

THE PROJECTING WING MOUNT RUNNERS FIT INTO THESE SLOTS & ALLOW WING TO BE MOVED BACKWARDS & FORWARDS

NOTE RUB SET AT ANGLE
 POSITION OF WING BRACES
 PIECE OF 1/32" SO TO RETAIN BAND
 BUILD WING COMPLETE THEN CUT AWAY ENTIRE SECTION BETWEEN LINES X & Y BEFORE LIFTING WING BUILD IN TOP HALF OF NACELLE
 STRUT IS ATTACHED TO POINT DIRECTLY BELOW POINT C
 WING MOUNTS

SHEETING CUT AWAY TO SHOW POSITION OF BOXES & WING MOUNT
 WING MOUNT
 POSITION OF WING BRACES
 PIECE OF 1/16" SHEET TO MAKE BOX WATERPROOF (SEE FIG. 11)
 BOX C
 POSITION OF WING BRACES
 WING BRACE STRENGTHENERS
 POSITION OF 1/8" WIRE
 POSITION OF 1/16" WIRE

PIECE OF 1/16" SHEET
 BLOCK
 BOTTOM OF BOX
 1/16" SHEET FILLET & BLOCK B FOR WATER PROOFING WING
 VIEW SHOWING UNDERSIDE OF WING BOX NOTE SMALL BLOCK TO PREVENT REC SLIPPING
 BLOCK B

VIEW SHOWING HOW BOX "C" IS CONSTRUCTED
 FIG. 3
 CUSSET
 BOX C
 BOTTOM OF BOX C
 Balsa STRENGTHENER

WING TIP FLOAT'S OFF
 1/16" SHEET
 1/16" SHEET CROSS LAM
 SHEETING CUT AWAY FOR CLARITY
 Balsa BLOCK IN HOLE
 1/32" SO TO RETAIN ELASTIC BAND
 FLOAT COVERED WITH 1/16" SHEET
 REEL IS CUT AWAY TO TAKE BOX D
 THIS SPLICOT FITS INTO WING RECESS
 REEL IS SLOTTED TO FORMERS
 POSITION OF NACELLE
 BOX D
 BOX E

VIEW OF COMPLETE NACELLE SHOWING SHEETING & STRUNGERS
 BASIC LONGERONS
 POSITION OF WING STRENGTHENERS
 BUILD ALL NACELLE FORMERS IN TWO SEPARATE HALVES
 BASE LINE BEHIND 1/16" SHEET COVERED UP
 POSITION OF WING STRENGTHENERS
 WING STRENGTHENERS
 BOX POSITIONS
 3/32" DIAMETRAL UNDER EACH TIP
 ALL FORMERS OF 1/16" SHEET Balsa
 1/16" SHEET
 VIEW OF NACELLE
 BASIC LONGERONS

WING TIP FLOAT
 SPLICOT FITS INTO WING RECESS, SECURED BY AN ELASTIC BAND PASSED THROUGH BOXES E&D
 ATTACHED TO NACELLE AFTER ASSEMBLY ON WING
 LOOP FOR FREE WHEEL SOLDER TO SHAFT
 1/8" SNG WIRE
 1/16" SHEET
 1/16" PLY

FIG. 4
 FIG. 5
 FIG. 6
 FIG. 7
 FIG. 8
 FIG. 9
 FIG. 10

FIN IS BUILT IN NORMAL MANNER
 BASIC FORMER NO. 1
 BASIC FORMER NO. 2
 FIN SPLICOT
 PERSPECTIVE SHOWING HOW BOX "A" IS CONSTRUCTED
 BOX A
 MAKE ALL FIN RIBS OF 1/8" SHEET Balsa
 WING STRUTS MAKE 2 OFF
 SECTION OF STRUT TO FIT INTO FUSELAGE SLOT
 BOX FORMED TO TAKE ELASTIC BAND
 20 SNG WINDING HOOP SEE BUILDING INSTRUCTIONS
 BRASS BUSH INSERTED THROUGH BAMBOO PLUG
 POSITION OF STRONGHOULDS
 ALL NACELLE STRUNGERS OF 1/32" SO
 POSITION OF STRONGHOULDS
 SET ROOT RIB AT ANGLE SHOWN IN FRONT VIEW
 THIS PART OF FIN IS FITS OVER REAR OF FUSELAGE SPLICOT
 TAILED RIB FIRST BUILT UP OF 1/32" SO AS SHOWN BY CRANED WOOD THE UPPER PART OF EACH RIB IS THEN CEMENTED IN PLACE & ALSO SHOWN BY CHAIN LINE

