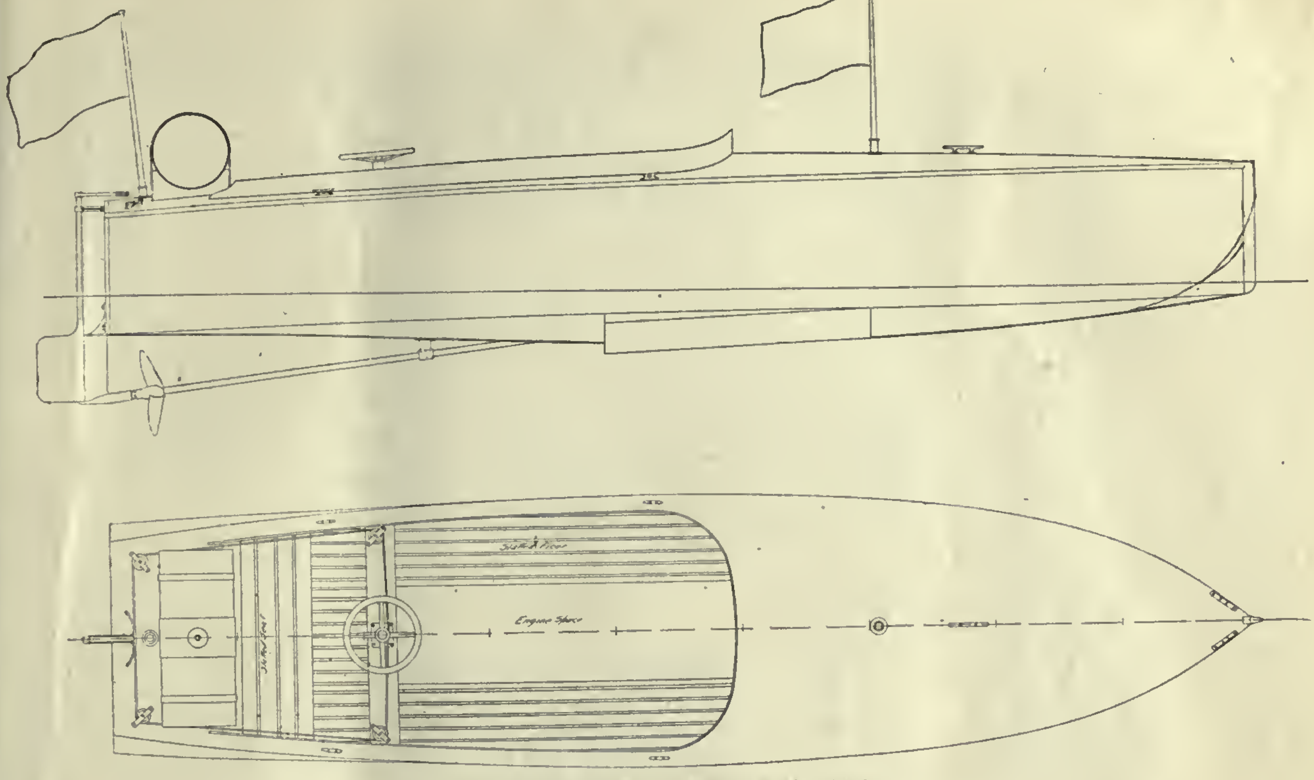


OUTBOARD PROFILE AND DECK PLAN

How to Build a Single Step Hydroplane

By George F. Crouch

THE racing results of the season of the past year have shown clearly that the hydroplane type of boat has come to stay. Every important race—referring, of course, to the speed boat classes—was won by some type of "hydro." Weather conditions had much less effect on their speed than we had been led to expect; and, taken as a whole, I believe that they were better performers in rough weather than the displacement boats of equal length and less speed.

Riding in a good "hydro" is a joy which can be found in no other sport. The little boats are so "alive," they respond so quickly, turn in almost their own length and flutter over the surface of the water in a delightful way. A displacement boat seems dead after one has become accustomed to the hydro. One misses the "pat-pat-pat" of the hydro as it glides over the ripples and one misses its stiffness. The displacement racer seems to heel down on her beam ends as if she were never coming back while the hydro keeps moving along on an even keel.

The progress of the last year in hydroplane design is a surprise to all who have closely followed the course of development. At first it was thought that the hydroplane must be marvelously light and every effort was made to cut down weight; hulls were pared to the limit, motors of the lightest possible types were chosen, and in some cases this weight reduction was carried to a point where light men were chosen for the crew. No doubt this was the correct thing to do with the hulls used, but the latest models show that fairly heavy construction and a medium weight racing motor can be used with almost equally good results as far as speed is concerned, and much better results when endurance and reliability are considered.

The little boat, which is the subject of this article, is of this latest medium weight type. The hull is not extremely light but the construction is such that it is unusually stiff and rigid. As may be noticed, the cross floors, the keel and the two fore and aft stringers form a strong truss even without the planking and the fore and aft edge stringers.

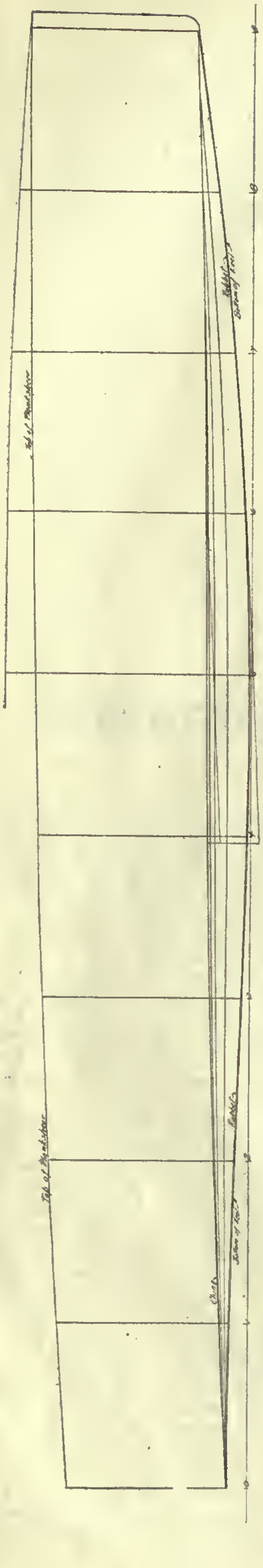
The hull is of the single step type, the step being formed by putting a metal plane on the hull after it has been completely planked. It is not necessary to explain the manifold advantages of an applied metal plane as any one interested in hydroplanes knows them. With regard to the hull construction it is not an easy matter to show a boat which will be easily built and yet possess all the strength, rigidity and lightness that the boat turned out by the professional builder will show. The general scheme which I have used is that of having no bent or steamed frames whatsoever. The moulds, instead of being made of rough material,

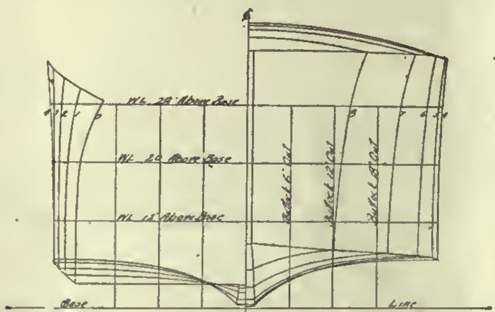
GENERAL DIMENSIONS OF HYDROPLANE

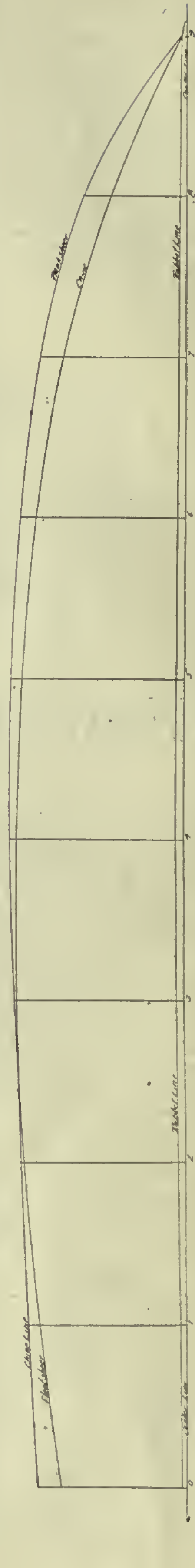
Length, overall	19 feet	4 inches
Beam, extreme (at planksheer, outside ½ round)	4 "	8¼ "
Beam, extreme (at chine)	4 "	4⅜ "
Depth of hull (forward)	2 "	2½ "
" " " (amidship)	2 "	9¾ "
" " " (aft)	2 "	3½ "
Draft of hull (at rest)	0 "	11 "
Draft (at rest, with 18-inch wheel)	2 "	5 "

are to be of selected spruce, nicely finished and put together as shown on the drawings of the molds or frames. These molds stay in the hull and take the place of the ordinary system of framing so care must be used in getting them out and in finishing them. In fact, throughout the whole construction anything put on the work stays there in the completed hull. There are no molds to rip out after the boat is planked, no ribbands to be used in "fairing up" and then taken off again.

