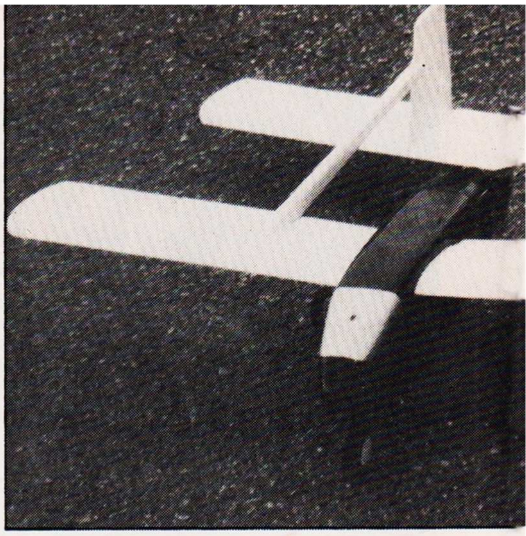
'WASP' Tandem Wing

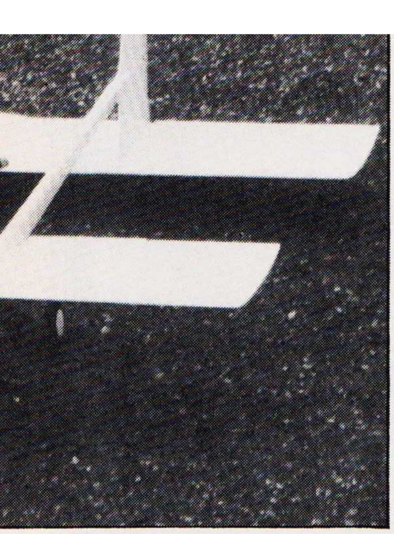


Sting the opposition with A. G. Lennon's unique canard pusher for .15cu.in. engines and four function radio

THE WASP is classified by this author as a "Tandem Wing Biplane" – both wings being of equal chord, span and area. It has the non-stalling characteristics of a canard whose foreplane is substantially smaller than the aft plane. Obtaining the correct cg with the Wasp's configuration is easily accomplished without ballast – which cannot be said for a canard with a pusher engine located behind the aft wing.

Aerodynamic theory, confirmed by wind tunnel testing, indicates that equal span wings in tandem have lower induced drag than a conventional wing-tail arrangement provided the vertical separation (GAP) and the longitudinal spacing (stagger) between the wings is adequate. The Wasp configuration was based on this data. In addition the Clark Y wing section employed for both wings has surprisingly low profile drag at the low Reynolds Numbers (150.000) at which this model cruises. Particular attention was paid to drag reduction in other components; landing gear legs have fairings, the engine is completely cowled, wheels are streamlined and control horns – except on the twin rudders are enclosed in the structure.

The model portrayed in flight and in the drawings is, I regret to say, the second version. The first crashed after a short flight, due to poor selection of front wing airfoil (Eppler 385M) which assumed its zero-lift angle of attack with aft wing still lifting. This resulted in a violent nose dive which demolished all but the aft wing and fins/rudder. Pitch control with full span elevators on the foreplane proved over-sensitive, contributing to the crash. Aileron control, with differential action (twice up to down action) proved excellent during the short flight. Radio, servos and engine were undamaged.



Genuinely different and well researched by a USA top designer

Biplane

The model was redesigned. The foreplane airfoil was changed to that of the aft wing, Clark Y. The fuselage was moved forward relative to the front wing to advance the cg; and the angles of incidence of both wings were adjusted to provide balanced lift – taking into account the impact of the downwash, from the front wing, on the aft wing. The front plane elevators were reduced to 70% of the wing's span.

The model was rebuilt and test flown, successfully. Longitudinal stability was excellent, aileron control precise, but the model was unstable directionally, and tended to spiral dive readily.

The vertical tail surfaces, during the initial design process, were each increased in area, as a precaution, compared to the calculated areas. Cutting off the tops of both fins and rudders and replacing the top-caps removed this additional area. Subsequent test flights confirmed this action. The aircraft was stable around all three axis.

The adjustable trim flap in the aft wing, inboard of the ailerons and fins, was found unnecessary and has been deleted from the drawings.

The black and white construction photos are of the first version, but construction of both versions is almost identical – and the small difference should present no problem. Note that the fuel tank is almost centred on the cg; very little change in cg occurs as fuel is consumed.