BASIC FORMER NO. 2
 CUSSETS
 FIN IS BUILT IN NORMAL MANNER
 BASIC FORMER NO. 1
 TAILED RIBS
 ADD THESE UPPER PORTIONS OF RIBS AFTER CONSTRUCTING TAIL OF 1/32" SO
 POSITION OF WING BRACES
 POSITION OF WING BRACES

CUT AWAY
 WIRE TO ENCASE IN GREENWHEEL LOOP
 BRASS BUSH INSERTED IN BAMBOO PLUG
 SPINNER IS SHOWN AS BEING SEPARATE FROM BLADES BUT IS REALLY PART OF THEM
 HOLE FOR INSERTION OF BAMBOO PLUG & GREENWHEEL CLUTCH
 BAMBOO PLUG
 BRASS BUSH
 CEMENT PIECE OF WOOD WITH WIRE TO FORM SPINNER NOSE
 PLY DISC RECESS TO ALLOW ENTRY OF GREENWHEEL LOOP
 METHOD OF CONSTRUCTING PROPS
 FIRST CEMENT 3 BLADES TOGETHER TO FORM 2 SEPARATE 3 BLADED PROPS, THEN PLACE BLADE A OF BLAME 2 OVER BLADE A OF BLAME 1. THE SECTIONS OF BLAME WHICH COME OVER PORTIONS INDICATED BY DOTTED LINES ON BLAME 1
 CUT AWAY
 SIDE VIEW OF PROP BLADE

NOTE: FOR DETAILS OF FUSELAGE CONSTRUCTION SEE BUILDING INSTRUCTIONS.

REEL MADE OF 1/32" SHEET
 WING MOUNT RUNNERS
 1/32" SHEET
 1/32" SHEET
 1/16" DIA REC FITS INTO HOLE IN FIN
 1/16" SHEET
 1/32" SO STRUNGERS
 1/32" SHEET
 BOX B
 RETAINING REC FOR ELASTIC BAND
 FIN SPLICOT
 PERSPECTIVE SHOWING HOW BOX "A" IS CONSTRUCTED
 BOX A
 MAKE ALL FIN RIBS OF 1/8" SHEET Balsa
 WING STRUTS MAKE 2 OFF
 SECTION OF STRUT TO FIT INTO FUSELAGE SLOT
 BOX FORMED TO TAKE ELASTIC BAND
 20 SNG WINDING HOOP SEE BUILDING INSTRUCTIONS
 BRASS BUSH INSERTED THROUGH BAMBOO PLUG
 POSITION OF STRONGHOULDS
 ALL NACELLE STRUNGERS OF 1/32" SO
 POSITION OF STRONGHOULDS
 SET ROOT RIB AT ANGLE SHOWN IN FRONT VIEW
 THIS PART OF FIN IS FITS OVER REAR OF FUSELAGE SPLICOT
 TAILED RIB FIRST BUILT UP OF 1/32" SO AS SHOWN BY CRANED WOOD THE UPPER PART OF EACH RIB IS THEN CEMENTED IN PLACE & ALSO SHOWN BY CHAIN LINE

BASIC FORMER NO. 1
 BASIC FORMER NO. 2
 CUSSETS
 FIN IS BUILT IN NORMAL MANNER
 BASIC FORMER NO. 1
 TAILED RIBS
 ADD THESE UPPER PORTIONS OF RIBS AFTER CONSTRUCTING TAIL OF 1/32" SO
 POSITION OF WING BRACES
 POSITION OF WING BRACES

TAILED RIBS FIRST BUILT UP OF 1/32" SO AS SHOWN BY CRANED WOOD THE UPPER PART OF EACH RIB IS THEN CEMENTED IN PLACE & ALSO SHOWN BY CHAIN LINE

POSITION OF BASIC FORMER NO. 1
 ALL LONGERONS & STRUNGERS OF 1/32" SO
 POSITION OF BASIC FORMER NO. 2

BASIC FORMER NO. 1
 BASIC FORMER NO. 2
 CUSSETS
 FIN IS BUILT IN NORMAL MANNER
 BASIC FORMER NO. 1
 TAILED RIBS
 ADD THESE UPPER PORTIONS OF RIBS AFTER CONSTRUCTING TAIL OF 1/32" SO
 POSITION OF WING BRACES
 POSITION OF WING BRACES

