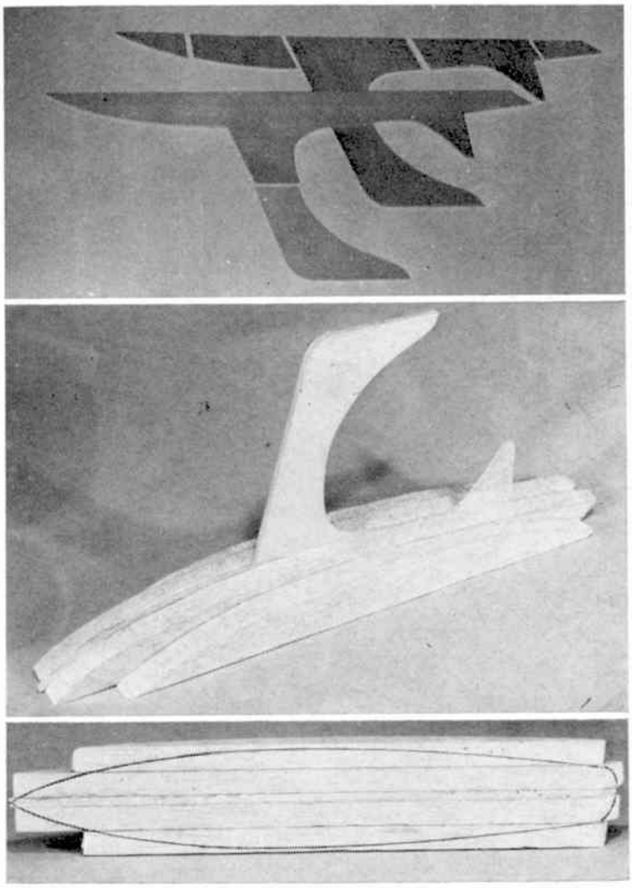
Full-size plans for a miniature racing yacht

SPLINTER

designed by Vic Smeed

Inexpensive and simple to build, this model nevertheless has excellent performance



Picture above shows the prototype sailing on a reach and moving quite fast; absence of a marked wash is indicative of a hull slipping easily through the water. Below, top, centre lamination with one of the side laminations behind; use of 3 in. wide sheet makes short pieces inevitable. Centre, balsa planks cemented to core, and, bottom, hull plan view marked out on top ready for sawing.

THIS model was designed after watching the performance of some small toy sailing boats which must have been quite a disappointment to their owners. Some toy boats are able to sail moderately well on some courses, but manufacturers cannot produce the type of sophistication needed for good performance at a price that would make the model attractive to undiscerning customers.

