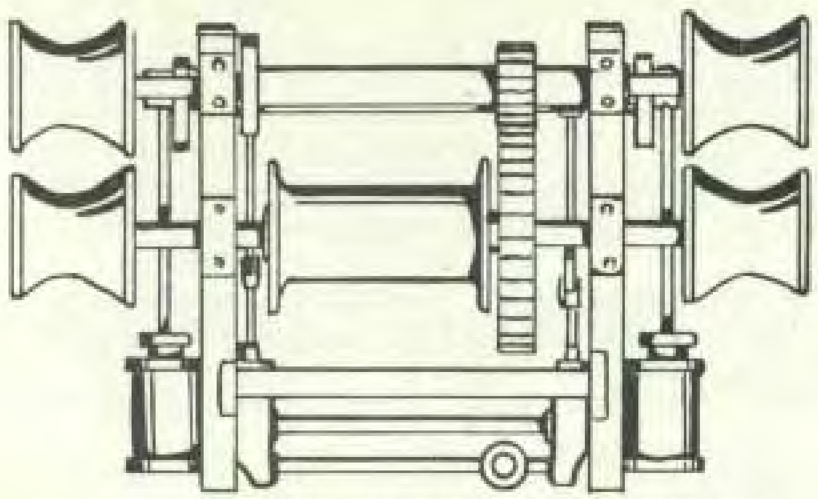


*Fig.* 58—A CLARKE CHAPMAN CARGO WINCH

line, is useful in case of a breakdown or lamp failure. This should be kept on a reel to prevent the line getting tangled.

When required, the *modus operandi* is to get a friend to take the end with the lead and walk round the other side of the lake until he gets about opposite the boat. At this point he should stop and hold his end steady while you manœuvre the line over the boat. When you are in position with the line across the boat, preferably towards the bows, you signal your friend to let go and proceed to haul in. The sinker will drag across the bottom until it comes to the boat when its weight will keep the line from slipping off, and you should then be able to recover your boat without difficulty.

In the case of the engine, lubrication is the most important thing. Not only does the engine require lubrication while running, but the engine should be well soused with oil before putting the craft away to avoid rust. This applies to the inside of the engine almost more than the outside.

In addition to the engine the hull requires care to preserve its appearance. When the model has been run on salt water or a dirty pond, the hull and decks should be washed down after running with clean fresh water. Paint and enamel can be dried with a chamois leather, and when required polished with furniture polish.

One of the most important points in running a boat is stopping her. In the case of a fast or heavy boat there is considerable risk of injury unless the right methods are used. Many people have had their hands badly knocked about by getting them sandwiched against the concrete edge of ponds. If stopping from the bank, the arm should be well extended, and it is best to go down on one knee in order to get a longer reach and a firm position. The veteran model powerboat owner usually has a knee pad fastened to his leg. These vary from a piece of old carpet with two strings, to quite elaborate contrivances. Never attempt to stop a boat with a rigid arm, but let the hand come back with the boat. This lessens the shock both to boat and owner. Never, however, let the hand come back against the pond edge. In the case of a big, heavy, fast boat, the easiest method of stopping is to use waders and go into the water. It is easier to build a new nose on a boat than heal a damaged hand, so if the worst comes to the worst let her crash rather than invite injury. The main point, however, is not to run the boat too fast until the owner has got used to stopping.

A further little caution is not to put the face over the funnel, as if by any ill chance the lamp flares at this moment, the owner will be lucky to escape with singed eyebrows.

However clean it may appear, pond water is sure to be full of germs. There is no sense in taking unnecessary risks, and, in the case of a cut or graze, it is advisable to paint the place at once with a little iodine as a precaution. The writer carries a small tin in which a miniature first-aid outfit is housed. This contains a small bottle of iodine with brush (or one of the handy forms in which this useful disinfectant is sold), a small roll of sticking plaster, a piece of lint and a bandage.

The writer does not wish to convey the impression, however, that model steamers are dangerous things, as this is not the case, but a little care minimises the chance of anything untoward happening. Even in such a placid pastime as gardening occasional grazes and scratches occur, and, if not attended to and properly cleaned, may lead to serious consequences.