TAILED RIBS FIRST BUILT UP OF 1/32" SO AS SHOWN BY CRANED WOOD THE UPPER PART OF EACH RIB IS THEN CEMENTED IN PLACE & ALSO SHOWN BY CHAIN LINE

POSITION OF BASIC FORMER NO. 1
 ALL LONGERONS & STRUNGERS OF 1/32" SO
 POSITION OF BASIC FORMER NO. 2

BASIC FORMER NO. 1
 BASIC FORMER NO. 2
 CUSSETS
 FIN IS BUILT IN NORMAL MANNER
 BASIC FORMER NO. 1
 TAILED RIBS
 ADD THESE UPPER PORTIONS OF RIBS AFTER CONSTRUCTING TAIL OF 1/32" SO
 POSITION OF WING BRACES
 POSITION OF WING BRACES

TAILED RIBS FIRST BUILT UP OF 1/32" SO AS SHOWN BY CRANED WOOD THE UPPER PART OF EACH RIB IS THEN CEMENTED IN PLACE & ALSO SHOWN BY CHAIN LINE

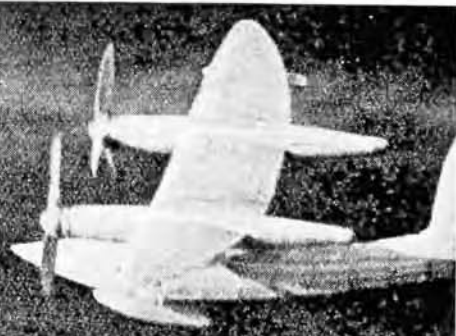
POSITION OF BASIC FORMER NO. 1
 ALL LONGERONS & STRUNGERS OF 1/32" SO
 POSITION OF BASIC FORMER NO. 2

Dryad

AN ADVANCED DESIGN FOR

A MODEL FLYING BOAT

By H. E. WHITE, B.Sc.



A.T.P. Photo

THIS model, portrayed on the front cover this month by C. Rupert Moore, is a fairly advanced design both from the technical and practical point of view. It is not a simple structure, either to describe or to build, but a job that should provide a fairly skilled and experienced aeromodeller with something to get his teeth into during the close season for model flying.

It was decided above all to attempt to design a model flying boat of "semi-scale" appearance, with an airframe which was practical from every model-aerodynamic and structural point of view. The model must be capable of being trimmed and able to withstand the rough treatment which flying models usually experience during trials, and yet it must look as much as possible like a real flying boat without being an actual copy of any existing full-sized machine, because this would seriously limit its flying capabilities.

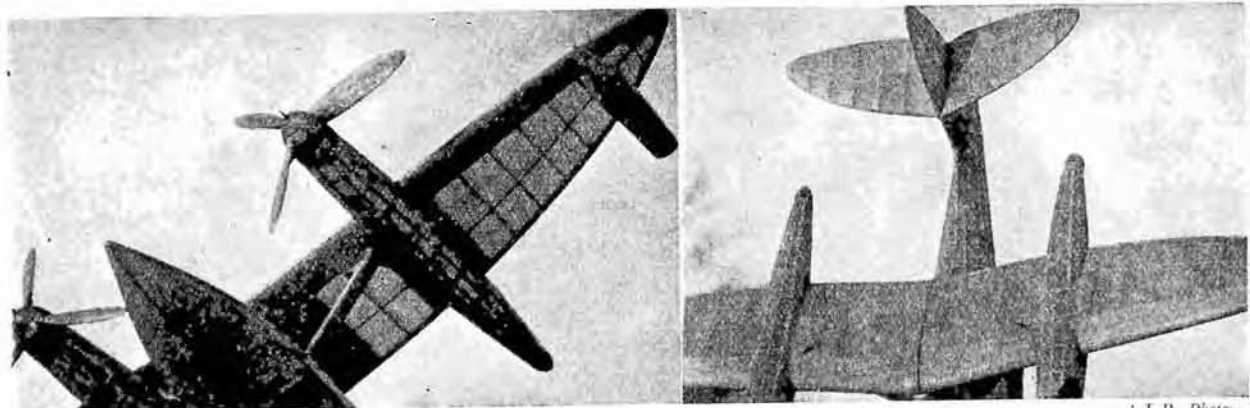
After some experiments with various types, the "Catalina" type was decided upon, involving a low hull with good lines, the main plane supported on a central streamlined pylon with bracing struts. The twin motors are carried outboard on the wings and the tail-plane is mounted high up on the fin. The nacelles carrying the motors are built into the wings and not suspended below them. Three-bladed propellers are used in order to reduce the height of the wings as far as possible, without sacrificing the advantage of using large airscrews with rubber motors.