Although the construction is fairly simple, it is a much more difficult boat to build than the *Water-Bug*, the plans and building instructions of which were published in MOTOR BOAT for January 10 and 25, 1911, and I, therefore recommend that boat for those who have never had any boat-building experience rather than for them to attempt this new one. The troubles which the beginner would find in building to this new design are not so much in the hull itself—although the planking of concave "veed" bottom means work—as in the motor and drive installation. I have counted on using a gear drive to the propeller shaft as this gives a good shaft angle and allows the







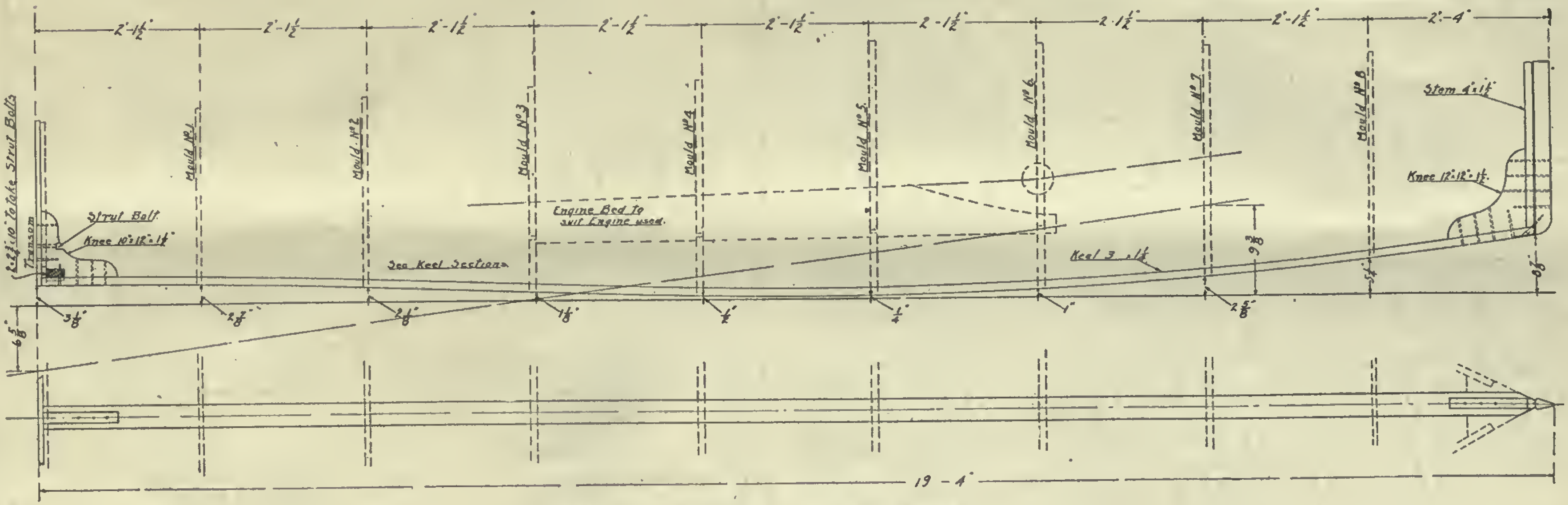
LINE DRAWING OF SINGLE-STEP HYDROPLANE
Lines are shown to outside of plank

motor to be placed well aft. This motor position is of utmost importance in a boat designed to carry a fairly heavy motor. Since motors differ so widely in power, size and weight, I cannot give definite measurements for the driving gear and motor beds, so the builder must use his ingenuity and experience in following out in detail what I can only indicate in a general way.

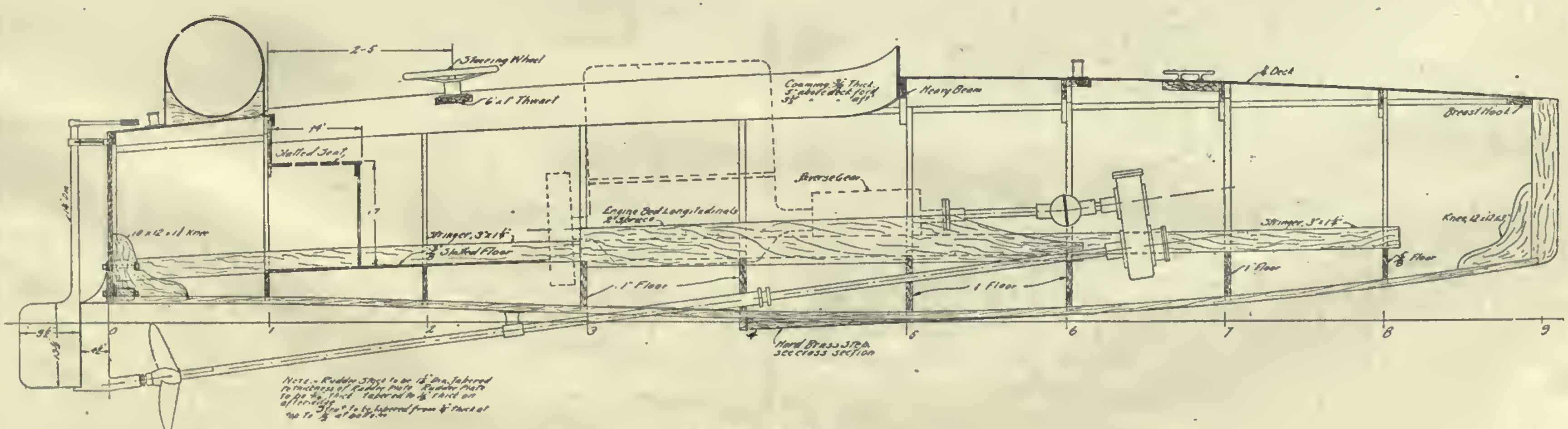
The motors which may be used in this hull range in power from 40-hp. to 120-hp. I would not advise using much less than 40-hp. and the weight of such a motor should be not over 600 pounds. The speed to be expected with such an equipment is 28 to 30 miles an hour, while with a 120-hp. motor weighing about 1,000 pounds the speed should be about 40 miles an hour. Any motor between these two should give proportionate results. Of course you would not use a 40-hp motor weighing 1,000 pounds for the weight should be in proportion to the power. If a motor too heavy for the power is used, the boat will not "get up" but will plough along at canal boat speed. The motors should be of fairly high speed capable of turning somewhere between 900 and 1,500 r.p.m., and the driving gear can be proportioned to suit the motor chosen so that the propeller will turn 1,500 to 1,600 r.p.m.

I will not stop to tell you how to choose a place to build the boat nor what tools you will need, as I assume that you have some knowledge of boat building and know that small boats are always built under cover, that a hammer is used to drive nails, and so on.

The first step toward the actual construction of the boat is to get out the keel, stem, transom and the knees for connecting them together. The plan of the keel and the keel sections gives full information as to size and form of the keel. If possible, the keel should be in one length and the best material to use is white oak, although yellow pine might be used as a substitute in case it is impossible to secure oak. Between molds No. 3 and No. 7 the keel has considerable bend in it, and it will be neces-



KEEL PLAN, SHOWING POSITION OF MOLDS



INBOARD PROFILE

sary to take the stiffness out of it by steaming in a long steam box or by pouring boiling water upon it until the required bend can be given to it. If you cannot secure a piece of oak long enough to make the keel in one piece, two pieces may be used and the joint between them stiffened by an oak butt strap about 2 feet long, thoroughly riveted to each part of the keel.