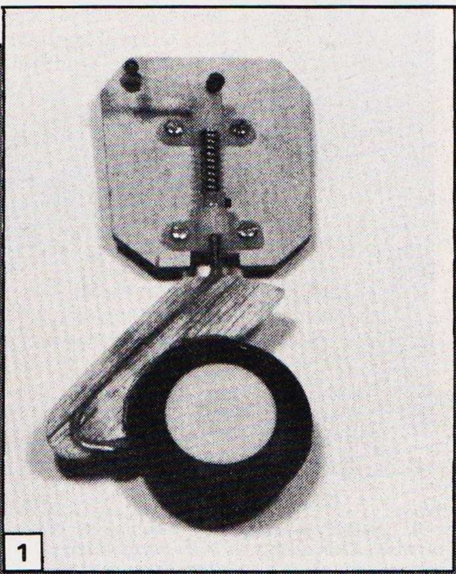
The engine is installed inverted with a Tatone universal exhaust manifold which permits cowling the power plant completely. The exhaust pipe ($^{9}/_{32}$in dia. alum. tube) is directed downward through and below the cowling.

Cooling air enters on both sides of the fuselage through NASA-developed, recessed, low drag "scoops", and exits through the opening below the spinner – aided by the propellor which "sucks" the air through the cowling, to effectively cool the engine.

Accessibility to all four servos, fuel tank, on-board battery and nose wheel steering is achieved through the easy removal of the top of the fuselage (canopy). Similarly, the lower portion of the engine cowling is easily removed by hand for access to the glo-plug and carburettor.

The connections to ailerons and rudders from the servos are Sullivan Gold'n Rod cable type, stock No. 507; this consists of $^{1}/_{32}$in dia. stainless steel push-pull cable, copper plated for easy soldering, running in a plastic outer sheath .070od by .040id. This arrangement is very flexible and ideal for a small model. Goldberg or Dubro connectors are used at the servos and small "home made" brass clevises are soldered at the rear end – and connected to the ply control horns of rudder and ailerons using ordinary pins. (See drawing). The elevator control connection is a $^{1}/_{32}$in. dia. push rod "Z" bent at the servo and with a Dubro ball joint at the elevator horns.

Because inverted glo engines are prone to stopping at low rpm, this model is equipped with an on-board glo-plug heating system, powered by a 1½V size AA battery and operated by the engine servo which actuates a roller-level micro-switch (see drawing) to energize the glo-plug, at low rpm only. This arrangement must be adjusted so that when the transmitter's engine control stick and engine trim lever are at their lowest position, air and fuel are cut off, the engine quits and simultaneously



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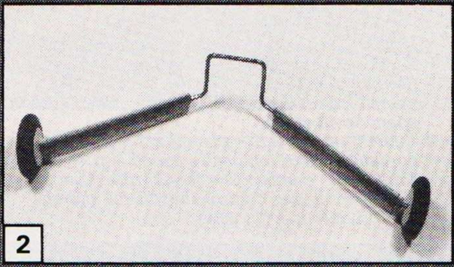

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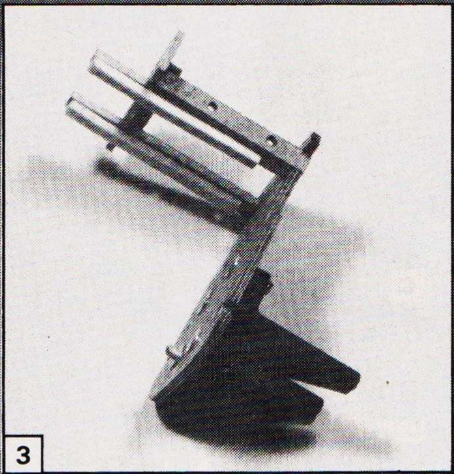

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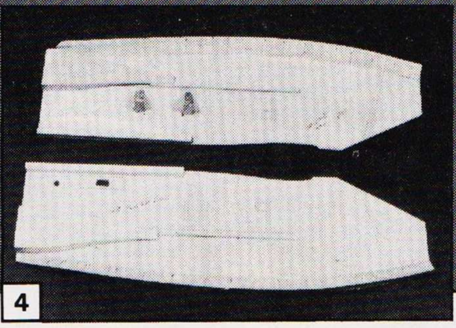