The Hull. Begin as if you were making a simple slab-sided fuselage, building up the two sides, one on top of the other, on the drawing board. Now make up the two "basic" formers and cement them in position with the two sides. Make sure the alignment is correct by resting the assembly upside-down on a flat board.

Next, insert the cross-pieces in the top of the hull and carefully join the sides at bow and stern. Now turn the hull upside down again and insert the forward keel and the central stringer aft of the step. At the various "former" positions, build in the pairs of struts forming the triangular keel supports both fore and aft of the steps, finally completing each "former" by cementing in place the two halves of each bottom strut. This part of the assembly needs great care and continual watch must be kept to see that the lines and symmetry of the hull are kept perfect. Now cut out the stringer-formers which support the side and deck stringers, and cement

them in place. Follow up with the stringers, still keeping careful watch on the general alignment, and firmly cement the rails in place which support the bracing struts. If this somewhat tedious job is done carefully it is possible to make a very strong and rigid hull frame. Build up the struts, formers, etc., which make up the central pylon, and build in the details of the tail emplacement. We are now ready for the "sheet-work." Most of the sheet used in this model has been salvaged from superannuated pre-war models, and is about .025 in. thick. The larger pieces, however, were produced by carefully sanding 1/16 in. soft sheet until the required thickness was attained. Cut paper patterns of the two pieces for the forward hull-bottom by "offering up" stiff paper to the hull, marking out with pencil, and cutting out, making a final careful test to see that the patterns fit exactly *at the keel*. Overlapping a little at the outer edge will not matter as this can be trimmed off. Cover the portion of the hull aft of the step as shown, and then start on the pylon. The forward semi-circular section is easy to cover, and the after section, although it involves a compound curve, can be covered with two separate pieces only, one each side, if the grain is suitably chosen and warm fingers judiciously applied whilst the cement is setting.

Wings. Make tracings of the wings in the usual way, drawing in the position of the nacelles. Cut out the ribs and build up the basic wing-structures with the ribs and spars. Note that there is no leading-edge spar, and that the trailing edge may be built up, using $\frac{1}{8}$ by 1/32 in. strips. This is much better than using a bent V-section spar. Note also that rib No. 1 is placed at an angle to suit the dihedral, and that rib No. 4a is only inserted temporarily, for reasons which will appear later. Cut a number of 1/16 in. and $\frac{1}{8}$ in. strips from 1/32 in. balsa sheet, and "plank in" the leading edges. The narrow strip will be used where the curve is most acute, but as soon as the sharp curves have been covered the remainder of the sheeting, which is carried back to the main spar, can be carried out with a single broad strip, if you have sufficient large pieces of sheet. The sheeting of the underside of the leading edge box cannot be completed yet as the wing *must not be removed from the board* until the nacelles are built in. The wing tips should be roughly carved, slightly oversize, from 5/16 in. balsa, and cemented into position, where they can be glass-papered to shape



A. J. P. Photos.

Motor Nacelles. It is better to leave the wings at this point and build up the four halves of the nacelles. These are very simple to build as they are semi-circular throughout. Cut out the semi-circular formers, erect them at the appropriate stations on the drawings (you will need four tracings—it's quicker than waiting for each assembly to "set") and fit the stringers. Use plenty of cement, as these nacelles are going to form part of the wing structure. When they are ready, remove them from the board; no deformation should take place.

Fitting the Nacelles. Now go back to the wings, and carefully cut out the portions of the leading and trailing edges outlined by the tracing of the nacelles. Remove also the portions of the wing spars, and the temporary rib (No. 4a) between ribs Nos. 4 and 5. The two portions of the wing will thus be completely separated, leaving a gap into which the top half of the nacelle can be fitted so that it lies flat on the board. It should now be obvious why the wing could not be removed from the board at this stage; cutting away the unwanted section must be done without causing any part of the wing structure to move out of line. The longerons at the base of this half-nacelle should fit exactly so that they touch the cut ends of the main and rear lower wing spars, and the trailing edge. Put plenty of cement on these joints and place the half-nacelle in position. Now cut short pieces of hard 3/32 in. square "strengtheners" spars, which will pass right through the tops of the nacelles and rest in the slots provided in the ribs Nos. 3, 4, 5 and 6. The forward strengthener actually forms part of the upper main spar. See that they fit properly *without strain* and cement them into position. Before removing the wings from the board, fit and cement all the 1/32 in. balsa sheet gussets to the nacelles, complete the sheeting on the top of the wings and fit the capping strips on ribs and spars. "Capping" the spars may be avoided if they have been left standing "proud" of the ribs by 1/32 in. as shown in the drawing.

