FREE PLAN FEATURE

CLIVE SMALLEY'S SUPE

The proud owner and designer, Clive Smalley, shows off the simple shape of this compact glider. The unusual name was inspired by the origial colour scheme of day glow orange wing tips and fuselage! No chance of losing sight of that — an important point when choosing the colour scheme for any Radio Controlled model.

INTRODUCTION

THE MAJORITY of model magazine plan articles nearly always seem to adopt the principle that the reader is already an expert modeller, capable of interpreting plans and deciding just how the models should be constructed. Often little consideration is given to the person who perhaps having built one or two models from kits, has never tackled building from a plan with its attendant problems. The favourite phrase is "as the model is quite straightforward to build, no glue A to B instructions will be given, only the interesting points of construction will be highlighted".

In presenting this article and plan I felt the time had arrived to alter this situation, and guidance for building from any plan can be gleaned from a study of the general methods adopted. It is recommended that should the reader be an absolute beginner to this hobby, he also obtain and read in conjunction with this article, any of the excellent books now available on how to build model aircraft in general.

IMPORTANT TOOLS

For any model to become a successful flying machine it is absolutely essential for it to be accurately built. This means taking care to build wings and tail free from warps and fuselage dead straight, not banana shaped. Most badly built models can be trimmed to fly but they will never be as responsive or as 'sweet' to fly and will usually have some nasty built-in tendencies. It is essential to work on a flat, true, building board; I strongly recommend investment in a piece of 1in thick blockboard which should be checked for straightness and trueness using a metal straight edge before purchase. Basic tools required include modelling knife, pliers, razor blade plane, pins, etc.

Never use glass-paper held in the fingers only, as unevenness will be followed and therefore the surface not smoothed down. Use a sanding block making up your own 'files' from strips of glass paper contact glued to slightly larger strips of plywood. 'No. 1 Grade' for rougher work with 'flour' grade and No. 300 wet and dry for final sanding.

It is important to the strength of any model to always use the correct adhesive for each job.

Balsa cement is used for areas of small cross-section where little stress is taken or when quick drying time can be used to advantage. When gluing end-grain of balsa wood, a far stronger joint will be obtained by 'pre-cementing'. This means coating end-grain separate parts with cement, rubbing into the grain with the finger if necessary and allowing to almost dry. Then re-coat with more cement and complete assembly of the joint. Pre-cementing keys into the grain and produces a far stronger joint.

PVA White Glue adhesive is used for most of the general structural work but takes up to 30 minutes to dry. Pre-cementing also helps but large glueing areas may curl wood through 'wetting' unless weighted flat.

Contact Adhesive, Evostik is used where larger surface areas joints not subjected to stress, are required, such as laminating doublers to fuselage sides.

Two Part Glues such as five minute expoxy resin is used for heavily stressed areas or joining metal or plastics.

I use a small 'toffee hammer' to pin components to the building board removing pins with pliers. Pushing pins in with the fingers is both dangerous and does not hold the component securely enough.

THE DESIGN

The 'Orange Box' was conceived as a light wind slope-soarer for flying from my local hills, which are not really suitable for heavy models. The construction is light yet strong enough to withstand heavy landing manoeuvres. When flown from the slope even in only a gentle breeze, the prototype has achieved flights of well over one hour duration, flying being only limited by the radio batteries, changes in the wind, pilot fatigue or the cries of other pilots on the same frequency demanding some flight time! The prototype has also performed well when flown as a thermal-soarer from either tow-line or 'bungee-launch'.

Read through the building notes several times in conjunction with a study of the plan, until a mental picture is built up of exactly how the model is constructed. I recommend starting with the tail unit to gain experience.

BOX ORANGE BOX

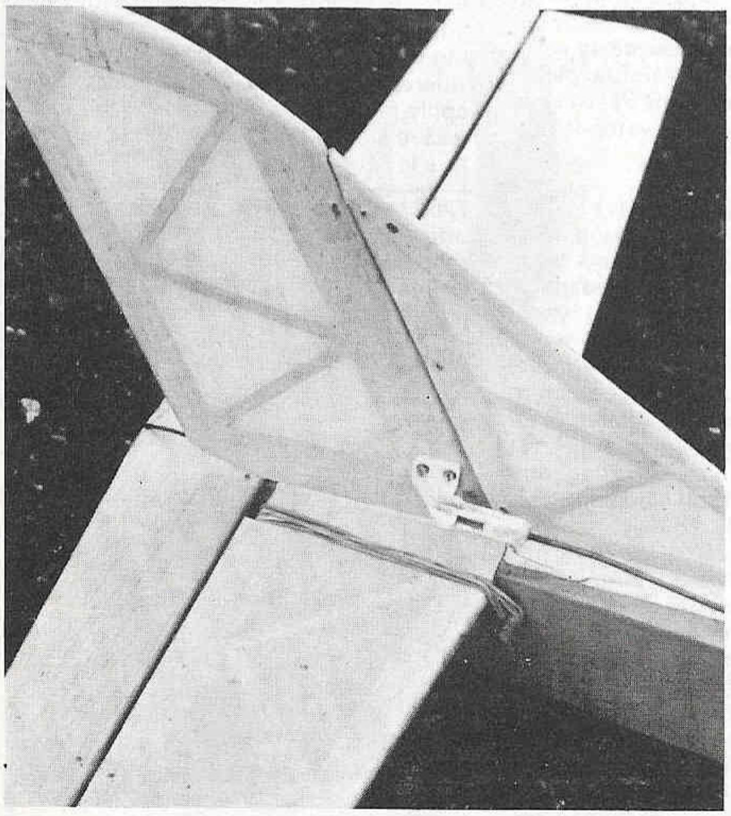
■ 1800mm WINGSPAN RADIO CONTROLLED LIGHTWEIGHT GLIDER ■