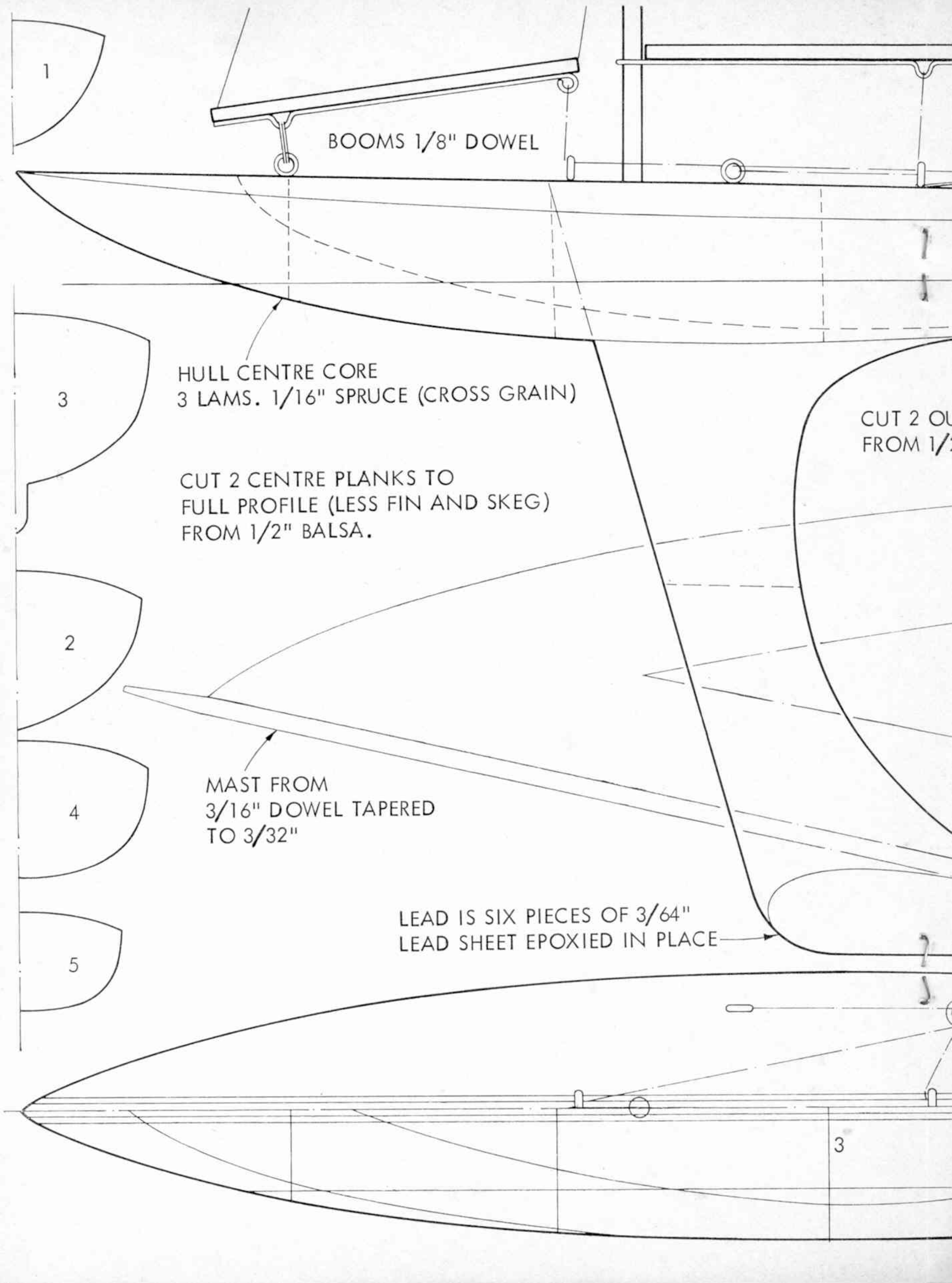
A number of older model yachtsmen have also said that you can't make a boat sail if it's under about three feet long, which is the sort of statement that we cannot believe until we've tried it!

There are a couple of factors in small models which have to be taken into account. The first is the "cube law". If you take a stable model yacht and halve its size, it will be half as long. Its sail area, however, will only be a quarter, as it is two dimensions ($\frac{1}{2} \times \frac{1}{2}$) and its displacement will only be an eighth ($\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$). Without going into a long explanation, this means that the model will be less stable and you cannot increase the lead weight because of the displacement limitations. A small yacht must therefore be different from a larger one in order to be stable.