The great beauty of building and running model steamers is that the building is a most engrossing indoor pastime, and the running provides healthy open-air exercise as well as being very fascinating. A model steamer is seldom so perfect that the owner cannot find something he can work at and improve,



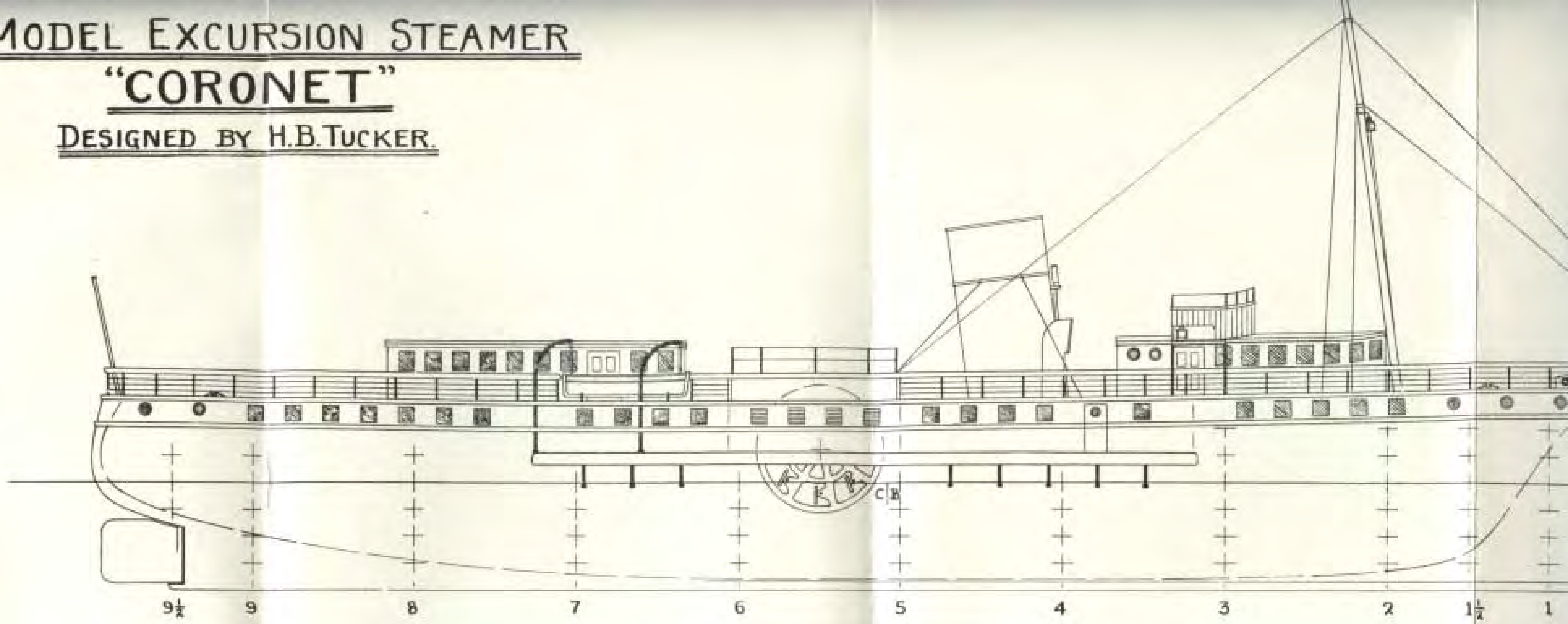
and thus the interest is sustained. Those of my readers who have already tried it, will not need to be told this, but I can assure those who are thinking of building a first boat that they will not regret doing so.