Remove wings from the board and finish sheeting in the leading edges. Cement capping strips on the lower spars and ribs. Cement the lower halves of the motor nacelles in place, making a sound job of this so that the semi-circular formers are well and truly impregnated with cement at the joints. Cut the front and rear facing formers from 1/16 in. plywood and cement them in place

Wing Roots. The roots are completely sheeted in, but before doing this provision must be made for the rubber bands which hold the wings together. Channels are made by constructing a "rectangular tube" of balsa. As there are a number of these it is advisable to make them all up in

a single length. Take two strips of 1/16 in. sheet $\frac{1}{2}$ in wide and cement two lengths of 3/32 in. square balsa between them to form a box section. Study the drawing and cut rectangular holes in rib No. 1 and the wing root rib in the correct positions. Now rest the wing on a flat board with No. 1 rib touching the board and the tip resting on a block of wood so that the correct dihedral angle is maintained. Build up the wing root, inserting the "boxes," cutting them off flush with the ribs. Remove the wing from the board when the cement has set and fit the extension boxes which slope downwards to the under surface of the wing. Complete the sheet work on the wing root.

Three jobs now remain—the emplacements for the tip floats, the runners for the wing fixing, and the boxes for the bracing struts. These details can be followed quite easily from the drawings.

In all the work connected with the wings care must be taken at certain joints to make sure that water cannot enter if the model should make a bad landing when alighting on the water. This applies particularly where such details as rubber band channels emerge—plenty of flat surface must be provided to ensure a good joint with the paper covering.

Wing-tip Floats. Start with the keel and former, cement the sides in place, cut away the keel where necessary and cement a length of "channel" in position. Cover the upper and lower surfaces with 1/32 in. sheet, build up the strut or pylon, and fit the platform on top. This is made with two layers of 1/16 in. sheet, cemented together, with the two grains crossing each other at right angles, so that a "two-ply" platform results. Build it around the projecting channel, and allow plenty of overlap in size, as it is best to finish the platform to size by "offering it up" to the recess in the under-surface of the wing, after the projecting channel has been trimmed off. This will make sure that the float lines up fore and aft.

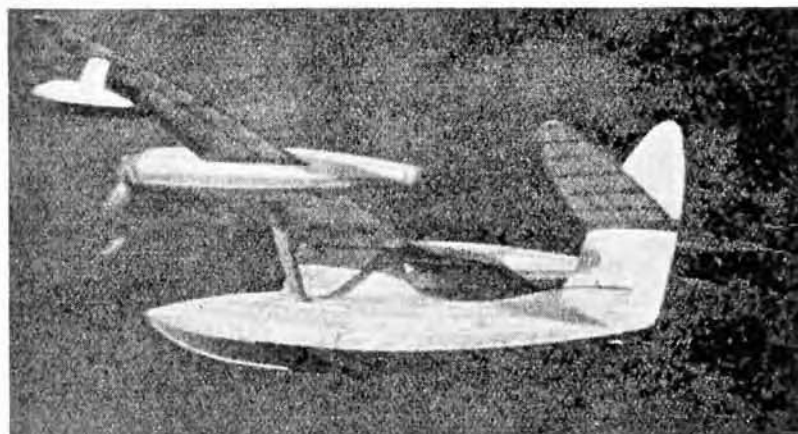
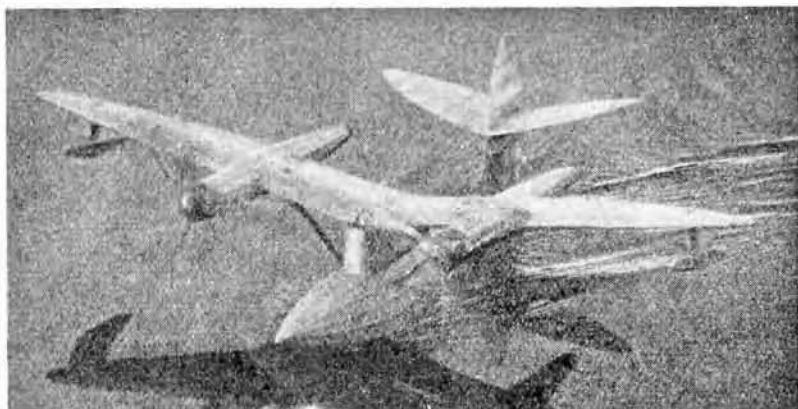
Bracing Struts. These are a simple job. Use hard balsa, and plenty of cement. It is advisable to make them $\frac{1}{8}$ in. longer than shown in the drawing, so that they can be trimmed off at the upper end when the model is finally assembled in order to correct any slight inaccuracies in dihedral or alignment which are bound to arise. Do not forget the little block cemented to the under-side of the wing against which the strut bears.