TAILPLANE, FIN AND RUDDER

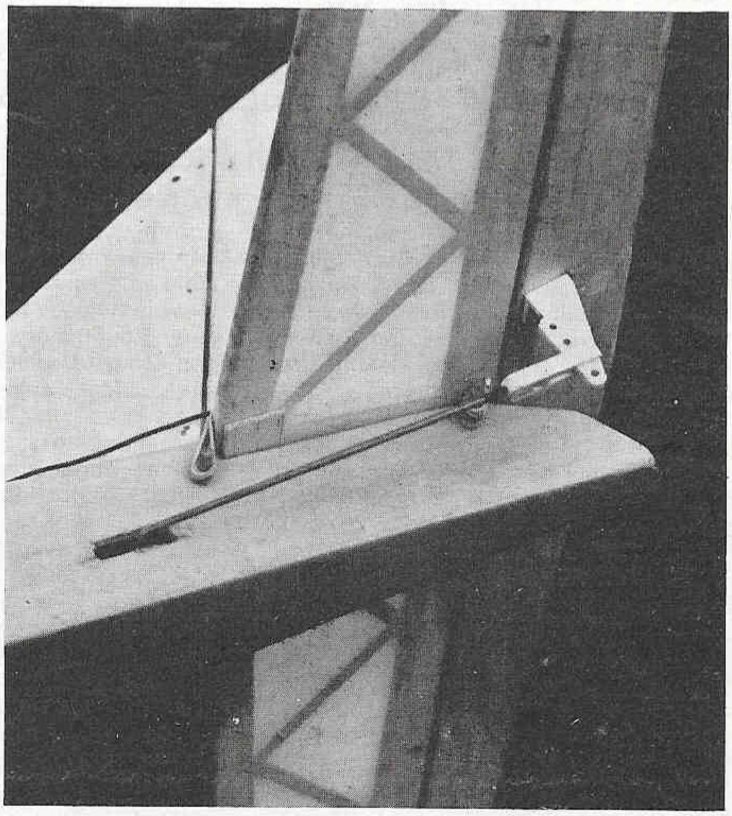
Sellotape the plan to the building board and either cover with a clear plastic polythene sheet or rub soap onto the plan at each joint position. This will help to prevent excess glue sticking the framework to the plan. Carbon copy or trace components onto the required thickness sheet balsa ready for cutting out. Cut strips of $^3/_{16}$in x $^1/_2$in balsa for the two L.E. (leading edge) halves and the spar, which can be left slightly over length for trimming later, plus centre and tip pieces. Cut the centre joint angles and pre-cement each half, recoat and pin down, using at least three pins each. Check that the centre section tips and spar all fit with a 'dry run' and trim if necessary. Pre cement and pin in position. The remaining $^3/_{16}$in x $^3/_{16}$in ribs can now be individually cut, dry positioned to check size, pre cemented and glued and pinned in position. Leave to dry thoroughly for a couple of hours. When dry remove from the board and trim off excess material at the L.E. and spar. Remove excess glue 'blobs' and glass paper lightly over top and bottom surfaces equally. Incorrect sanding can result in the tailplane curving towards the side sanded most. Carefully sand all edges smooth and round-off leading edges and tips. Cut slots in the rear spar to clear elevator from tailplane retaining rubber bands. Trace the elevator on to $^3/_{16}$in sheet balsa and cut out using a steel straight edge as a guide. Sand smooth and round-off all edges. Mylar strip hinges are adequate for this model and should be cut into pieces about $^1/_2$in wide x $^3/_4$in long. Use five hinges for the elevator and two for the rudder. Carefully mark the hinge position on both the tailplane and elevator, being extra careful to mark at exactly half the wood thickness, then slot with knife for the hinges. Dry fit but do NOT epoxy permanently at this stage. Repeat the construction processes for the fin and rudder.