The stern is a piece of white oak shaped as shown on the detail plan. The rabbet should be roughly cut to form, as should that of the keel, leaving the finishing touches to be given after the frames have been set up and the boat is ready for planking. The knee joining the stem to the keel is sided 1½ inches, the same as the stem and may be made of hackmatack or even of straight grained oak, in which the oak should, of course, run diagonally between the stem and the keel. Note the stopwater where the keel joins the stern.

The transom should be made ready next. It is of ⅝-inch mahogany or oak shaped as shown in the transom detail. It is too deep to be made in one piece, so the separate parts must be joined together and then stiffened by vertical pieces of oak as shown. Do not cut the round at the top of the transom down to the line, but leave that until the deck is on.

In getting out the molds or frames, which is the next operation, you will find it a good plan to make full sized drawings of these molds on heavy paper or on a clean board before you start in. These full sized drawings will allow you to compare the shape of the pieces you are making with the required shape and to check the completed mold after you have riveted it together. This drawing should be made for both sides of the mold from the dimensions given on the mold or frame details. These dimensions on this drawing are given to the inside of the planking.

The molds themselves are of spruce, the pieces up the sides being 3 inches wide and ⅝ of an inch thick, the bottom cross floors are 1 inch thick in way of the motor and gear drive, and are ¾ of an inch at the ends of the boat. The pieces should be cut to shape and then riveted together as shown, using corner pieces of oak ½ inch thick. The molds which have deck beams may have these cut and fitted at the same time as the other parts of the molds. The molds on which beams are not required must be held across the top by a temporary cross piece in order to keep them from spreading or squeezing together. Do not cut any notches in the molds for the fore and aft ribbands, that covers up the seams between the planks until after the frame is set up, but the notches to take the keel, the chine and the clamp should be cut as shown on the drawings. When setting up the molds be careful to get them spaced just as shown on the plans, or else you will find that there will be trouble in getting the proper bevel on the molds after the plank edge battens have been run in.

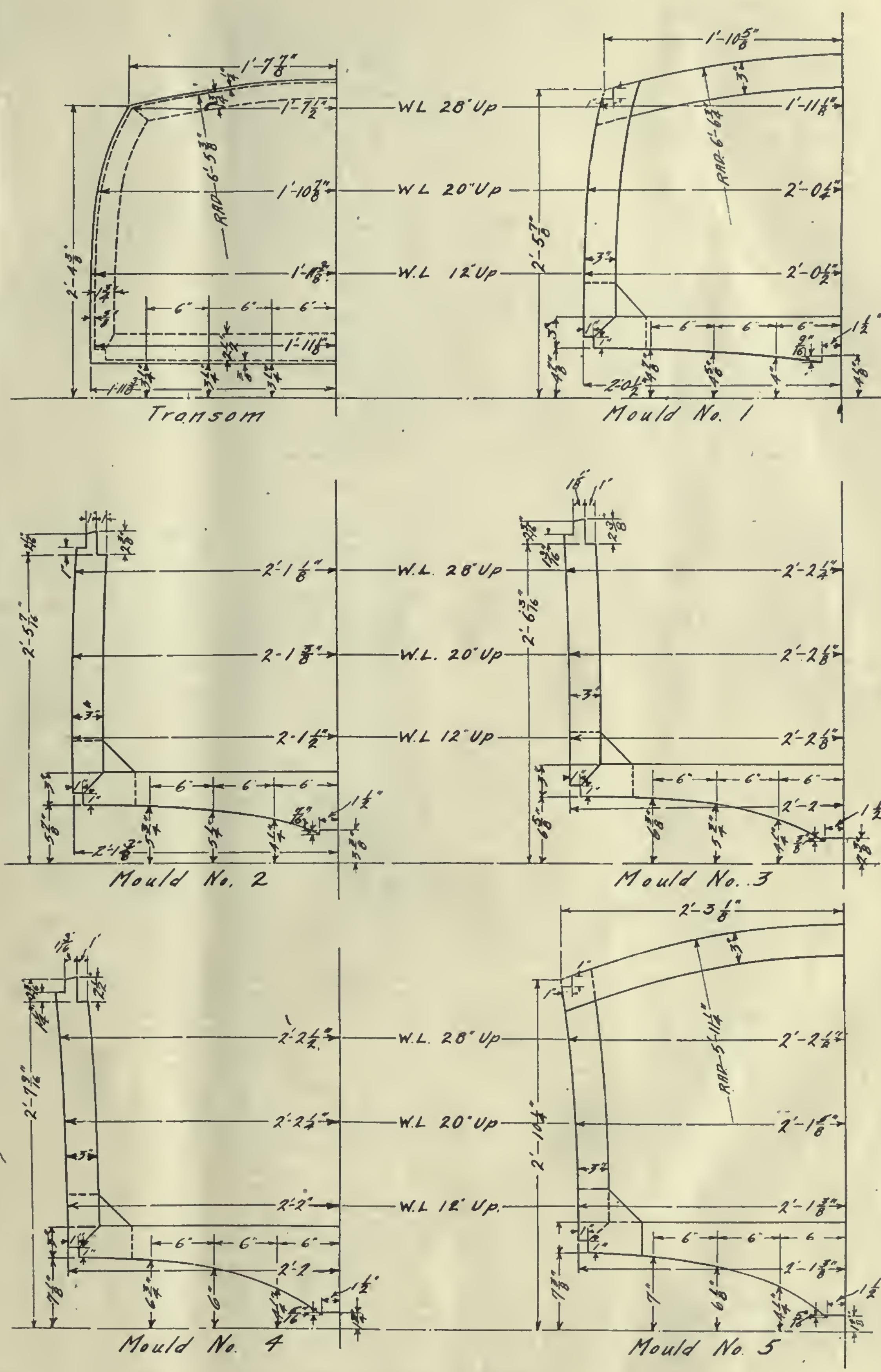
After the various parts have been prepared as described, they should be "set up." I am not going into any great detail with regard to "setting up" the molds as the drawings show clearly the relation of the parts to each other. The boat may be built upside down or right side up equally well. Some builders will prefer the first method and others the second. Whichever you use, be sure that all parts are securely fastened and that the molds are all parallel and square across the center line. If you set the molds in an inverted position, which is probably the easier method for the amateur, the keel should be kneed to the transom as shown, and fit into the notches cut in the molds to receive it, and should then be bolted to the knee at the stern. Make sure that the bend in the keel does not force any of the molds out of position. The chine piece of 1 inch by 1 inch yellow pine or spruce should then be run fore and aft