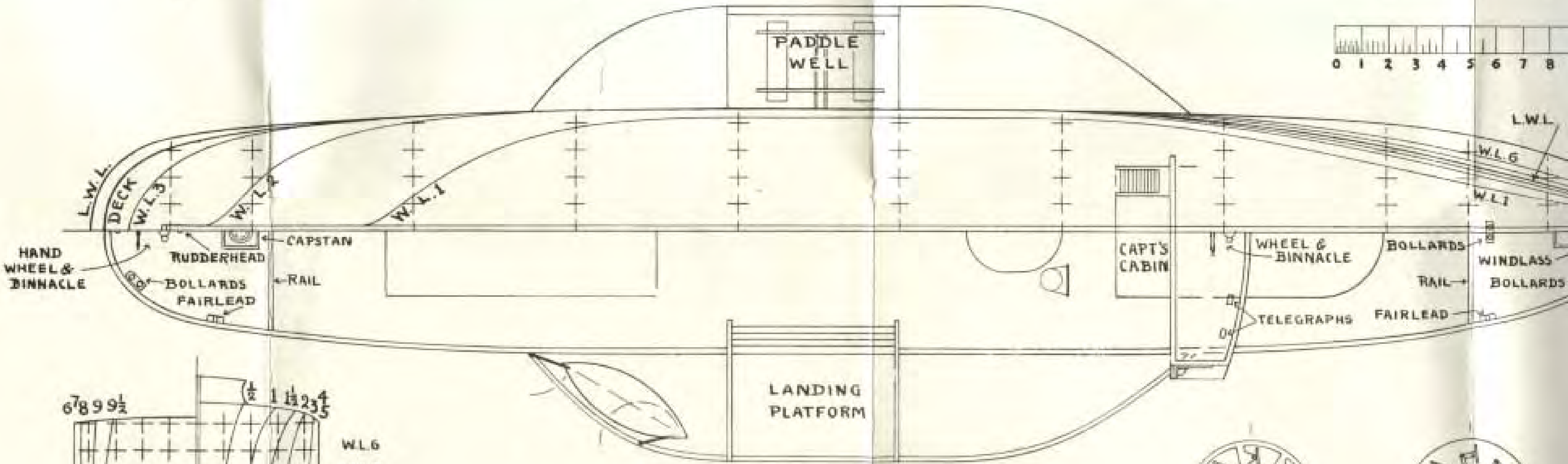
This book is primarily intended to help beginners over their difficulties, and experts may consider much of it elementary. It would have been possible to include additional chapters on boilermaking, etc., but this would have meant increasing the size and price of the volume, and in general the beginner will not have the skill or facilities required for more advanced work.

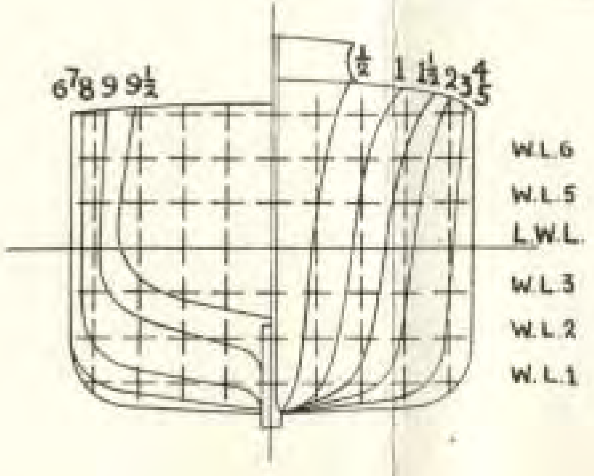
The first boat is always the most difficult, and I trust this manual will help to make many first boats a success. If it does so, I shall consider myself amply repaid for writing it.

# MODEL EXCURSION STEAMER "CORONET"

DESIGNED BY H.B. TUCKER.




## DIMENSIONS.

| | | |
|---|---|---|
| L.O.A. | 60·5 | INS. |
| BEAM (HULL) | 9·0 | ,, |
| DRAUGHT | 4·0 | ,, |
| DISPLACEMENT | 49·5 | LBS. |

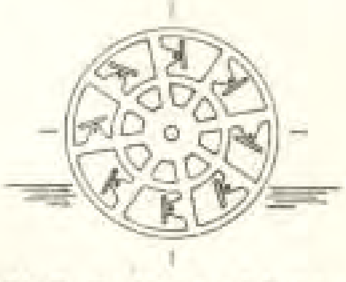
NOTE:- THE TYPE OF VESSEL REPRESENTED IS 200-210 FEET LENGTH OVER ALL.