FUSELAGE

Select two sheets of $^1/_8$in sheet balsa for the sides, ensuring similar weight and stiffness as this will help to keep the fuselage true when the sides are bent to the plan form. Trace or measure shape of sides onto wood and cut out using straight edge guide. Similarly make the nose doublers from $^1/_{16}$in ply and the tail doublers from $^1/_{16}$in balsa, noting grain direction. Contact glue doublers to sides, being careful to make one left and right side. Cut out the formers F1–F5 from $^3/_{16}$in balsa and mark centre lines. Lay right hand side over plan and mark former positions across the wood. Lay left hand side bottom edge and continue the former positions across to the left hand side to ensure that former positions are identical on both sides. Epoxy formers F3 & F4 in position to one side at right angles to side until epoxy has cured. Mark centre-line along $2^1/_2$in wide $^3/_{16}$in sheet bottom using long straight edge and biro. Apply epoxy to the remaining edge of formers F3 and F4, join two sides ensuring the formers line up on their

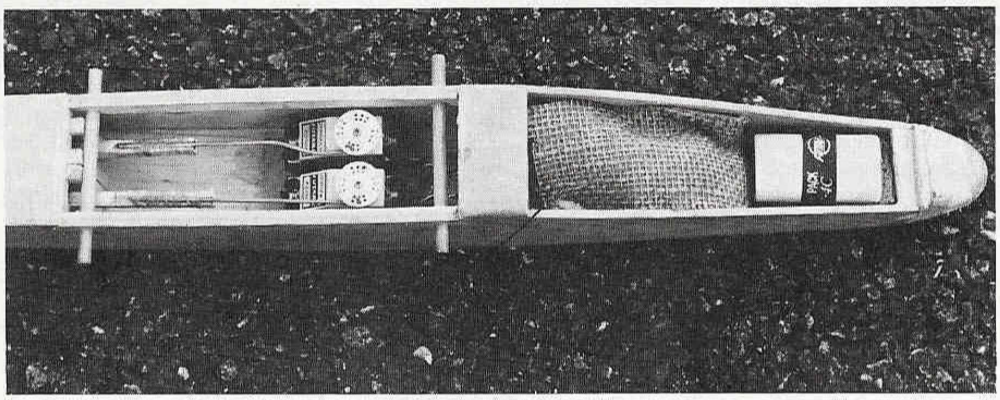


Detail of rudder linkage shows push rod exiting through fuselage top connected to rudder horn. To achieve required 40° movement, rudder horn must be short to achieve maximum leverage. Although the original used conventional pushrod coupling this is really unsatisfactory because the rudder hinge is raked back. A ball and socket connection is needed to cope with changing geometry. Note tail retained by rubber bands.



Underside of tailplane shows linkage to plastic control horn and elevator, original used strong balsa push rods with threaded bike spoke ends bound to ends. Push rod exits through slot in fuselage side. Note 1.5mm packing under leading edge of tail used for windy weather to help keep nose down preventing stalls. Spots near hinge line are pegs through mylar internal hinge to stop control surfaces dropping off!

ORANGE BOX



Top hatch and wing removed to reveal radio control installation. The heaviest component, the battery pack, is located at the nose to balance the model. The receiver comes next, inside a protective wrapping of foam rubber, in this case, carpet underlay. Lastly the control servos which are fitted to base of fuselage with double sided adhesive servo tape. Note the wire connectors bound and glued to balsa pushrods and the vertical packing pieces to prevent unwanted sideways movement.

marked positions and place fuselage upright on building board to check bottom edges are in contact along full length eliminating fuselage twist. Leave to cure then apply epoxy to former F1 and fit, hold in position with a rubber band around the nose. Eye along the bottom from tail and line up all the centre marks on the bottom of formers F1, F3 and F4 to ensure equal bend in the sides at the nose. Now fit former F2 with epoxy, pull together at rear and epoxy, adjust until fuselage is symmetrical. When cured fit former F5. The basic fuselage can now be glued to the bottom sheet using white glue to allow time for adjustment. Double check that the centre lines of all formers are on the centre line. Leave to thoroughly dry. For additional strength a fillet of white glue can be run along each of the side to bottom joints on the inside. Whilst drying add 1/16in sheet top decking, join a sufficient number of sheet widths to make up the required length, this cross grain adds greatly to fuselage 'bursting' strength and prevents bowing when covering is applied. Cement join widths and pin or Sellotape until dry. Decking can now be glued to the fuselage, when dry trim off excess wood flush to the fuselage sides, likewise with bottom sheet. Add the 3/8in x 1/8in wing runners. Lining the inside of the two nose compartments with fibre-glass cloth and resin adds considerable strength. As most models need some form of nose weight to achieve the correct flying balance, it is better to make the extra weight work. Draw around the nose area to mark out the 1/32in ply bottom reinforcement cut, and contact glue in place. Cement together laminations of scrap sheet for the nose block, leave oversize and epoxy to former F1. cut-out and epoxy 1/8in ply hatch retaining plate in place. Make hatch from 3/8in sheet balsa again oversize and glue in place with only four 'spots' of cement. Carve and sand the hatch and nose block to shape. Remove the hatch by cutting the cement 'spots' with a modelling knife. Saw about 1in in from the hatch front and glue back in place. Make the 1/8in ply front hatch retaining plate a snug fit between the sides and epoxy to the hatch bottom face. Drill through hatch into hatch plate for the fixing wood-screw. Drill holes for the wing and tailplane dowels, placing a scrap block of wood against the inside faces when drilling, to prevent the wood splitting. Finally add scrap sheet under tailplane position. This completes the basic fuselage, corners can now be lightly sanded but do not overdo this as it will weaken the joints. Epoxy the fin to fuselage, ensuring dead vertical and exactly on the centre line, add triangular fillets each side to strengthen. Test fit the tailplane using three small rubber bands each side and check that rudder and elevator do not foul.