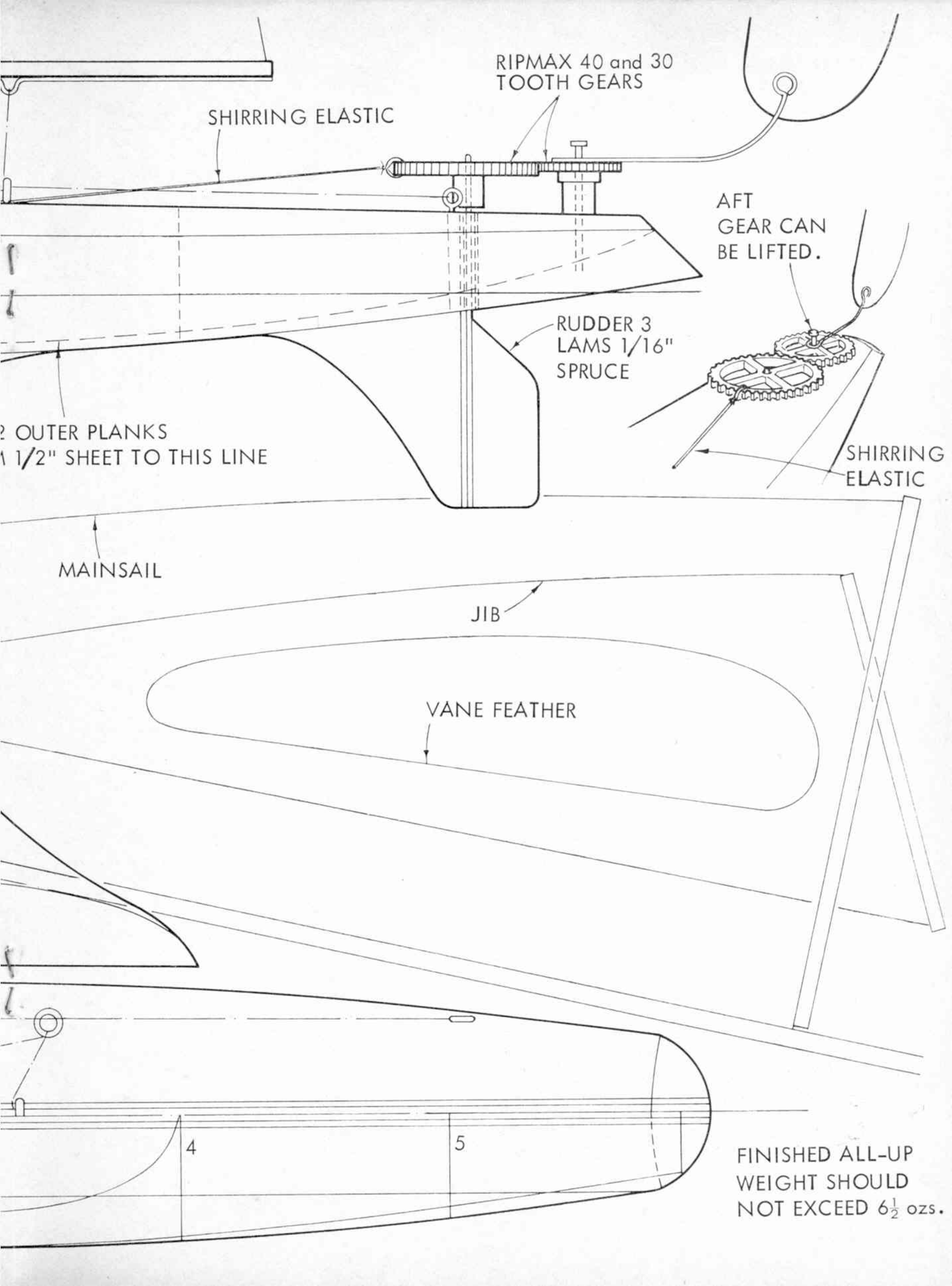
The second factor relates to pressure. We know that the pressure on the water surface is normal air pressure, which is the weight of the column of air above the area being considered. Below the surface the pressure increases by the weight of the column of water covering the area. Obviously, pressure on an inch or two below the surface is less than that a foot or so down, so that the top "layer" of water is relatively easily disturbed. Resistance to sideways motion of, say, a yacht's keel is therefore less, so that a shallow yacht will blow more rapidly sideways, or make more leeway.

From this it is obvious that if we dispose the keel area deep and narrow we shall get a better grip on the water and the yacht will sail better. We can also put the permissible lead ballast right at the bottom so that it acts through a longer lever and the boat will therefore be more stable.

While we are considering natural factors, we might also think of wind gradient. Because of friction, the bottom of the air moving across land or water is slowed up, so that the nearer the water, the less the wind is felt.



1
BOOMS 1/8" DOWEL
HULL CENTRE CORE
3 LAMS. 1/16" SPRUCE (CROSS GRAIN)
3
CUT 2 CENTRE PLANKS TO
FULL PROFILE (LESS FIN AND SKEG)
FROM 1/2" BALSA.
2
MAST FROM
3/16" DOWEL TAPERED
TO 3/32"
4
LEAD IS SIX PIECES OF 3/64"
LEAD SHEET EPOXIED IN PLACE
5
3


RIPMAX 40 and 30 TOOTH GEARS
SHIRRING ELASTIC
AFT GEAR CAN BE LIFTED.
RUDDER 3 LAMS 1/16" SPRUCE
2 OUTER PLANKS
1/2" SHEET TO THIS LINE
SHIRRING ELASTIC
MAINSAIL
JIB
VANE FEATHER
4
5
FINISHED ALL-UP WEIGHT SHOULD NOT EXCEED 6½ ozs.