OFFSET TABLE

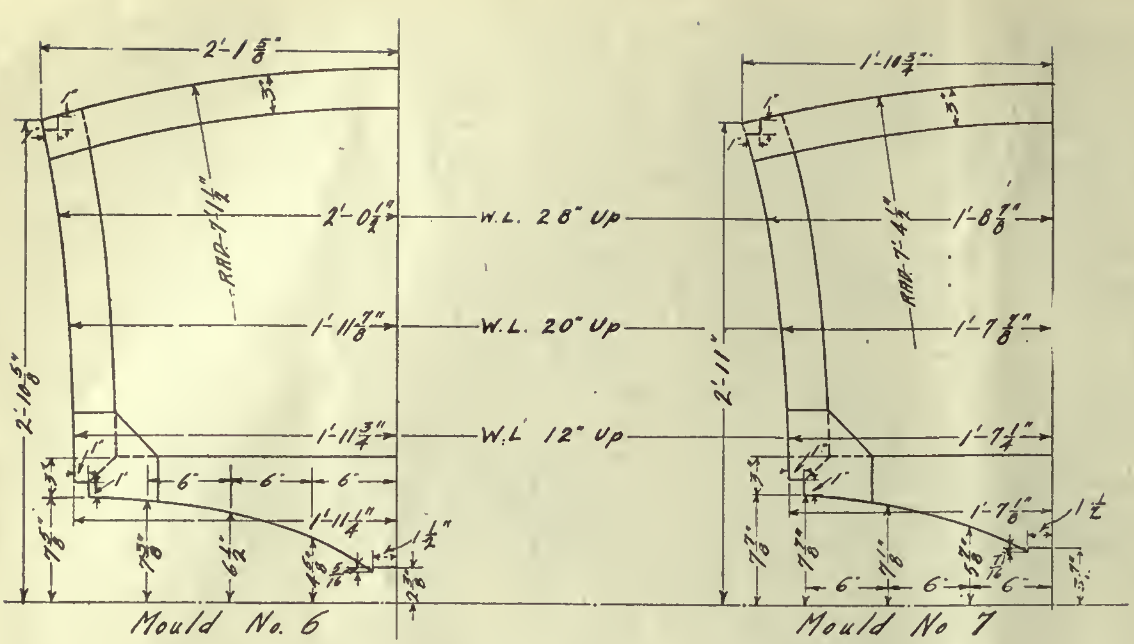
	Heights Above Base Line							Half Breadths						
Stations	Bottom of Keel	Rabbet Line	Buttock 6" Out	Buttock 12" Out	Buttock 18" Out	Chine	Plank Sheer	Bottom of Keel and Rabbet	Chine	W.L. 12" Up	W.L. 20" Up	W.L. 28" Up	Plank Sheer	Stations
0	0-3-1	0-3-2	0-3-2	0-3-2	0-3-2	0-3-2	2-4-3	0-0-6	1-11-4	1-11-3	1-10-7	1-8-0	1-7-7	0
1	0-2-7	0-3-0	0-3-5	0-4-2	0-4-4	0-4-4	2-6-1	0-0-7	2-0-7	2-0-7	2-0-5	1-11-4	1-11-0	1
2	0-2-1	0-2-2	0-3-7	0-4-7	0-5-3	0-5-4	2-7-5	0-1-0	2-1-6	2-1-7	2-1-6	2-1-4	2-1-2	2
3	0-1-1	0-1-2	0-3-6	0-5-3	0-6-0	0-6-2	2-8-7	0-1-1	2-2-3	2-2-4	2-2-4	2-2-5	2-2-6	3
4	0-0-4	0-0-5	0-3-6	0-5-5	0-6-3	0-6-6	2-9-6	0-1-1	2-2-3	2-2-3	2-2-5	2-3-1	2-3-5	4
5	0-0-2	0-0-3	0-3-6	0-5-6	0-6-5	0-7-0	2-10-4	0-1-1	2-1-6	2-1-6	2-2-0	2-2-4	2-3-4	5
6	0-1-0	0-1-1	0-4-2	0-6-1	0-7-0	0-7-2	2-10-7	0-1-1	1-11-5	1-11-6	2-0-2	2-0-7	2-2-0	6
7	0-2-5	0-2-6	0-5-3	0-6-6	0-7-4	0-7-4	2-11-2	0-1-0	1-7-4	1-7-5	1-8-2	1-9-2	1-11-1	7
8	0-5-2	0-5-3	0-7-1	0-8-0	—	0-8-0	2-11-3	0-1-0	1-0-1	1-0-2	1-1-0	1-2-2	1-4-4	8
9	0-8-7	0-9-0	—	—	—	0-9-0	2-11-4	0-0-6	0-0-6	0-0-6	0-0-6	0-0-6	0-0-6	9

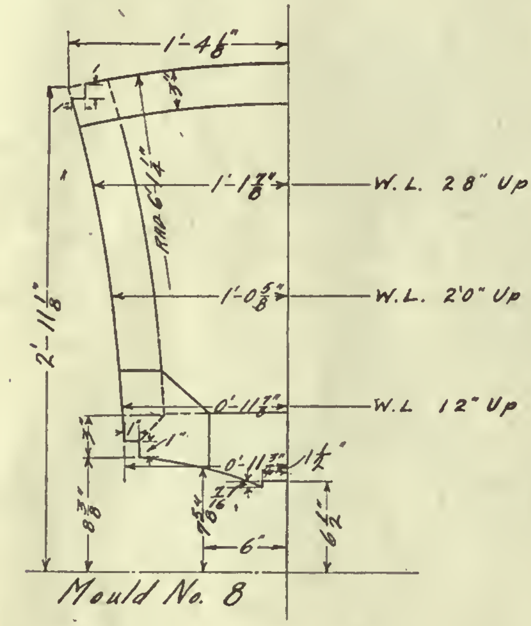
NOTE:— Frames spaced 2'-1½". For'd edge of stem 2½" forward of Station #9.

Dimensions are given to outside of pla nk, in feet, inches, and eighths of inches



DETAIL OF MOLDS





DETAIL OF MOLDS

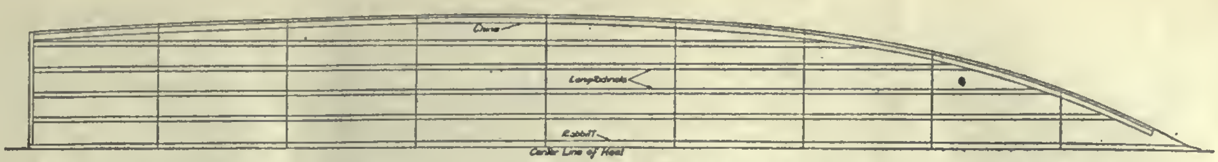
in the notches at the corners of the molds and should be connected to the transom by knees and to each side of the keel at the fore end by oak blocks as shown in the sketch. The clamp is next run in by the same method, the size and material being the same as for the chine.

If the notches for the clamp, the chine and the keel have been cut square to the edges of the molds you will notice that the clamp, chine and keel will not fit evenly into these notches but will bear on one edge of the molds as shown in the sketch; particularly on the molds in the fore part of the boat. The notches must be trimmed down to the line shown in the sketch so that the clamp, chine and keel bear evenly on the molds and are then fastened in place by long brass screws or by long copper rivets if you so desire. The screws for fastening the chine and clamp should be about 2 inches long and those for the keel about 4 inches. The clamps on each side of the boat should be connected to each other and to the stern by a "breast hook," and should be kneed to the transom. The fore end of the chine is connected to the keel at the fore end by a triangular piece of oak which is shown in detail on the drawing of the fore end of the keel. These pieces should be fastened to the sides of the keel by long rivets or by long brass screws. At the transom the chine is fastened by knees similar to those used to secure the clamp

The edges of the molds have been cut off square to the side of the molds, and if you take a long batten and bend it along the molds at the sides or the bottom, you will find that the batten touches only one edge of the mold and that the molds must be trimmed at an angle or level before a long batten will bear evenly on all the molds anywhere on the surface, which is to be planked. This beveling is the next operation and is done most easily by using a spoke shave cutting down to the proper angle by trial with a batten or long thin straight piece of wood. One of the pieces of spruce ¾ inch by 1 inch, which you will use later to run under the edges of the planks, will do very nicely for this work. After the molds have been beveled this batten should bend smoothly anywhere over the molds and should touch the full width of the mold edge.

It will be noticed that where the chine is run in the notches that the bottom of the chine does not exactly carry out the line of the mold on the two forward frames, but should do so on the other molds. The bottom of the chine should be planed to carry out the form given by the molds, and, of course, the outside of the chine should be flush with the sides of the molds.

The material for the battens, which are run fore and aft to cover the seams of the planking should next be prepared. For this you will need 16 pieces, each 20 feet long, of clear, straight-grained spruce 1 inch wide and ¾ inch thick. As may be seen on the midship section, the bottom planking consists of five planks on each side of the keel and the side planking of five planks above the chine. On the bottom, therefore, four of these battens are required on each side of the keel and these should be spaced so that they divide the bottom at frame No. 4 into 5 equal parts. I believe you will find it a simpler job to run these bottom battens about parallel to the center line of the keel, as shown in the sketch. The batterns should be held in the desired position by wire nails through them into the molds, and after marks have been made where the edges of the battens cross the molds they should be taken off and notches cut to receive the battens. Care should be taken to have the inside edges of the battens bear snugly against the bot-



SKETCH SHOWING HOW BATTENS TO TAKE EDGES OF PLANK ARE RUN ALONG BOTTOM OF BOAT

tom of the notches, and to have the battens fair and smooth for the whole length.

Where the bottom battens meet the chine they should be fastened to it by a couple of screws or rivets, as shown in the detail sketch. At the stern these battens are let into the frame which is fastened to the fore side of the transom and fastened to it by a screw through the end of the batten.

The battens for the sides should be run in and notched into the molds in exactly the same fashion; they should be spaced to divide the side into five planks of about equal width, and should be fair and smooth throughout their length and should be flush with the molds, connect the pairs on the opposite sides of the boat where they come together at the stern by a breast hook and let them into the frame on the transom just as you did the bottom battens.