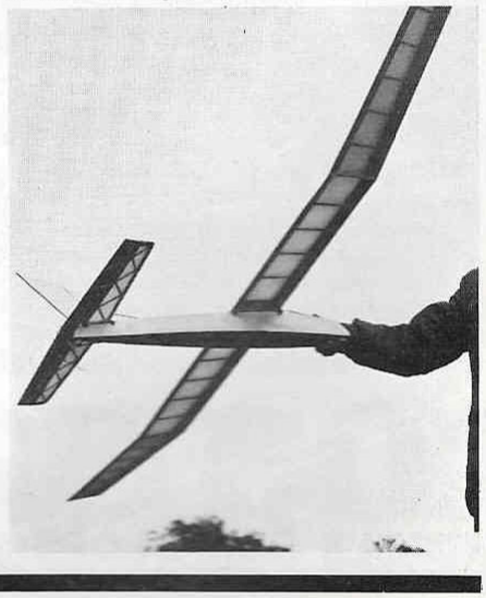
WING

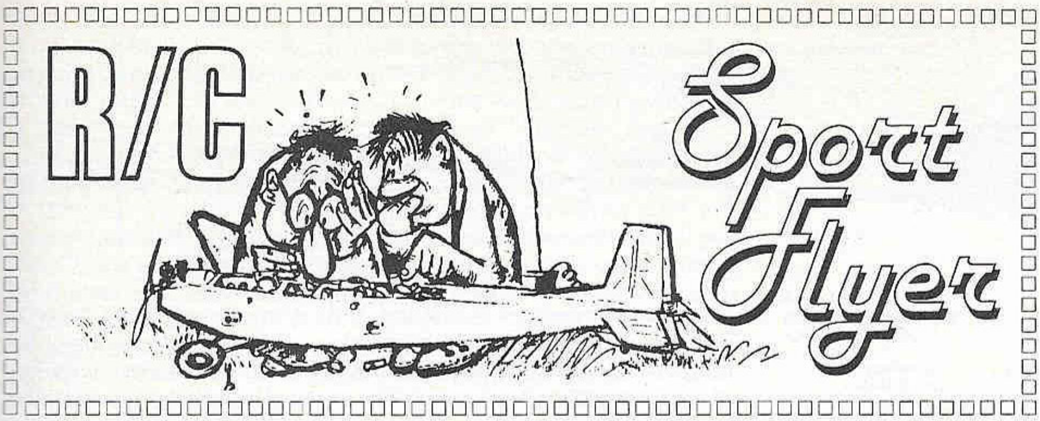
Commence construction by making a rib template from 1/16in ply. Make this template as accurately as possible and make two pin holes to pin it to the sheet when cutting out the ribs. Cut carefully to avoid damaging template, using two or three strokes. Make a complete set of ribs, tip ribs are made by skewing template over rib length blanks. Prepare the LE and TE (trailing edge) sheeting by cutting out using a straight edge. Upper leading edge sheet should be slightly over-size to allow for the rib curvature. Make the 1/16in ply dihedral braces and dihedral template.

The wing is constructed in four separate panels built flat over the plan on the building board. The procedure is identical for each panel. The slots for the dihedral braces are cut later. Pin down the lower LE and TE sheets. The lower cap strips can either be glued or pinned now or added when the structure is completed. Cut the lower spar slightly overlength and using white glue, pin in position along the rear edge of the sheet. Pin thoroughly and check that it is dead straight. Fit each of the ribs in position using white glue, setting square and vertical or using dihedral templates for the end ribs. Add in the top spar and the leading edge strip, gluing to the sheet and nose of ribs. Do not shape LE to rib curvature at this stage. Carefully cut out the spar webbing noting that the grain is vertical and glue each in position with white glue between ribs. Pin until dry. Repeat for TE webbing, although grain can run horizontally here, flush with the top edge of ribs. Glue on rear upper TE pinning down well, especially along the rear edge joint. Leave assembly to dry then remove from building board and sand LE to match rib curvature. Re-pin to building board, add upper LE sheeting and cap strips using white glue, pinned in position. The panel should again be left to completely dry. This completes the basic wing panel construction. Trim off the surplus spar and sheet and lightly sand smooth. round-off the leading edge, add tip blocks, carve and sand smooth. Cut slots for the dihedral braces and epoxy outer braces to centre panels. When cured, pin centre panel to building board and apply epoxy to the brace and both end ribs. Position outer panel and block up 4in to the correct dihedral. Repeat the process for the centre joint, pinning down one panel and blocking up the other by 1in. The completed wing can now be sanded overall. Finally cut a 2in wide bandage of nylon to wrap around the wing with about 1/2in overlap, pulling taut and smoothing out any air bubbles. This nylon adds considerable strength to the centre joint, apply more white glue until all the nylon weave is filled. The basic airframe structure is now complete.