Thus a small model needs tall sails to reach up into the faster moving air. Wind gradient, incidentally, can be felt with a glider or light aeroplane coming in to land, and is usually the reason why a model aeroplane heading into wind will glide smoothly in and then suddenly drop the last couple of feet.

To stand the best chance of success, then, a small model yacht must have a deep and narrow fin keel with its ballast right at the bottom, and high aspect ratio sails. These are the most important points, but there are others, like keeping top weight low, which have been incorporated in this little design.

How does it sail? Well, we were surprised and delighted at its speed and ability to move on the lightest trace of breeze, as well as its ability to point, which means sailing into the wind closely. Most large yachts can sail at 40 deg. or slightly less to the wind direction, and *Splinter* can match them pretty well.

As befits what is in effect a miniature racing yacht, it incorporates a simple vane steering gear and the grand-sounding "synchronous sheeting", which means that one adjustment controls both sails and keeps them correctly set in relation to each other. How this works will be clear when we come to make it.

Construction:

There is very little weight to be saved in making a tiny model like this hollow, so the structure can be designed for strength and simplicity. It is necessary to make a strong and warp-free fin, and this is achieved by making the whole boat round a centre core of three laminations of $\frac{1}{16}$ in. spruce (it could be obeche if easier to buy). The centre lamination has the grain parallel with the top line of the deck, and those each side have it in line with the fin leading edge. The first step is to trace the complete outline on to a sheet of $\frac{1}{16}$ in. spruce 3 in. wide and cut it out accurately. This can then be used to mark out the rest of the laminations; the photographs should make it clear.

Cement the core laminations together (use balsa cement or Bostik clear adhesive) and leave to dry thoroughly on a completely flat surface with weights on top. While drying, trace the full hull outline (not the fin or skeg) twice on to $\frac{1}{2}$ in. balsa and then the dotted line of the outer planks twice, and cut out the four pieces. There is no need to use hard balsa, since we already have the core for strength.

Cement the four planks to the core, lining up the stern ends carefully, and leave under pressure to dry. When dry (and this means overnight, even with balsa cement) trace the plan view on to the block and fretsaw round it. The hull can now be carved and sanded to shape; trace the half-sections 1–5 on to post card and cut out carefully, mark the section positions on the block, and offer the templates, sanding until they fit. Make sure the hull is symmetrical—this is more important than absolute accuracy with the templates, though carve exactly to them if you can.

The fillets of the fin and skeg should be carefully streamlined and blended to the hull, using fine glass-paper wrapped round a piece of thick dowel or similar round object. Don't at this stage sand the bottom of the fin, and leave the after edge of the skeg square.

To avoid the necessity of casting a lead, buy a piece of sheet lead from a builders' merchant. You only need a piece a full 1 in. long cut from the end of a 9 in. strip of the sort of lead used for flashings; it measures under $\frac{1}{16}$ in. thick and is probably 18 swg. Trace the lead profile from the drawing and cut out. Use the paper pattern to mark six pieces on the lead and cut out with an old pair of scissors. The pieces as cut should weigh about 3 oz. or just under. Flatten them by gentle tapping or squeezing in a smooth-jaw vice, and sand their faces clean. Glue together and to the base of the fin (three each side, of course) using epoxy resin and leave under pressure to cure.

When dry, carve the lead to shape with a pen-knife (it's quite easy) and file to a smooth bulb. Mix a little more epoxy and fillet the bulb to the fin, and again when cured, file and sand everything smooth, including the fin.