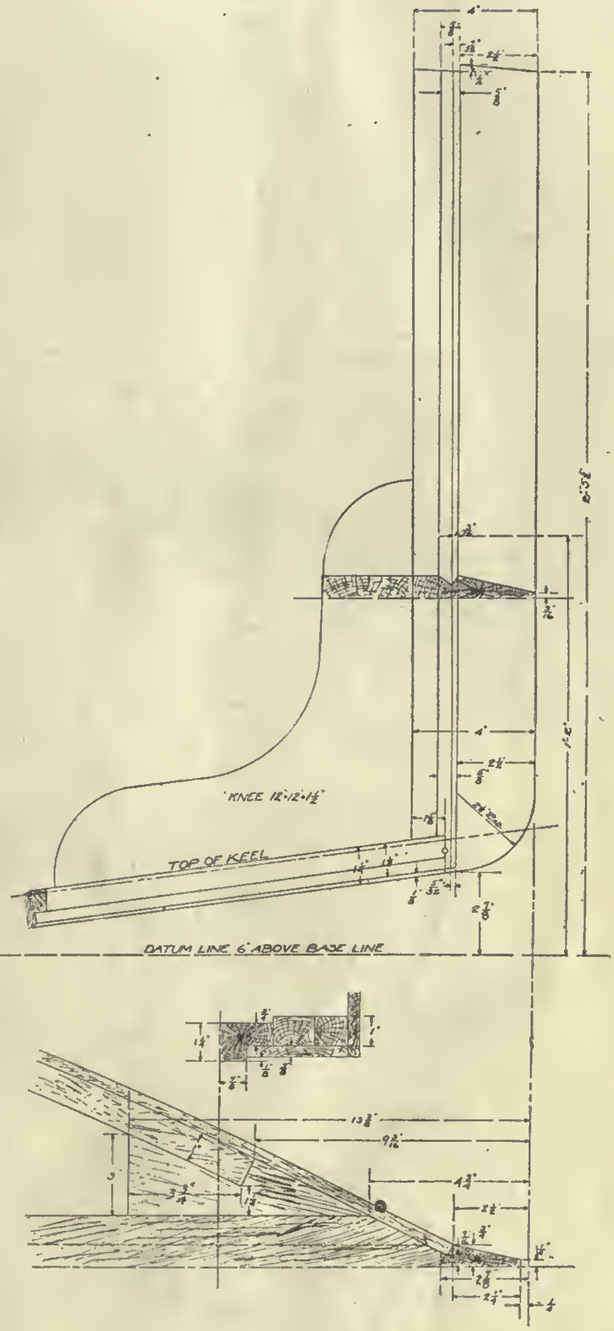
These battens, both along the bottom and the sides, should be fastened to the molds by 2-inch brass screws with the heads well countersunk into the battens.

When this is finished you will have a good idea of the form of the boat and will doubtless find it different from anything you have seen before. She is flat forward and flat aft with a fairly sharp section right amidships. The flat sections at the ends are so designed to give her a big lifting power. When running at full speed she really breaks the water with the sharp V-ed section of her forward plane, and this sharp section will make her easier and faster in rough water than she would be with a flat plane.

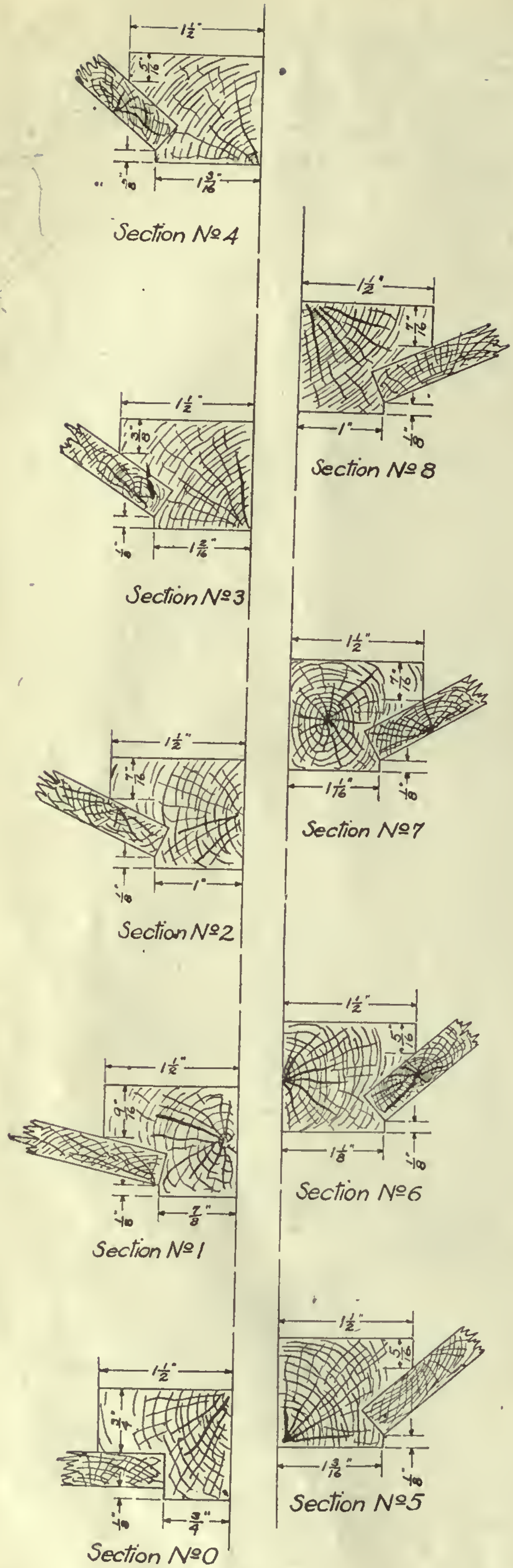
After trimming up the rabbet in the keel and stern, which may be done by laying a ⅜-inch thick strip along the battens and fitting it into the rabbet on the keel and stern, the boat is ready for planking. The material of the planking as called for on the midship section, is ⅜ inch mahogany, but clear white cedar or white pine could be used equally well. Mahogany is more expensive but it is also much stronger and will take a better finish than the other woods. It is also somewhat heavier but the difference in weight is much more apparent when the wood is dry than it is after the boat has been in the water for some time.

Start planking the bottom first and fit the garboards into the rabbet in the keel and have the other edge come on the center of the first batten. In order to do this you will have to take a spiling, using a thin board clamped or lightly nailed in place and marking off the points on it after the fashion which has been explained again and again in Motor Boat. Owing to the curvature of the hollow V-ed sections you will doubtless find it necessary to make the garboard and the next plank somewhat thicker and then work this hollow into the planks with a plane. The planks should be fastened to the keels and to the battens with copper nails riveted over burrs and fastened to the mold and stern by screws. Set the heads of the rivets and screws flush with the outside of the plank as the plank is too light to allow any countersinking and plugging without weakening the fastening unduly.

The fore end of the garboard should be carried on out a little beyond the outside of the chine, and at the after end the garboard should butt against the flat of the transom. The same is true of all the other bottom planks. After the garboard has been fitted, and fastened in place, the next plank should be cut to the proper shape, and so on, each plank being cut from a spiling taken similarly to