Next month: Clive Smalley concludes his article with some final details on finishing models plus some flying tips for those first flights at the slope.

This underside view, reminiscent of a model heading out from the slope, illustrates the lightweight construction that makes the glider a good all-rounder. Designed for the gentle slopes of the Leicestershire country side, Orange Box will stay aloft in the lightest breeze which will ground heavier machines.





We wrap up our ORANGE BOX plan feature with radio installation and flying technique details

Covering and Finishing

There are several ways the model can be covered and finished. Nylon, silk, tissue or plastic film are all suitable. The choice is largely dependent upon the builder's preference and whether the model will be slope or thermal soared. The prototype was covered overall in nylon, the fuselage and outer wing panels in day-glo orange and the remainder in white. I can recommend the use of a strong colour scheme when flown from the slope at long distances to help with orientation problems. However do not paint all the wings or tail as this adds too much weight. Dope, enamel, coloured nylon or tissue are fine on the fuselage. Plastic film has the advantage of solid colour even on wings for no additional weight but is not quite as durable as nylon. The name 'Orange Box' originated through the use of the above mentioned colour and boxy shape of the model. I do not propose to deal in depth with stage by stage notes on covering this model. This has been well dealt with in the model press and in books, and there are so many variations I could not hope to give more than brief details. In any case, this stage is the same whether a model is kit built or plan built and therefore, falls outside the original aim of the article. After covering, the rudder and elevator can be permanently hinged and pegged. Aim for an all up weight, ready to fly of about 28ozs, lighter for a purely thermal soaring where heavyweight tissue could be used, but do not exceed about 2lb for a slope soarer as the light wind performance will suffer.

R/C INSTALLATION

Rather than take the glib way out by telling you to install the R/C equipment as in the manufacturer's instructions, we will take you through a typical installation.

Fig. 1 shows a typical installation for the complete airborne pack of two servos, receiver and battery pack. Note that the battery, the heaviest single item, is at the nose. In the next compartment is the receiver and behind that, under the wing, are the servos. This layout is a compromise of convenience and necessity. The battery pack is positioned nearest the nose to ensure that, in the event of a crash, it does not tear forward and damage the more vulnerable receiver and servos as would be the case if the battery were placed at the rear. Ideally, the receiver, being the most vulnerable of all, should be placed behind the servos, but the practicalities of installation make such an arrangement inconvenient.

This general placement of equipment is helpful in achieving the correct balance of the model when complete, the final adjustment being made by shifting equipment components backwards and forwards in their installation compartments to achieve final balance.

Good installation begins before the airframe is constructed by laying the R/C equipment over the plan to give a general idea of the installation requirements. Any installation aids, such as servo rails, switch mounts, push rod guides, etc, which may need to be built into the airframe as it goes together can be planned at this stage.

Push Rods

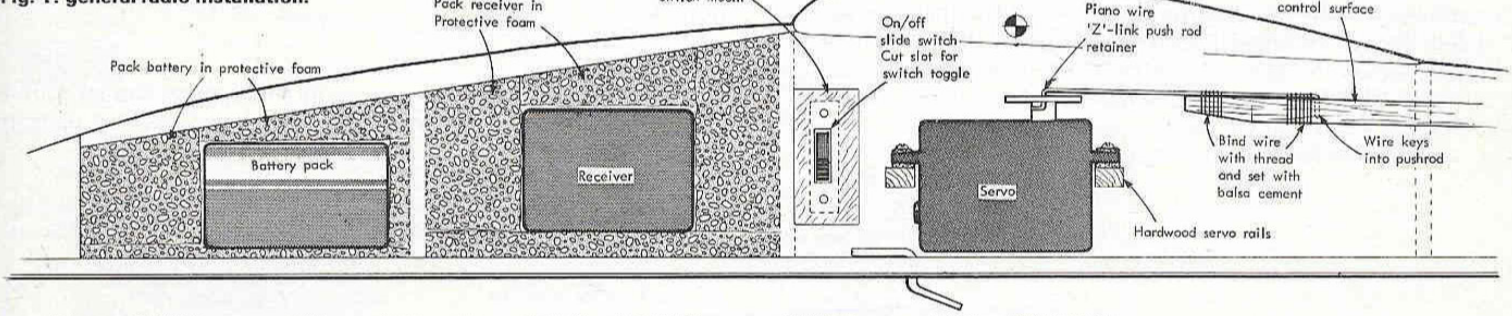
Early on in the construction stage you must decide which form of control linkage from servos to control surfaces is best suited to your model. Basically, you have a three way choice: balsa push rods; flexible "snakes" or a closed loop cable.