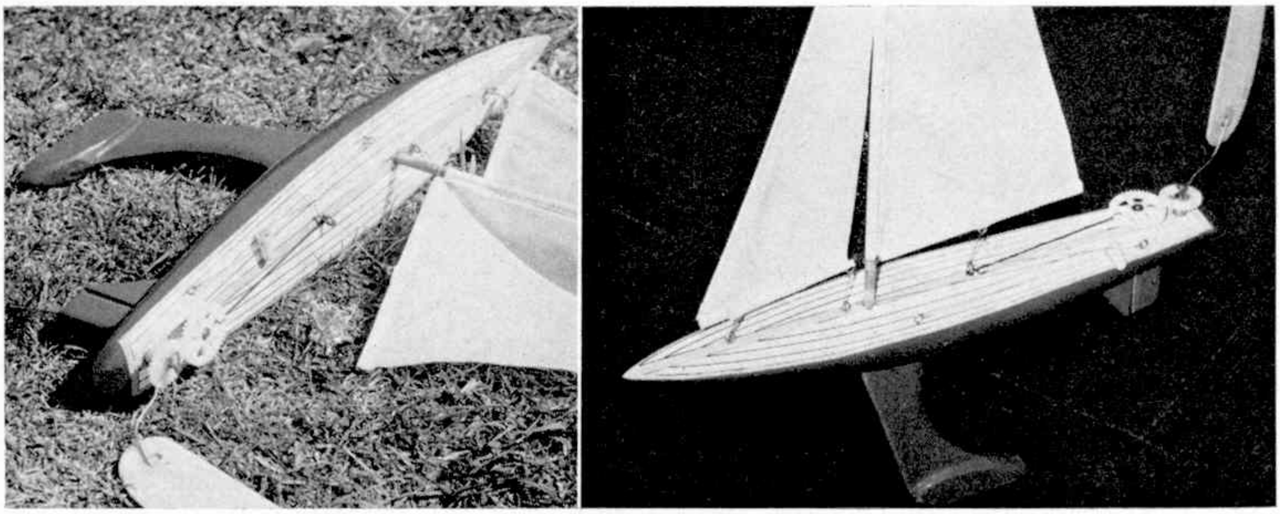
The rudder is from three scraps of $\frac{1}{16}$ in. spruce glued cross-grain and sanded to shape. If the leading edge of the centre piece is set a tiny bit back, it forms a seating for the wire or tube rudder stock. Drill carefully through the core with a $\frac{1}{16}$ in. drill, then enlarge the hole to accept a length of brass tube which is a sloppy fit on the rudder stock. A tube which fits well will stick after a time, and it is essential that the rudder moves completely freely. If you use 18g bore tube for the rudder, its outside will probably be about 14g, so the trunk, or tube through the hull, will need to be 12g. bore. Epoxy the tubes in their places; note that through the hull is only a full $\frac{3}{4}$ in. long, but the rudder stock is $2\frac{5}{8}$ in. Check that the hull tube is correctly placed with a wire etc. before the adhesive is set; the rudder must line up with the skeg. At this stage drill a $\frac{3}{16}$ in. hole $\frac{1}{2}$ in. deep for the mast, making sure it is vertical and in the right position.

The hull can now be finally sanded and painted. If you use cellulose sanding sealer (3–4 coats) and then enamel paint, a nice finish will be achieved, but enamel will not key to cellulose and you cannot mask a waterline etc. without peeling off the paint with the masking tape, so use oil undercoat if you want a two-colour hull.

Our procedure was to seal and paint the deck white and then draw on planks using Indian ink in ink compasses, using one leg of the compasses run along the deck edge to get curved planks. The centre king plank and "cover boards" (edge planks) were painted mauve, dried, and the deck varnished. The hull (sealed at the same time as the deck) was masked and a thin mauve waterline painted in. The masking was removed and the rest of the hull painted purple, (well, aubergine is the fashionable name for the colour) cutting up to the waterline and deck-edge free-hand. Not recommended if you haven't a steady hand and a writer's brush. The paint was mixed from mid-blue and red Humbrol enamels, and part was mixed with white to get the toning mauve shade.

The mast is a length of $\frac{3}{16}$ in. dowel planed and sanded to a taper, and the booms are $\frac{1}{8}$ in. dowel. A thin brass wire (or if necessary, 24g piano wire) is cemented to each boom. The jib has a kink where shown and an eye at the aft end. The main has an eye

The hull and lead carved to shape ready for sealing and painting. It really is quite simple to carve and sand to the necessary shapes provided you don't rush it.