DETAILS OF KEEL, STEM, CHINE AND KNEES. SHOWING THEIR CONNECTION AT BOW



KEEL SECTIONS

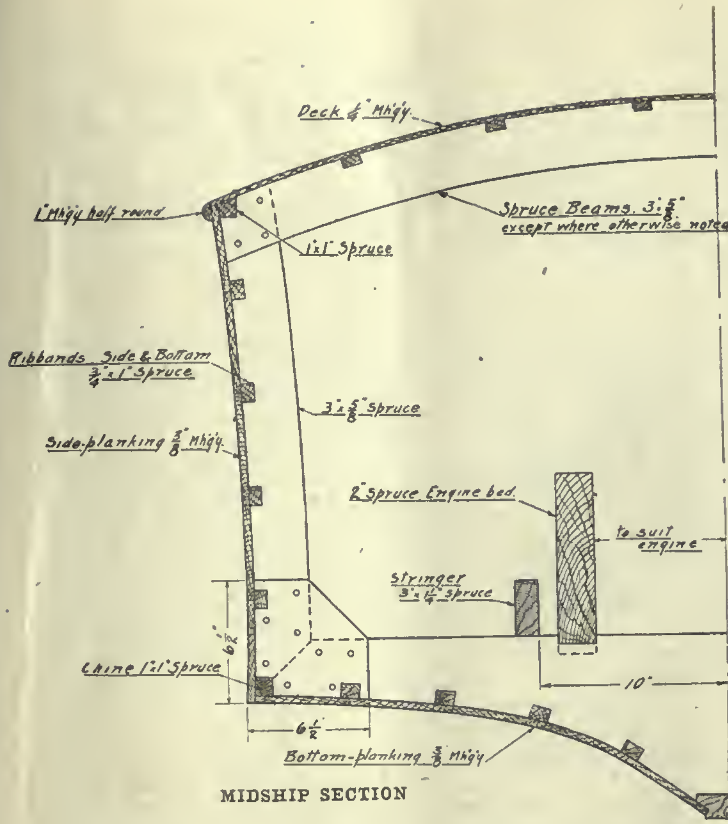
the garboard and they should all run a very little past the outside edge of the chine at the fore end, and should butt up against the flat of the transom at the after end. Do not attempt to make the joints between the two planks too close, as the wood you are using is dry and will swell when the boat is placed in the water. Unless there is a little room left at the joint, the planks will be forced against each other, and will raise up in ridges. After each plank has been fitted, and before fastening it in place, it would be wise to paint thickly that part of the plank that bears up against the edge batten with white lead or a very thin coat of marine glue, as this will greatly assist in obtaining water tightness. The rivets in the battens along the plank edges should be spaced about two inches apart, the heads being flush, as before stated, with the outside of the planking.

After the bottom has been completely planked, trim the outside edge of the plank until it is flush and fair with the outside line of the chine, as the side planks are to be extended down to cover the joint between the bottom plank and the chine, and must, therefore, have a fair surface to fit against.

The side planking is put on, cutting the planks to shape from spilings, just as you have done on the bottom planks, allowing the lowest bottom plank to come down and cover the joint between chine and bottom plank, as stated above. The fastenings of the side plank are the same as the bottom plank, being screwed to the molds and stem, and riveted to the chine, edge battens and clamp.

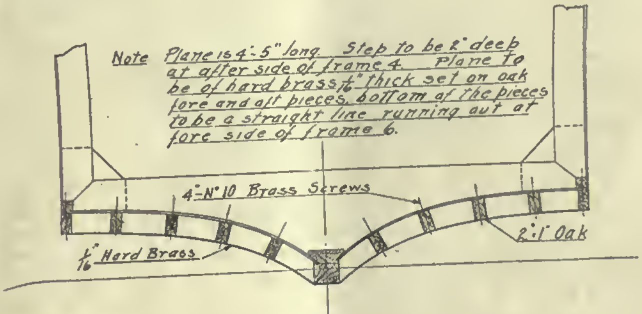
After the hull has been planked, smooth up the entire surface, first going over all rivet heads with a file to get them flush with the wood, using emery cloth, to bring everything, rivets and wood included, to a smooth surface. This smoothing up is of the utmost importance, as much of the resistance of a hydroplane is due to surface friction. After smoothing up, give the hull a good coat of wood filler, allow it to dry hard, and then sandpaper again. Then give the bottom a thorough coat of varnish or bottom paint, whichever you desire. It would be wise to use at least two, or better three, coats of varnish or of bottom paint, but since this preliminary coat is given merely to allow us to put on the brass plane, and since the parts of the hull that are not covered by the plane can be finished and painted later, it would be a tedious and perhaps unnecessary delay to wait for the drying of these successive coats.

You are now ready to put on the brass plane. This is made of hard sheet brass, about one-sixteenth of an inch thick. The total length of the plane is 4 feet 5 inches. The position of the plane is shown on the inboard profile, extending from the fore side of frame No. 6 to the after side of frame No. 4. The appearance of the step formed by the plane is shown in a sketch. As may be seen, oak wedges, 2 inches deep at the step, are spaced about 5½ inches apart. The bottoms of these wedges are straight lines, and taper out to nothing at the fore side of frame No. 6. The wedge at the keel is made the full width of the bottom of the keel, for it will not be possible to get one sheet of brass of the width required. The two pieces of which the plane must be composed come together down the middle line of this middle wedge, and must be very thoroughly secured to this wedge with brass screws, spaced not over an inch apart. The wedges are fastened to the floors of frames Nos. 4 and 5 by long brass screws, put in from the outside, and between the frame screws are put down from the inside of the plank into the wedges. After the wedges are all on fair up the surface defined by the wedges by bending a thin strip of wood over them, and noting whether it lies smoothly over all the strips. Plane up the bottoms of the wedges until you can do this. The brass plates are next secured in place. At the fore edge they are screwed through the plank into the floor on frame No. 6, using 1½-inch brass screws spaced as shown in the sketch.



MIDSHIP SECTION

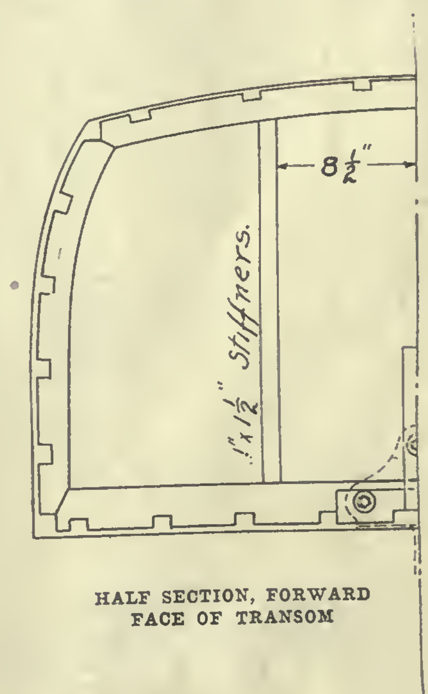
Do not let the fore edge of the plane into the plank, as this would cause weakness at this point. Simply file it down at a bevel; it will make very little resistance, as at extreme high speeds the boat will practically run on the plane itself and not on the forward part of the planking. The planes must be fastened to each of the wedges by brass screws, spaced about three inches apart, along the line of the wedge. All screwheads should, of course, be flush. Particular care must be taken to have the fastening at the forward edge of the plane very carefully done, for if it were possible for the water to force its way under this plane, it would soon rip it off. The after part of the plane at the step is left entirely open. When at rest, water may flow into the space between the outside of the planking and the upper side of the plane, but as soon as the boat is under way, it will drain out. If you wish to make a very fancy job, set the screw heads a little bit below the level of the brass, and then put a drop of solder over the heads. Next file this solder down flush, but there is no great need of doing this, if the slots in the screw heads are all placed in a fore and aft line, and the solder would be a great hindrance should you wish to remove the plane to get at the hull underneath. The plane should be finished by being polished by emery, either a fine emery cloth or emery flour.



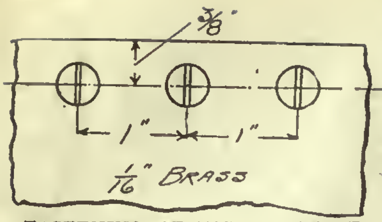
SECTION AT AFT END OF STEP LOOKING FORWARD

You are now ready to turn the hull over and put on the deck. The beams are shown on the molds, which give the curvature as part of a circle having a certain radius. These circular arcs can be easily drawn in by taking a long strip of wood, driving a wire nail into one end of it, measuring off the required radius from this nail, and drilling a small hole through which you may put the point of a pencil, then use this just as you would a compass to draw the arc. The top of the clamp and the top of the upper side plank should be cut to carry out the curve shown by the beams. The general scheme of deck construction is exactly that of the planking, but the material is somewhat lighter, and is of the size shown on the midship section.