(i) **Balsa push rods.** Probably the oldest method of linking servo and control surface and in many ways still the best. Use hard ¼in or 5/16in balsa dowel or ¼in sq strip for a model the size of *Orange Box.* Take an adjustable control clevis with threaded wire rod, shape the wire to pass through a slot in the fuselage and bind to the control surface end of the push rod sealing the thread with balsa cement. Fig. 2 shows how. Ideally, the wire end should not be more than about 3in long to remain stiff under air load.

The servo end of the push rod also ends in a wire rod, preferably 16swg. In the case of a rotary type servo output a "Z" link is used to connect up. Details of this wire end, and the method of shaping the "Z" end are shown in Fig. 3. The rotary output of the servo disc must be removed from the servo to slip over the wire end, but when replaced, the wire is safely retained and cannot be removed, even by force.

Linear output servos require a slightly different connection

Fig. 1: general radio installation.



ORANGE BOX

Fig. 2: push rod exits at fuselage rear.

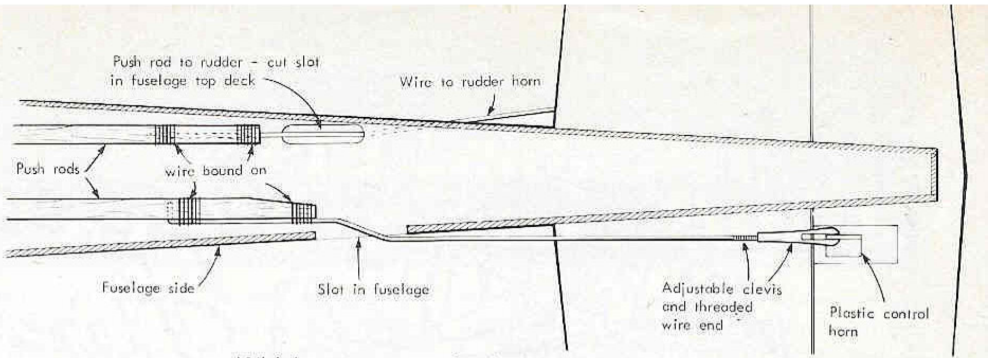
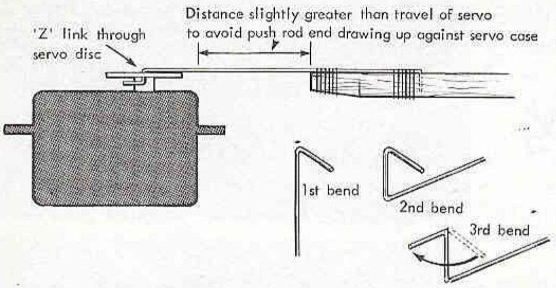


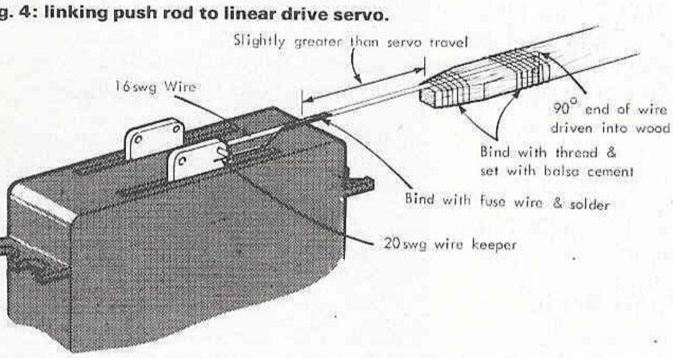
Fig. 3: detail of Z-link connection to rotary servo.



Bonding the Z-link.

arrangement. The output drive arm cannot usually be removed so that a simple snap-on/off keeper is required to hold the wire push rod end in place. See Fig. 4.

Fig. 4: linking push rod to linear drive servo.



(ii) **Snakes.** "Snakes" are flexible push rods consisting of either a Bowden cable in a plastic tube, or two tubes (inner and outer), the latter usually PTFE for minimum friction. The advantage is the ability to "snake" around internal parts of the airframe which, with a rigid push rod, would otherwise need to be either removed or re-positioned to permit free push rod movement. Disadvantages are that in practice there is a limit to the amount of "snaking" that can be introduced without a build up of friction which, in turn, loads the servos, which draws excess current and reduces battery life. Particularly in the case of *cable*-in-tube, care must be taken to ensure the bare ends of the wire cable do not accidentally become kinked which will seriously impair the rigidity of the rod and may, under air load allow the control surfaces to "blow back" toward neutral, thereby reducing control effectiveness.

Linkage ends to both servo and control surfaces are similar to those of the push rod and a typical installation is shown in Fig. 5.

(iii) **Closed-loop cable.** Fig. 6 illustrates the closed-loop cable system, which consists of multi strand control line wire, linked to a control horn on each side of the control surface. Properly set up, it achieves extremely precise control increments and has the advantage of minimising weight at the rear end of the fuselage. In practice, it requires two adjustable clevises and is the most complicated of the three systems to set up to best advantage.