Two views of the finished model showing rigging and fitting details. Deck lining adds greatly to appearance but is not necessary; if not done neatly it is better simply to paint the deck.

to fit round the mast and a kink as shown. These " kinks " are important as regards position.

We used a white polythene bag (from the butcher) for sails. Lay the polythene over the plan and cut the sails with a sharp blade, not scissors. The sails can be sewn to the mast and booms, but we used white plastic insulating tape. Cut a piece as long as the main boom and make a nick in its centre for the wire kink to poke through. Place the boom centrally on the tape, coax the tape round, lay the foot of the sail in place and press the tape together, trapping the sail between. Trim off surplus tape at the ends. Do the same with the mast, taking care not to overlap the tapes at the sail tack (front bottom corner). You may make a mess of it and have to cut another sail and try again; the secret is not to stretch either the tape or sail. When satisfied, firmly glue the mast in its hole, ensuring that it is upright from front and side, and leave to dry.

Fix the jib to its boom, then cut a length of tape for its luff (fore edge) and lay flat. Lay a piece of strong thread along the centre of the tape, with a couple of knots in the thread at the bottom and a few inches spare at the top. Lay the sail in place and fold over the tape. The jib is hooked to an eye in the deck with an S hook bent from wire, or an oval of wire, or at a pinch by several long stitches of thread.

When the mast is completely dry (and don't hurry this bit) thread the loose jib thread through a needle, hook the jib in place, and sew round the mast, through the tape, at the jib hoist position, drawing the thread taut and knotting it off centrally on the mast.

Four more screw-eyes must now be screwed into the hull, one beneath the jib eye, one beneath the main kink, and two along the hull side as drawn. Now find a conical plastic screw cap off a toothpaste or similar tube and make three holes through it, equi-spaced, using a hot pin. Thread one piece of thread through two of these holes and two pieces of thread through the third; knot the inside ends of these pieces so that they cannot pull out.

Tie the ends of the single thread to the two screw-eyes on the side of the deck so that the thread is tight; the cap should slide backwards and forwards on this line, and stay put when left. If it slips easily, force a piece of rubber from an eraser inside the cap.

Slide the cap right aft and poke the two free threads through the centre deck-eyes, one through the main eye and the other through the one beneath the jib. Tie to the mainboom kink and the jib boom eye so that both booms are held central. Touch glue on all the knots and cut off the spare ends. Now when you slide the cap forward, both booms will be freed off the same amount, and since the tying points are equidistant from the pivot points, both booms will always have the same angle.

Fit a 40 tooth gear on to the rudder stock with its grub-screw and check that the rudder moves completely freely. Scrape away any paint and sand the stock to a polish until it does. Now find a brass nail which fits the 30-tooth gear and drill a hole in the deck to glue the nail in. The gear teeth must mesh easily and you must be able to lift the smaller gear high enough to turn it and drop it back in engagement. Bend a wire and epoxy it to the small gear so that it misses the pivot but comes out radially, i.e. it would go straight across the middle of the gear if you hadn't bent it to miss the pivot.

Cut a vane feather from light $\frac{1}{16}$ or $\frac{1}{32}$ in. balsa and cement it to the wire. Make sure it is upright and also radial to the gear. Now tie a piece of shirring elastic (or other very thin elastic) to the large gear and make it off with very light tension to the base of main eye. This is just to bias the rudder very lightly to centre. Slacken the grub-screw and centralise both gear and rudder, then re-tighten the screw.

You are now (at last!) ready to sail. Slide the sheet adjustment forward until the booms make an angle of about 30 deg. to the hull centre line and hold the model at about 40–45 deg. to the wind. Lift the vane and rotate till the feather is straight down-wind, then drop it into re-engagement, as close as possible. Release the model, which will maintain a constant course *relative to the wind*. If the wind changes direction, so will the model. This is a beating course, and to go on the other tack all you do is lift the vane and re-engage it at the same angle on the opposite side.

To reach (across wind) ease the sails to 45 deg. or so and set the vane out to one side; always point the model where you want it to go then line the vane up with the wind. To run, ease the sheets so that the booms are at 90 deg. to the hull and the vane feather will then be pointing forward. Try minor adjustments to the sail setting to get the best out of the boat.

We think you'll be amazed at the speed of the model and the control you have over it.