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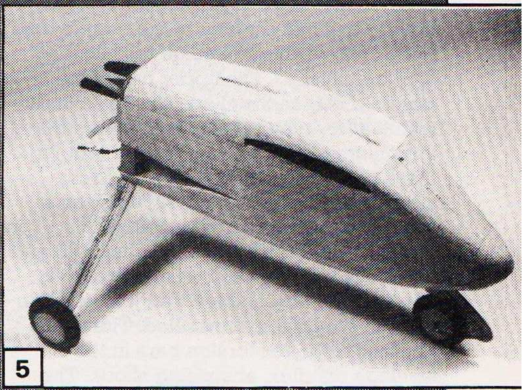
Fuselage – Photos 1, 2, 3, 4, 5 and 6.

1 Groove and epoxy balsa fairings to all three landing gear legs and sand to streamline cross section.
2 Cement in and in triangular stock. / in sq. floor supports and NASA scoop components to both sides.
3 Install nose gear on bulkhead No. 2.
4 Add motor mount, tank mount, main landing gear. Contact cement in thick rubber sponge to the tank mount and similarly cement the tank in position.
5 Epoxy front wing hold downs to bulkhead No. 3.
6 Epoxy rear wing hold downs to bulkhead No. 4.
7 Epoxy bass blocks to plywood engine servo mount.
8 Bolt (2-56) plastic AA size battery holder to plywood base.
9 Epoxy maple block in top balsa nose block for front canopy hold down.
10 Assemble sides, floor, bulkheads and engine servo mount. Install radio battery and receiver in foam. Add bottom sheeting. Install glo-plug battery holder and base.
11 Cement nose blocks in position.
12 Build canopy on assembled fuselage and sand all corners as per drawing.



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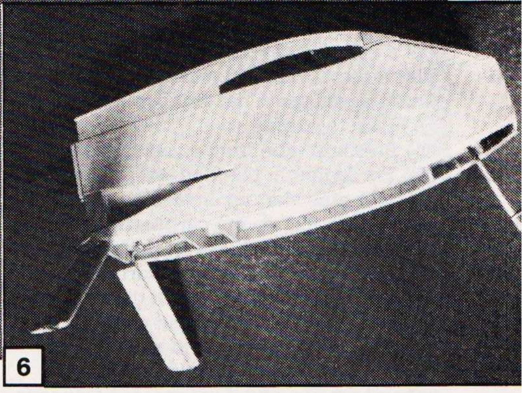

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current to the glo-plug is cut off. A separate on-off switch in this circuit is not needed. For engine starting, a small jack is wired into the system, which permits external 1½V current to flow to the glo-plug via a plug inserted into the jack. The on-board circuit is interrupted, in the jack, to the plug so that engine start up does not drain the onboard battery.

This plug-jack combination has an important safety feature – it can be mounted well away from the propellor - on the "Wasp" it is located in the fuselage side wall ahead of the forward wing, where the plug can be removed well away from the "sting" of the rotating prop. The connection to the glo-plug is a clip made from $^1/_{32}$in dia. phosphor bronze wire (see drawing). It is easily installed or removed for glo-plug change and has been used with no problems on an least seven of the author's designs. The drawing details this arrangement. The jack, plug, level switch and battery holder are available from, Tandy Corporation outlets.

This system would be useful for 4-stroke engines, for glo-plug heating at low rpm where the reduced firing frequency inherent in 4-strokers can cause engine quits from cooled glo-plugs.

To mount the exhaust manifold on the engine, the bosses at each end of the exhaust (OSmax –.15r/c) were drilled (No. 50) and tapped (2.56) ½in deep. Corresponding holes in the lower half (engine inverted) of the manifold permit bolting that half directly to the engine (use No. 2 lock washers beneath the ⅜in long 2.56 bolt heads). The upper half of the manifold is then installed. The holes in the manifold for the normal attachment method are plugged with 4.40 bolts after tapping these holes accordingly. The $^9/_{32}$in dia. aluminium exhaust tube is retained by a small self-tapping screw inserted in a $^1/_{16}$in dia. hole drilled through both manifold and tube. The landing gear, as mentioned, is faired with balsa and low drag. Streamline wheels 1¾in dia. are installed. The main gear incorporates torsion bars in the fuselage that flex, absorbing shock. The nose gear includes a spring for the same purpose.