Whichever system is chosen, time and care must be taken to ensure unimpeded, friction free linkage movement over the entire range of control surface travel. Any binding up, friction or fouling of the linkage will cause servo overload, leading to excessive battery drain. In really extreme cases, output transistors in the servo amplifier could be damaged – and that will cost you money!

Installing the System

Having roughly positioned components of the R/C system to achieve correct balance as far as possible, commence by installing the servos, which can be either wood screwed to hardwood rails or direct to the internal faces of the fuselage sides using double sided adhesive foam tape. See Fig. 7 & 8.

Fig. 7: Servo installation on hardwood rails.

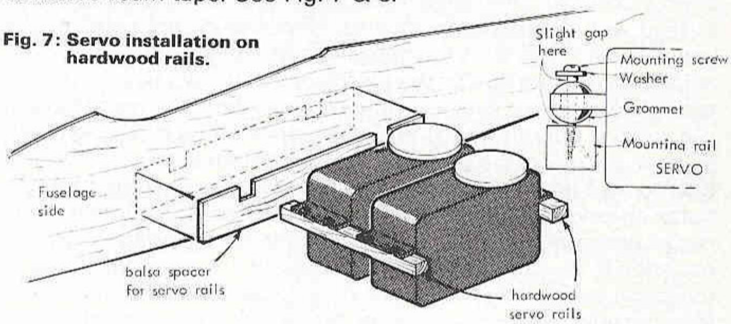
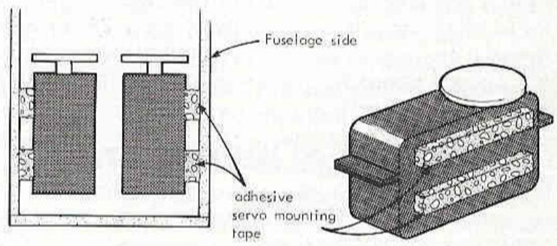


Fig. 8: Servo installation using double sided sticky tape.



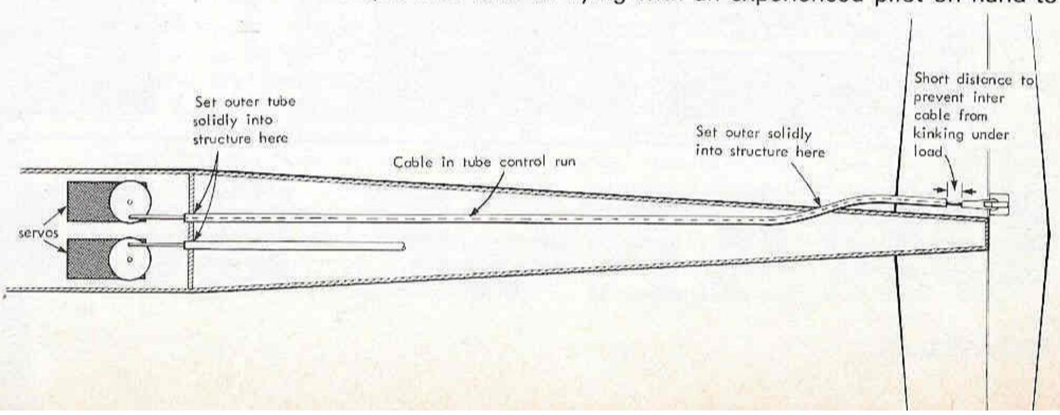
Finally, receiver and battery pack are installed into their respective compartments using foam packing so that each component is prevented from flopping around, but at the same time is not so rigidly packed that the cushioning effect of the foam is lost. Fig. 1 shows how, the general arrangement.

Ensure that the leads from receiver to battery pack and servos are dressed down away from the receiver and be sure to run out the receiver aerial as far away from the servos as possible to avoid picking up any "noise" interference generated by the servo motors.

FLYING

I feel initially it is easier to learn to fly this type of model from a slope. This form of flying with an experienced pilot on hand to

Fig. 5: Snake type push rod installation detail.



assist, gives more air space beneath the model, enabling mistakes to be corrected before the ground jumps up and smashes the model. The long flight time also helps to give continuity to embryo piloting, without the panic of needing to find landing spots with the limited flight time available from a tow – or "bungee" launch.

Choose a calm day for the initial hand test glide, which can be in a flat field. Check that the balance point corresponds to that shown on the plan by adding nose weight if necessary. Start with the tailplane packed under the leading edge with a piece of 1/16in sheet about 1in x ½in. This should give a safe glide path. Always launch the model nose level directly into the wind and have the radio switched ON. Check and double check that the radio is working correctly and that the control surfaces are connected in the right 'sense' – i.e. Left stick is left rudder when viewed from behind etc. However do not use the radio to control the model unless something is seriously wrong; the object of the exercise is to adjust the model for perfect glide without the need for radio corrections. Adjust the packing until a steady descent over 20–25 yards is achieved with the elevator at neutral. Adjusting the neutral position by using the transmitter trims will achieve a similar result using small amounts of up or down elevator.