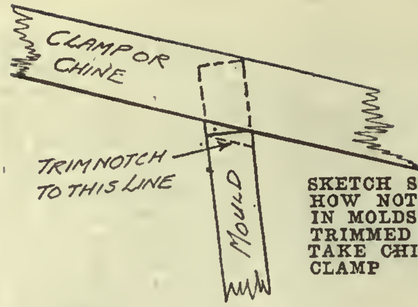
The length of cockpit shown will do very nicely for a 40 or 50-h.p. motor, but, of course, if you intend to install a large motor, you will have to carry the cockpit one frame farther forward. This is something that you can readily determine for yourself, and depends on the motor chosen. Put in the spruce stringer to which the cockpit coaming is to be fastened, making it 1 inch by 2¾ inches, and running it in the notches inside of the upright parts of the frames. Run this stringer only between the beams at fore and after ends of the cockpit. Screw this stringer to each mold, and between each mold and the consecutive one put in two short blocks, filling the space between the clamp and this stringer. Then using a long one-eighth-inch rivet, make a thorough fastening at these points between the stringer and the clamp. At the fore end of the cockpit, pine cornerpieces about 2 inches thick should be cut out, to take the curve of the cockpit. If you are experienced, you could of course change the fore end of the cockpit to the more fashionable flared V type of coaming. Fair up the upper edge of the cockpit stringer to the lines indicated by the beam in the clamp, and then arrange edge battens of spruce 1 inch wide and half an inch thick, to go under the edges of the deck plank, as shown on amidship section. This deck is shown in fairly wide pieces, only one-fourth of an inch thick, and should be easily applied if the battens are spaced about as shown on the amidship sections, and are run fore and aft, practically parallel to the center line of the boat. Notches for



HALF SECTION, FORWARD FACE OF TRANSOM



FASTENING AT FORE EDGE OF PLANE



SKETCH SHOWING HOW NOTCHES IN MOLDS ARE TRIMMED TO TAKE CHINE AND CLAMP

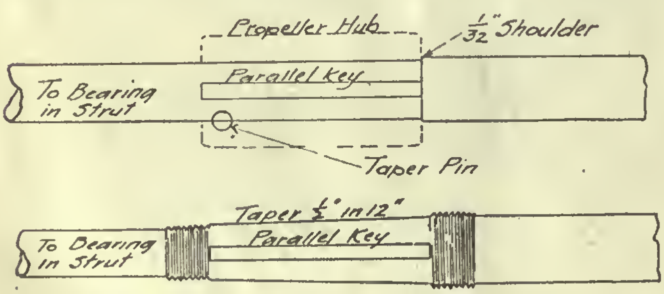
SKETCH SHOWING CONNECTION OF SEAM BATTEN TO CHINE OR CLAMP

the battens should be cut after the method used for the edge battens of the plank. The deck plank should be fastened with screws and rivets similar to the method used on the planking. Carry the planking to the outside of the side plank. Then trim it off smoothly and fairly with the side, covering the joint with a 1-inch half round of mahogany. A deck built after this fashion is light, strong and tight, but is not as handsome as the canvas deck, or the deck laid in narrow pieces.

The coaming is of oak or mahogany, 3/8 of an inch thick. If pine or cedar is used for plank and deck, oak might be used for the coaming, but it would, of course, be impossible to use oak on a mahogany planked boat. The coaming should be 4½ inches above the deck at the fore end, 3½ inches at the aft end. The detail of fitting the coaming is extremely simple, and space prohibits going into it in this article.

Slatted floors, about 3/8 of an inch thick, are shown on the plan. It is advisable to make these floors so that they may be removed in sections, as in this way you will be able to get at the bottom of the boat without ripping up the floor. The steering wheel of the simple drum type is shown placed on a thwart, an arrangement which gave unusually good satisfaction in *Water Bug* and is reproduced here. If the motor is exceptionally long, it may perhaps be necessary to dispense with this thwart and use a vertical post with a horizontal steering wheel

In getting in the shaft line, the approximate position of the shaft hole is readily seen from the drawing. Bore a comparatively small hole at about the position shown, putting on a small block on the keel to start the hole through the shaft at the bevel. Then from a point at the proper distance below the transom, as indicated on the drawing, pass a wire through this hole to the point shown on the mold as indicated, stretching the wire very tight. Then cut out around this hole, until it is large enough to clear the propeller shaft that you intend to use. The shaft line shown on the plans will take an 18-inch or 19-inch propeller. If you intend to use only a 16-inch propeller, it is advisable to decrease the shaft line from the bottom of the boat at the transom by about an inch. Use your common sense in making these allowances, as it is impossible to design a hydroplane to carry any old size of motor, and have everything work out to certain fixed dimensions. The motor bed is formed by fore and aft spruce stringers, set on the floor inside of two 3-inch by 1¼-inch spruce stringers; the lighter stringers run the full length of the boat, and are fastened



METHOD OF SECURING PROPELLER TO SHAFT

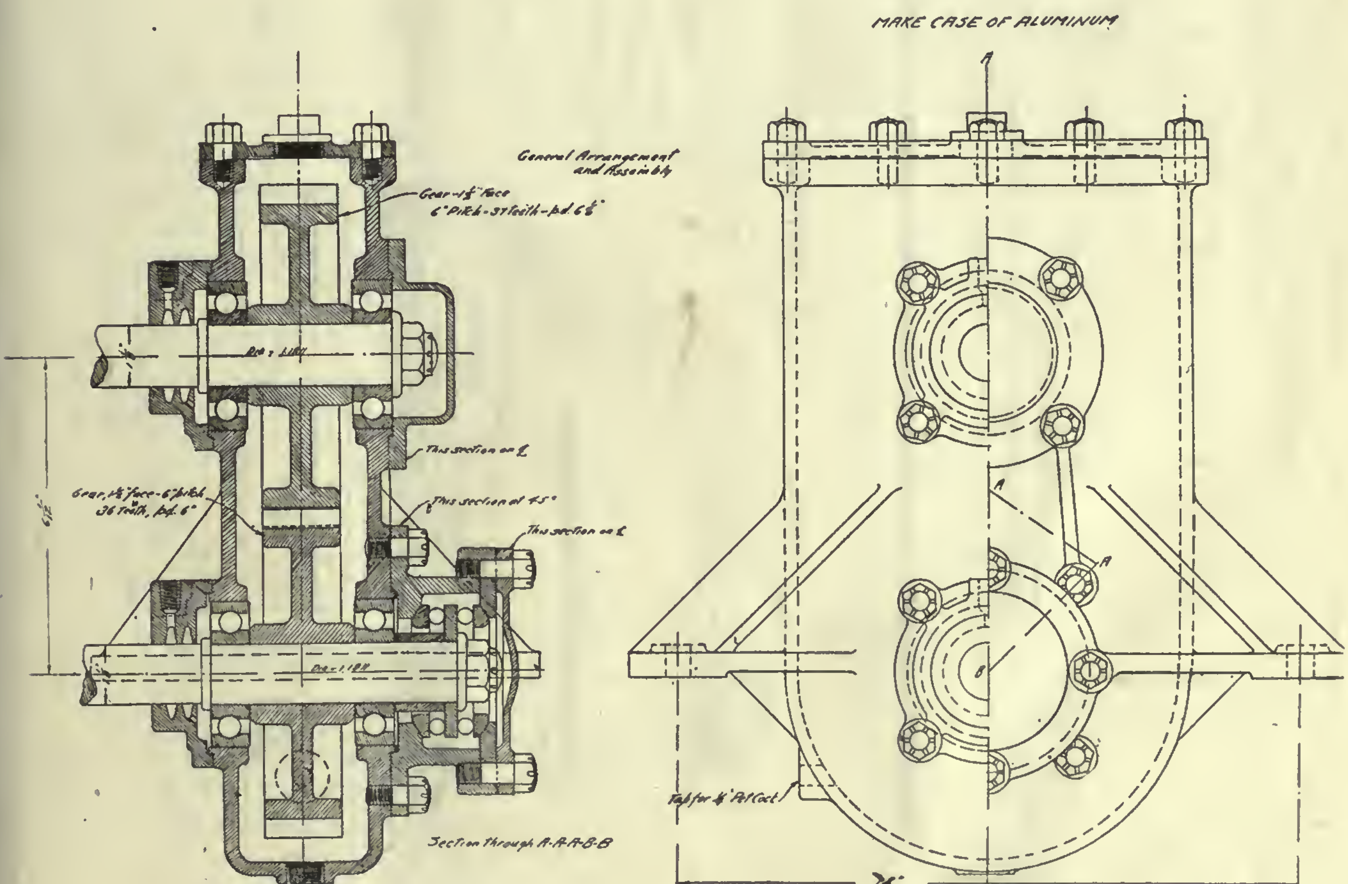
to the floors by long rivets running clear through the stringers and through the floors. The heavier bed stringers are notched over the floors and are also riveted to them, but extend only the length required by the motor and reverse gear.