A 2oz slant front Sullivan tank was used but a cylindrical 2oz. tank may be fitted. This size provides 10 minutes of engine run. Three openings in the tank are needed:
(A) Fuel to engine
(B) Pressure tube from exhaust manifold
(C) For fueling – plugged with a rivet.

For engine start up, invert the model to permit priming via the carburettor with the latter wide open. However, the model must be right side up for engine start up. If you use an electric starter, check that fuel is not trapped between piston and cylinder head from over-priming to avoid a damaging hydraulic-lock. Flip the prop by hand several times – and if unusual resistance is felt – hold the model so that the manifold is down to permit trapped fuel to exit via exhaust opening. Insert the plug in the jack and apply your electric starter.

The structure of the "Wasp" may appear complex; in reality it is very simple. It is based on stressed skin technology to get material as far from the neutral axis as possible.

Wings have minimal spars – fuselage and booms are box like with rounded corners, simple, light, strong and very warp resistant.

The cowling is an epoxy and fibreglass lay-up over a styrofoam mandrel; a bit messy but easily accomplished.

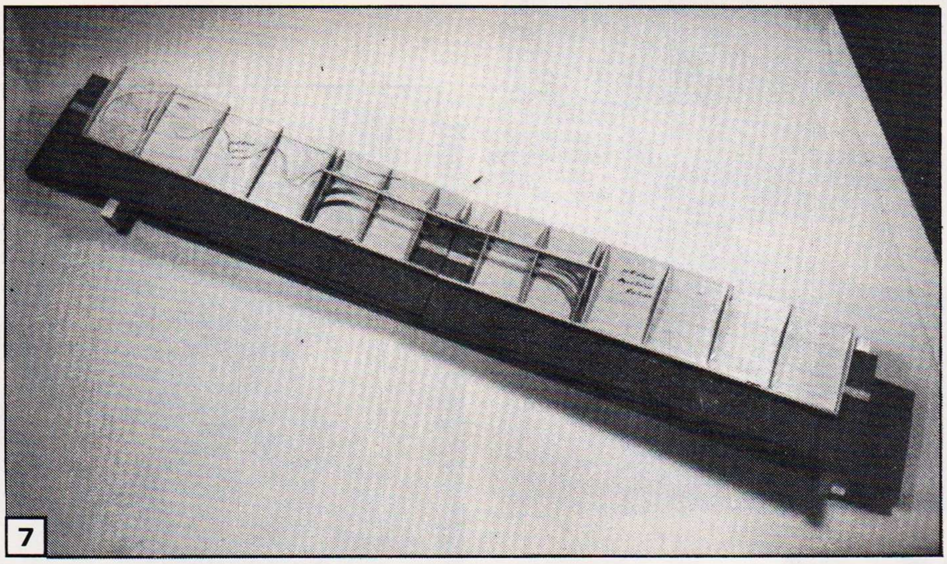
The aerial is installed, in the wing, during its assembly. It is necessary to cut the aerial and to install a brass tubing coupling. This is composed of ½in lengths of $^1/_{16}$in & $^3/_{32}$in brass tubing. Measure the aerial carefully before cuting (at a point 4in from the receiver). After soldering the coupling halves to both sections, (using heat shrink tubing over the solder joints) and joining them, measure again. It may be necessary to cut a bit off the far end of the aerial to compensate for the coupling. The author has used this procedure on many models, with duplicate aerials permanently installed in either fuselage or wing, with absolutely no problem. It permits moving the receiver from model to model easily. The $^1/_{16}$brass tube is a free-sliding fit in the $^3/_{32}$in brass tube. A bit of solder melted on the $^1/_{16}$in tube and filed down to provide a firm but disconnectable fit solves this problem.

Flying

This model's small size permits its transportation without disassembly – a real convenience.

Take-offs may be either rise-off-ground – or hand launch. Be sure to lower your hand quickly after launch – to avoid the "sting" in the Wasp's tail – that rotating prop. The model is stable – will not stall – just "mushes".