## NOTE FOR BUILDERS.

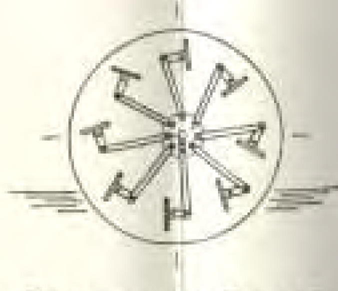
IF BUILT HALF-SIZE (I.E. 30·25 INS L.O.A.) DISPLACEMENT WILL BE 6 LBS. 3 OZ.

CORRECT FLAGS.

PENNANT OR HOUSE-FLAG AT MASTHEAD, RED ENSIGN ON FLAGSTAFF AT STERN.

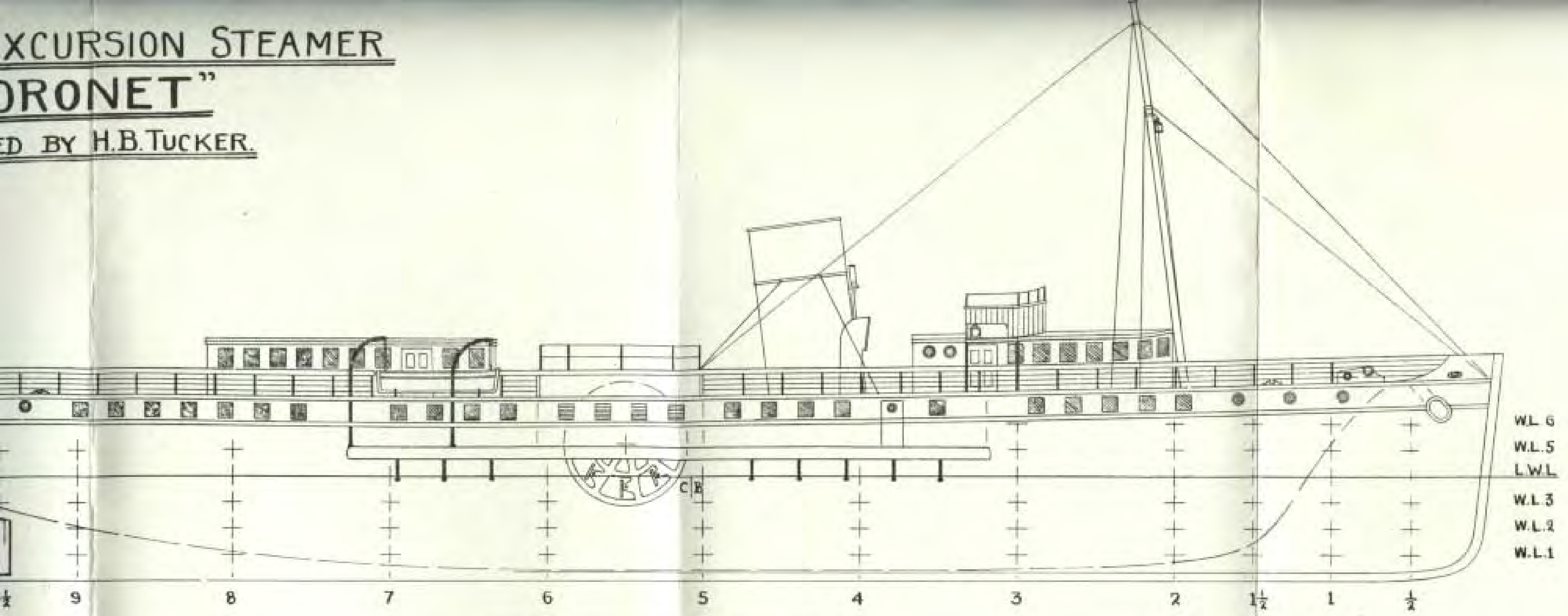


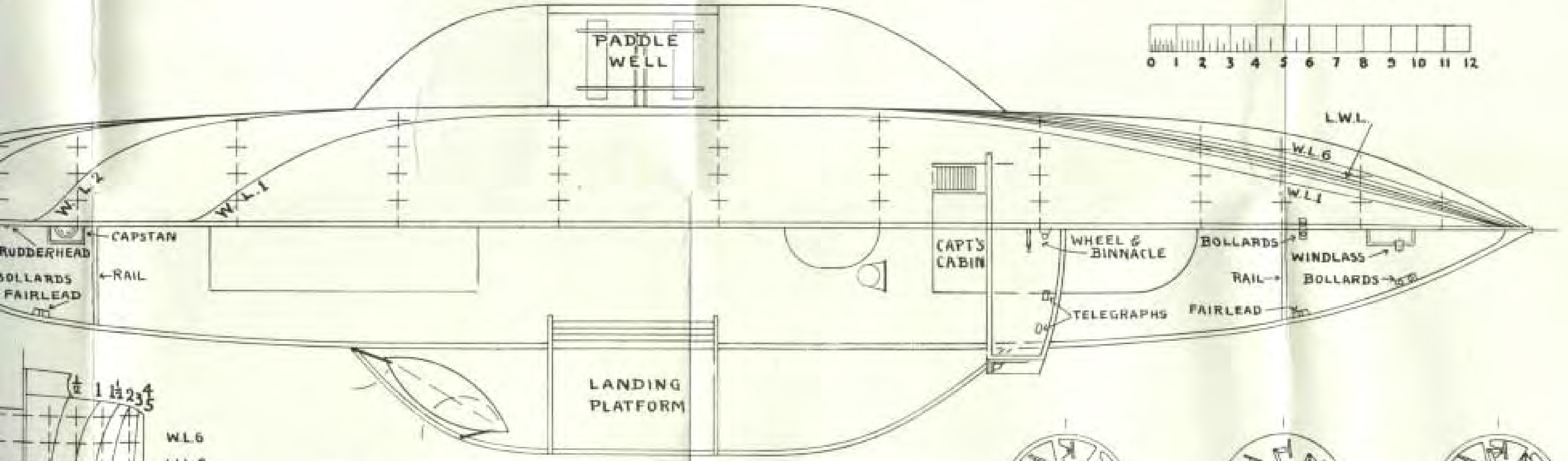
SIDE PLATE OF WHEEL SHOWING FLOATS

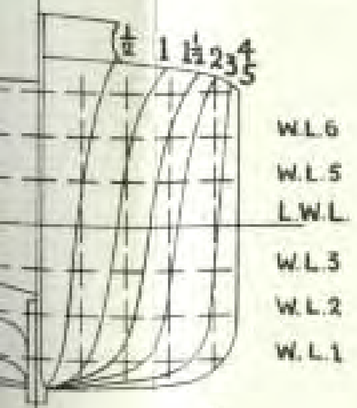


FEATHERING DEVICE ACTUATING FLOATS

## [E]XCURSION STEAMER
## "[C]ORONET"
[DESIGN]ED BY H.B. TUCKER.