When satisfied, first flight from the hill slope can be attempted in a gentle breeze. Wait for a day when the wind is blowing directly at the slope. Launch the model, preferably with a helper and from the crest of the slope, in exactly the same way as for the test glide. Keep the model heading straight out from the slope. If the model does not gain height or if it sinks well below the crest, do not turn it until well clear of the hill face and then attempt a landing at the BOTTOM of the slope. NEVER turn the model, even when experienced, back TOWARDS the slope unless it is considerably above the crest and at least 100 yards out in front of the slope. The only time that it is permissable to turn back is when a landing is being made on top at the back of the crest. Turns should always be made into the wind (see Fig. 9) in a series of 'S' turns.

During the first flight, should the model appear nose heavy, remove the 1/16in sheet tailplane packing or alter the transmitter trim. Do this a stage at a time noting what effect is achieved and make all adjustments in small stages. Trim until satisfied that the model will slowly penetrate into wind, gaining height in a steady level manner. Be prepared to do this at any time and even land if the conditions alter during a long flight.

Note there is a difference between airspeed and ground speed. The model may appear to fly backwards relative to ground but will still have forward airspeed relative to the wind. When properly built and trimmed, the model has no vices and is capable of loops and stall turns as experience is gained. It is also light enough to be kept flying when the wind dies down and grounds more heavily loaded models. In stronger winds, a little ballast at the balance position will increase the flying speed allowing penetration into wind, but don't overdo this and if the wind proves too strong, try again another day. In winds of more than a gentle breeze do not push the centre of gravity behind that shown on the plan. It is

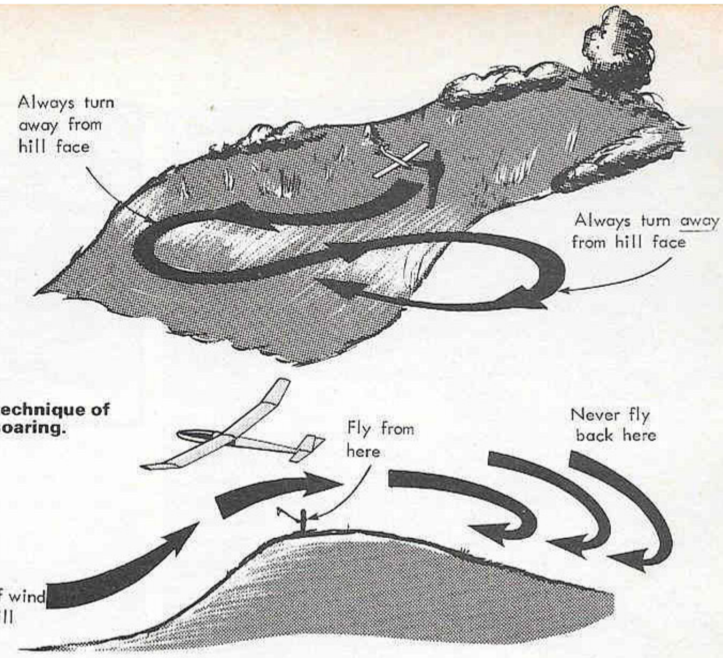


Fig. 9: Basic technique of slope soaring.

always safer to carry out a trim test flight with the model nose heavy as control will be retained, whereas if the model is tail heavy, stalling will occur with consequent loss of control.

For tow-line or bungee flying, the test flights should also be carried out as already described. For initial flights use a tow line of about 75–100ft length. Develop an understanding and an agreed signalling system with your tow line operator before any flights are attempted. Test the controls, hold the transmitter in one hand and raise the model to shoulder height in the level position. When satisfied, signal to your helper that all is OK. Your helper should acknowledge this signal and in return signal that he is about to start running. As he starts to run, take several steps forward and launch the model nose up. Do not throw it but allow it to almost rise up out of your hand. Your helper should start running fairly hard initially (less hard the windier it is) to get the model climbing. Once the model is climbing steadily, your helper should adjust the speed of his running to maintain a steady pull on the line, even moving towards the model if necessary in wind or for gusts. Concentrate on steering the model along a straight path with the rudder only and leave the elevator alone. When the model reaches the crest of the flight path and your helper is cursing the day he volunteered to tow, he should ease off running and allow the model to fly over his head, disengaging himself from the tow line. In an emergency if the model does not start to climb after launching but veers round to right or left through over-control or a bad launch, your helper should immediately stop running and release the line. Quick action may be required to save the model,thus released the model will slow down and control can be regained (with luck!)

I do not recommend 'bungee' launching to begin with until experience has been gained in piloting the model, as once launched the model is committed until the 'bungee' power is exhausted. If a bad launch develops with a fully stretched bungee things happen QUICKLY.

The prototype has achieved many hours of flying time, mainly from the slope and has repaid the efforts in construction time and time again. I do hope you enjoy both building and flying this model and advance to more complicated types.

Fig. 6: Closed loop cable system installation.