Tail Unit. Cut out the ribs for the fin, and with a steel rule and a razor blade, cut each longitudinally in two pieces, not exactly in the centre, but 3/64 in. off centre to allow for the thickness of the leading and trailing edges. Trace the fin and erect the wider

" half " of each rib at the correct station with a touch of cement, fitting the leading and trailing edges, tips and spars. Leave the lower ends of the rear spars and trailing edge oversize, and do not finish off this part yet. Detach from the board. Cement the remaining portions of the ribs in place, and add the spars. Now support the hull on blocks so that the pylon is vertical, and place the fin on its platform, holding it in place temporarily with pins, and fixing up a spar from the tip to some solid support to keep it steady whilst adjustments are made. See that the bottom rib rests snugly on the platform when the fin is vertical. If it does not, carefully break the spars away from their slots in this rib, and re-cement after making the necessary adjustment.

Now cut a piece of $3/32$ in. sheet to fit in between the rear spars where they touch the after end of the hull. Cement this piece to the hull to form a spigot whilst the tail is still supported in its correct position: trim the rear spars to length and build in the lower stern curve to the fin. Now remove the fin and cement a piece of $1/16$ in. sheet behind the rear spars where the spigot fits, and build up the " box " for the rubber band anchorage. Cement in the sheet balsa gussets as shown in the drawing. Make a tracing of the tail planes and build them up, using $3/32$ in. square balsa for both edges and ribs. Cut out the upper ribs from $1/16$ in. sheet to pattern and cement them on top of the $3/32$ in. square cross spars, and fit the wing tips and spars. Glass-paper to a smooth finish, remove the planes from the board, add the short lower spar, and cement the stabilizers in position on the fin, being very careful to locate them accurately and check the dihedral angle. I used two identical pieces of $3/32$ in. balsa, with pins stuck through them, to act as temporary struts from the tip of the fin to the tips of the stabilizers, thus making sure that the distances were exactly equal on both sides. Complete the job by cementing in the sheet work; the joints must be well fitted. Do this carefully; as the whole strength of the assembly depends upon good butt joints here. Cement the bamboo locating peg in to the hull, and fit the tail unit, checking carefully for alignment.

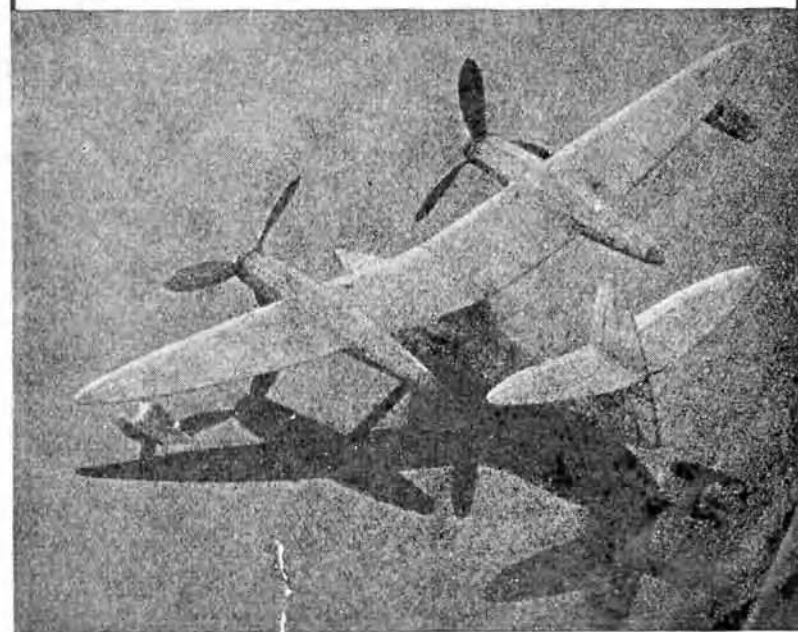
Motor Nose-Pieces and Propellers. These were fully described in a previous article on " Three-Bladed Propellers." Each