DIMENSIONS.

| | | |
|---|---|---|
| L.O.A. | 60·5 | INS. |
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| DRAUGHT | 4·0 | " |
| DISPLACEMENT | 49·5 | LBS. |

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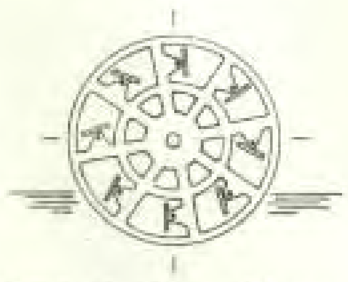
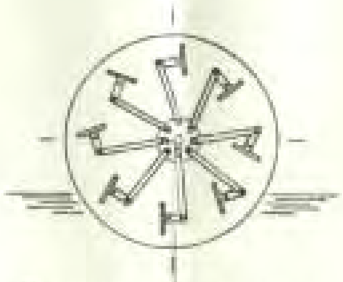
PENNANT OR HOUSE-FLAG AT MASTHEAD_ RED ENSIGN ON FLAGSTAFF AT STERN.



SIDE PLATE OF WHEEL SHOWING FLOATS



FEATHERING DEVICE ACTUATING FLOATS

STARBOARD WHEEL OUTER SIDE

# LIST OF FIGURES AND PICTURES