Control throws are adjusted by moving the connectors to different holes in the



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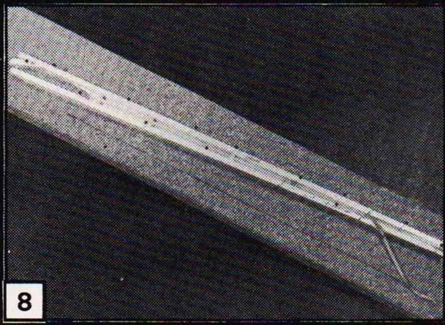
Wings – Photo 7.
An assembly jig composed of two pieces of ⅜in plywood, 4½in wide × 15 in long butted end to end, coated with ⅛in cork board, and with the outer ends elevated to the 4° dihedral anglke ($1^1/_{16}$in) is needed.

1. *Lightly pencil rib locations on bottom skins.*
2. *Pin bottom skins to assembly jig.*
3. *Cement rear spars and centre section lower spars (on front wing) in position. Install aileron spars on aft wing.*
4. *Cement ribs to skin – except at leading edge curvature – add top centre section spars (on front wing) – intercostal webs (front wing).*
5. *Install aerial, and control sheaths for ailerons and rudders in front wing.*
6. *Cement upper skins – except at leading edge curvature.*
7. *Add ⅛in triangular strips under upper skins ar rear of rear spar – ahead of elevators.*
8. *When cement has set, cement upper and lower skin leading edges to each other and to rib fronts.*
9. *Use ½in masking tape strips 3 in long to bring leading edges together. Apply strips on 1in centres, chordwise, half on top and half on bottom. Replace wing on jig and add weights to ensure that wing is flat on jig. Allow cement to set at least 12 hours.*
10. *Assemble and install servo mount in front wing.*
11. *Cement block balsa wing tips in position and cut and sand to shape.*

Control surfaces – Elevators, Ailerons, Rudders, Photo 10.
1. *Pencil rib locations on lower skins and one skin of rudders.*
2. *Pin skins to wing jig.*
3. *Cement leading edge spar in position and add ribs.*
4. *When cement is dry, add second skin.*
5. *Sand trailing edges to $^1/_{32}$in thickness.*



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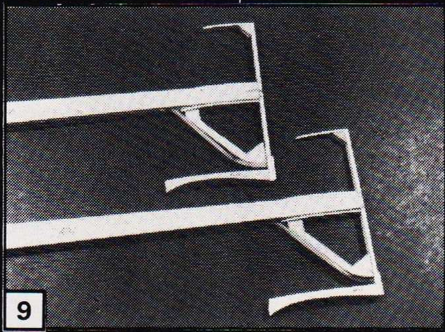

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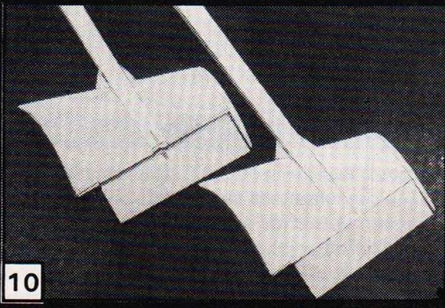

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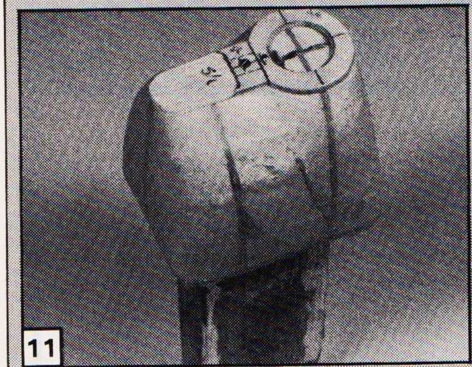
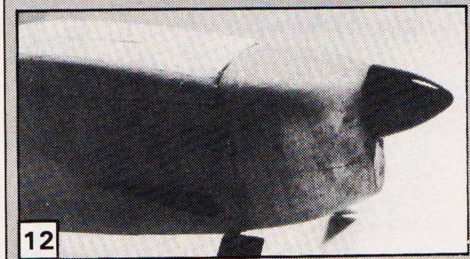
Booms and Fins. Photos 8, 9 and 10.
1. *Pin one side of boomn to wing jig.*
2. *Add top and bottom in sq. strips and in balsa "V".*
3. *Install cable sheaths and front guide.*
4. *Add second side.*
5. *Cement fin spars to boom end. Add ribs 1, 2, 3 and 4 and cable sheath guide. Cement cable sheath in lower fin through rear spar with cyanoacrylate cement.*
6. *Cement upper and lower skins to ribs and spars.*





Cowling – Photos 11 and 12.