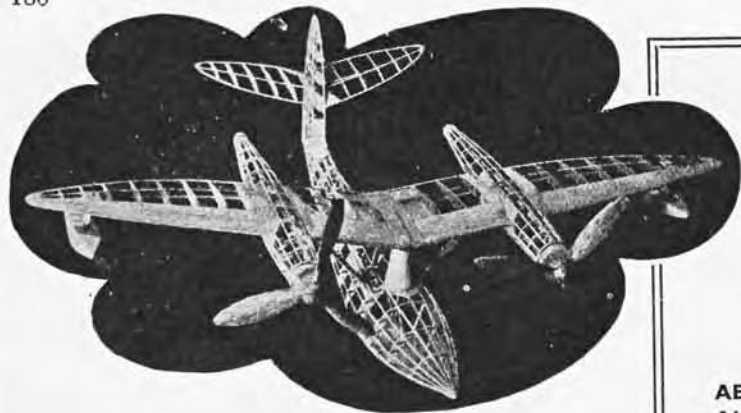


Photographs on the opposite page illustrate the characteristic pointed nose, built-in nacelles, and elliptical flying surfaces.

The top photograph shows the boat moving

A T P Photos
forwards for take off, whilst above is the model in flight. Below is the model at rest (yes, it is water, and not glass!) Note the tip floats serving their true purpose. They do not touch the water during take off





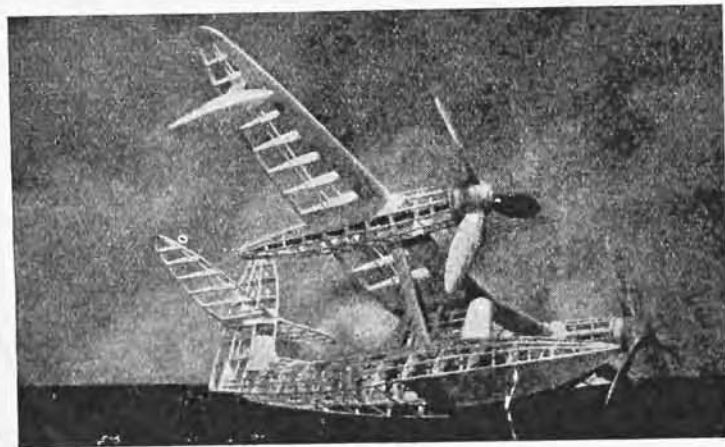
propeller is driven by 1 oz. rubber made up into a skein 22 ins. long, and pre-wound. According to published tables, this skein should take five or six hundred turns, but the rubber I have, although it has been very carefully preserved since 1940, breaks at about 250 turns! Be very careful, therefore, to test your rubber skeins before attempting to wind them inside the nacelles, a rubber "explosion" here would be very undesirable, to say the least. It is advisable to attach a thread loop to some part of one of the wing roots so that one propeller may be wound whilst the other is kept from turning by means of the loop. Both propellers can be held by the fingers of one hand before launching.

Covering. Before commencing the covering give every component a coat of banana oil, inside and outside. Should any water get inside the covering, serious damage might result if the balsa structure got wet. Furthermore, it is always advisable to dope *sheet* balsa before covering, if paste is being used, because the wet paste will cause warping if applied to the natural wood surface.

I used light tissue for the tail unit, and covered the rest of the model with heavy-weight bamboo tissue, since I had some left from a pre-war stock. This paper is ideal for flying boat or seaplane work as it absorbs the banana oil and forms a very tough skin. Of course, in the absence of this heavy-weight paper, other tissues may be used, but they must be such that the dope is *absorbed into the texture of the paper*, and does not just remain on the outer surface. Silk could be used, of course, particularly for the hull, but the modeller who can get silk can probably get bamboo tissue.

Covering is not an easy job. Start with the hull, cover

A.T.P. Photos.