The transmission gear to drive the propeller shaft is a thing concerning which it is almost impossible to give definite detailed dimensions, unless the motor is known, its power known, in order to estimate the stresses which the gear must withstand. The gear should be made by an experienced machinist of the very highest class, one accustomed to high grade automobile construction will know about what is required, as this transmission is similar in general principle and in the degree of skill required in its manufacture to that used on cars. The case should be of aluminum, about one-fourth of an inch thick for a 50-hp. motor and about 5/16 of an inch thick for a 100-hp. motor. Lugs should be cast at the sides to carry the gear on a foundation built to receive it. This foundation, although it need not be extremely long, should be very substantial, as all the thrust of the propeller comes upon it, and besides that it is under considerable twist, due to the propeller and motor torque. The casing should have both the front and back all in one casting, as a much more accurate machine job can be obtained, than when one of the faces is made as a cover plate and bolted up against the rest of the casting. If made as suggested, a cover plate at the top serves to introduce the gears, through which the shafts are slipped afterward. The drawing shows clearly the type of transmission gear advised. It is, of course, of the ball-bearing type, using annular ball-bearings of liberal size. The propeller shaft is fitted with a ball-thrust bearing for both reverse and ahead motion. In the gear shown, the upper gear on the motor shaft has 37 teeth of six pitch; the lower gear has 36 teeth of 6 pitch. This gear is suitable for about a 60-hp. motor. The gears have 1½-inch face, and the shafts are about 1 3/16 inches in diameter. The gears are held on the shafts by parallel feather keys. The casing is of aluminum, ¼ of an inch thick. It should be noted that a filling plug for oil is placed at the top of the casing, a drain plug at the bottom, and an oil level plug at the side. For the larger powers it would be advisable to use gears of 5 pitch instead of 6 pitch, and always make the number of teeth on the two gears so that they are numbers that are prime to each other. If you do this, then every tooth on one gear will eventually come into every space, in turn, on the other gear, so that wear will be evenly distributed. The gears wear in and run more quietly after having been in use for a time, than they do when new. If the gears have a number of teeth, such that they are divisible by the same factor, for instance, 48 teeth on one and 32 teeth on the other, both being divisible by 16, this distribution of wear is not accomplished; the gears wear unevenly, and become noisy. The gear material, the shafts and in fact every part of this transmission must be of the very highest quality. Special alloy steel should be used for the gear blanks, and after being accurately cut, they should be hardened. In designing the case for the gears, be sure to leave ample clearance all around the gears, in order to prevent your transmission from acting as a gear pump.

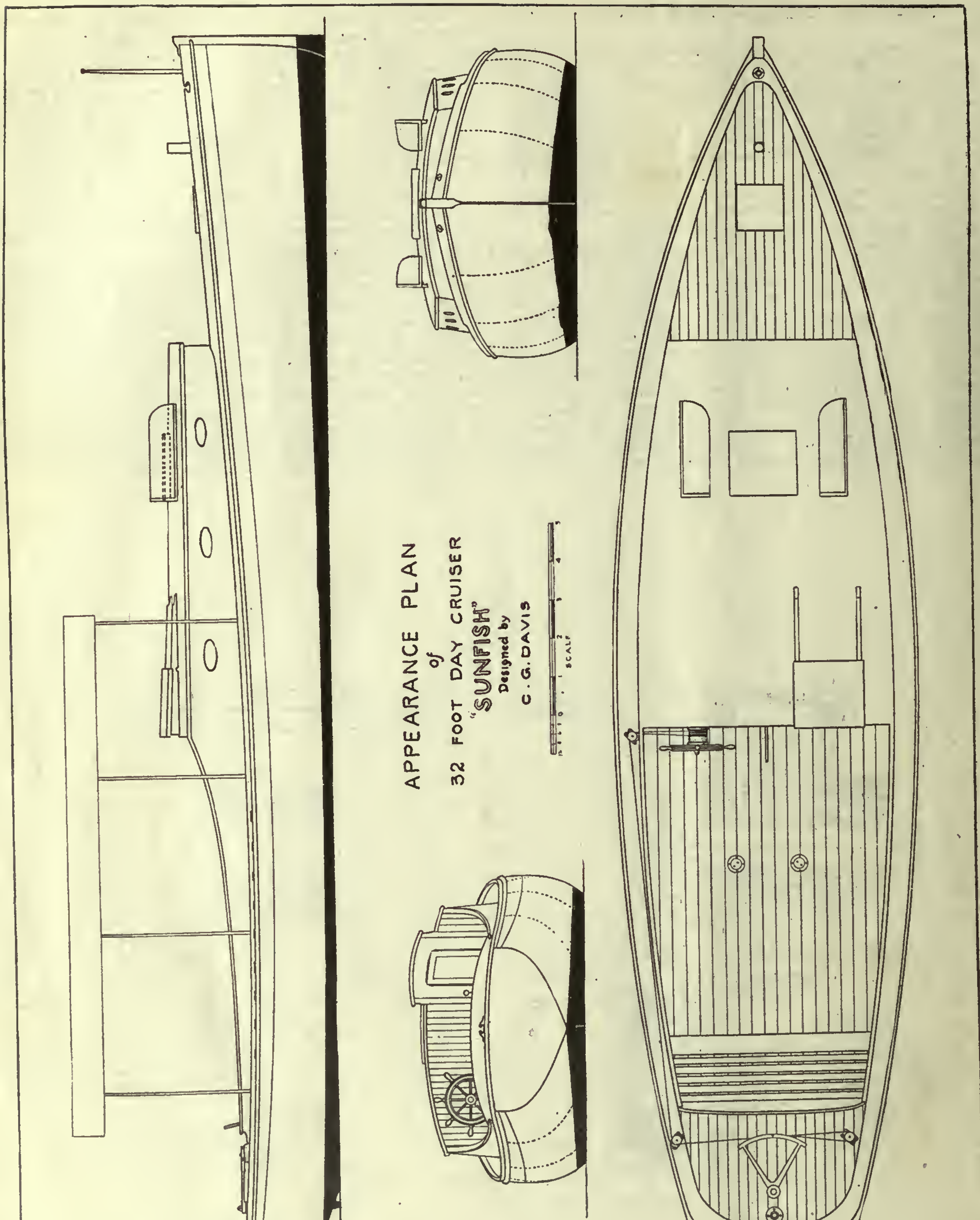
A universal joint is shown between the motor and the gear. This should be of ample size and is quite safe in this position, as it takes no thrust and is run at a comparatively small angle. Of course it could be eliminated, provided bevel gears at the proper angle were used in the transmission instead of spur gears, but bevel gears are much more expensive, are much more difficult to fit properly, and are apt to run noisily. Then, in addition, the universal joint provides for a certain amount of flexibility between the motor and transmission, which is very useful in hydroplane construction.

The strut and rudder present no unusual features, except that the rudder is hung at the bottom of the strut and at the top of the transom. The sizes are indicated at the joints. The strut is bolted through the back of the transom, one bolt at the back of the large palm going through the knee between the transom and keel. The bottom of the palm is wide, and has two bolts, the centers of which are about six inches apart, and go through the transom into an oak chock about 10 inches long and 2 inches deep by 2½ inches in a fore and aft direction. These bolts should be about ⅝ of an inch in diameter, and should be of bronze. The nuts should be at the outside, so that the strut may be removed, without crawling in under the deck. Sketches show how the propeller wheel may be applied to the shaft, either using a straight bore through the propeller, with a small shoulder at the fore end of the hub, and securing the wheel by a key and taper pin, or by using a tapered bore and nuts at the fore and aft ends of the propeller hub. The straight shaft and taper pin is much simpler, but it is much more difficult to remove a propeller than when the tapered bore and nuts are used. The water intake should be carried near the garboard, a little forward of the step, going down through the brass plane. An alternative arrangement would be to have the water intake project just a little below the plane coming down through the hull, just aft of the step.

For those who desire to work out their own construction, using perhaps a lighter, simpler scheme, the line drawing and offset table are given. If a big, heavy motor is to be used, the arrangement will work out better if the motor is placed aft and the crew forward of the motor, an arrangement which possesses many advantages; but in working out such an arrangement, it is necessary to know the definite motor weight, and should any of the readers desire to use this arrangement, I shall be glad to advise them where the center of the motor weight should be placed if they will furnish the necessary data regarding the motor sizes and actual motor weight.



TRANSMISSION GEAR AND CASING FOR 50-HP. MOTOR AT 1500 R.P.M.


APPEARANCE PLAN
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