1 Assemble spinner ring and lower cowl end plate to Goldberg flat hold down.

2 Assemble plywood lower front former and flat hold-down.

3 Assemble cardboard or balsa sheet templates – (back, vertical centre and upper and lower horizontal). Fill spaces with styrofoam. Add spinner ring assembly and sand styrofoam to template contours. Note that upper front portion of cowl overlaps bulkhead No. 5.

4 Apply two layers of medium weight fibreglass and epoxy to the form, and edges of front spinner ting assembly.

5 Sand smooth outside when epoxy has fully set.

6 Dissolve foam with acetone or petrol (outdoors; watch out for fire).

7 Cut openings for needle valve and exhaust stack.

8 Separate cowl upper and lower halves by cutting along parting line (see drawing) very carefully.

9 Fit lower front hold down to lower cowl as part of final assembly and epoxy to cowl.

servo arms. You'll need full up-elevator for inverted flight.

Because of the model's small size, bright coloured Monokote – or its equivalent is recommended for good visibility. This same covering material is used for hingeing all control surfaces. It provides a flexible hinge, and a gap seal (see drawing).

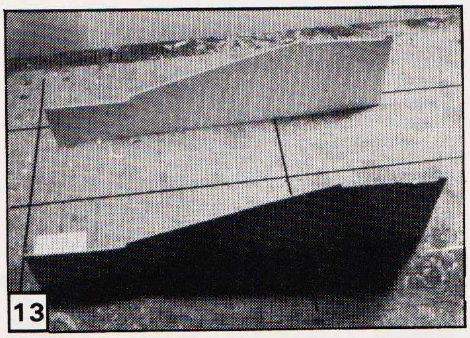
Construcion

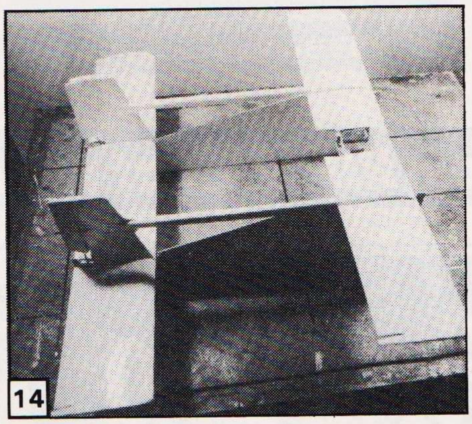
Your author made all components to drawing. Any drawing errors that showed up during assembly have been corrected.

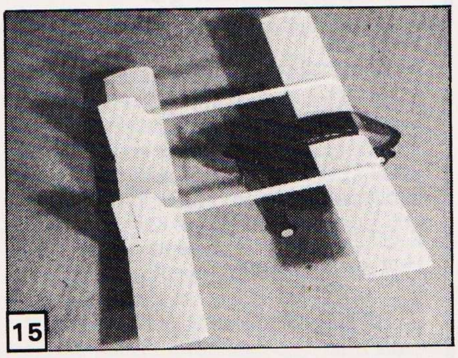
It is suggested that you proceed accordingly, starting with metal components, landing gear legs, elevator control horns and connectors – small brass clevises for ailerons and rudders etc.

Plywood components are next followed by balsa sheet members, and balsa block components – wing and rudder tips – nose block etc.

Assembly then consists of a group of sub assemblies for each major component – followed by assembly of those components and the final assembly into the complete airplane. The photographs will help.







Final Assembly – Photos 13, 14 and 15.

1 Cover all components and hinge elevators, ailerons and rudders to parent surfaces. Leave areas of wings bare where booms are cemented. Use your choice of iron-on plastic surfacing. Your author painted the cowling, landing gear fairings and nose block.

2 Install and align foreplane and fuselage. Drill and tap front and rear hold downs using wing servo mount bolt holes as templates.

3 Similarly drill and tap front canopy hold down.

4 Make cardboard jig as shown in photos and drawing for assembly of booms and fore and aft wings.

5 Assemble booms and wings as shown. Align cable sheaths of wing and booms as shown in the drawing. Make certain wing incidences are to drawing.

6 Install all four servos and push pull cables and elevator push rod.

7 Add fin sides, below rudder, to enclose aileron horns and cover with plastic covering.