FULL SIZE PLANS

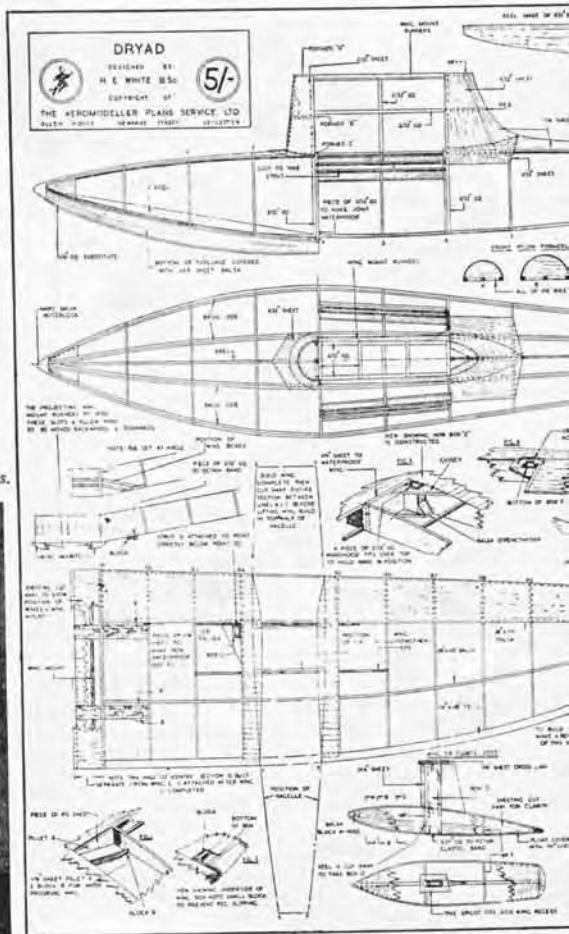
SEE 1/6th SCALE REPRODUCTION BELOW

PRICE 5/- POST FREE

FROM THE

AEROMODELLER PLANS SERVICE LTD.,
ALLEN HOUSE, NEWARKE STREET,
LEICESTER

the bottom, and then, using strips of paper, cover the curves of the sides and top, avoiding wrinkles. Remember that the joints *must be water-tight*; use a fair overlap and see that the paper is stuck well down everywhere. This advice applies to all the covering, for every component is liable to immersion. Next cover the wings and nacelles, tail unit, tipfloats and bracing struts.



Now spray with water and dry off in the usual way to tighten the fabric, and dope everything with a generous coating of banana oil—the thick, undiluted grade. When this is thoroughly dry, give the whole structure a second coat, which should be sufficient. See that the banana oil is allowed to flow into all crevices, and into all the channels through which rubber bands are passed. *Everything must be waterproof.*

Assembly. Make up a hook of 20 s.w.g. steel wire as shown on the drawing. First assemble the wings. Poke the hook through one of the boxes from the wing-root rib; hang a rubber band on it, and withdraw the hook, bringing the band through the box. Put a peg of 1/16 in. square hard wood through the band at the outer end to stop it coming right through. Draw a second band through the other box in the same half-wing. Now take the other half-wing and insert the hook at the *outer* end of the box, on the underside of the wing, and draw the overhanging ends of the bands in the first half-wing through the boxes in the other, inserting two more pegs to secure the bands. The wing can now be fitted on its runners.

To attach the struts, put a rubber band through the starboard strut, starting from the top, and insert a peg to prevent it pulling through. This is done by passing the wire hook through the starboard strut, starting at the lower end, and drawing the rubber band through so that it hangs out at the lower end. Now pass the wire hook through the slots in the hull, starting on the *port*

side, and draw the band through; this will draw the lower end of the starboard strut into position in its slot. Now take the port strut and poke the wire hook through it; withdraw the hook, drawing up the rubber band which is now hanging out of the port slot, and fasten it at the top of the strut with a peg.

It is now a simple matter to place the wings in position on the pylon runners, and, using the hook, draw the rubber bands through the boxes in the wings, inserting pegs on the upper side to hold the bands and support the wings.

The wing-tip floats are attached by passing the hook through both the wing and the float channels: drawing a rubber band through both of them and securing it at each end with a peg.

To fix the tail, first thread a band through the channel in the tail unit, inserting a peg in the box at the top on the channel. Now pass the wire hook through the channel in the hull, starting from underneath, and draw the band through, securing it with a peg at the bottom.

When the plane is being dismantled for transport, put long pegs through the rubber bands between the under surfaces of the wings and the struts, and remove the pegs on the upper surface of the wings. The wings can then be removed *without allowing the bands to slip through the struts*. The wing can be folded in half with the rubber bands which hold the two halves together still in position, and it is then easy to refit the wing without going through the process described above.