TOKYO ECHO

BY AZUMA KUDO

During the past ten years I have designed about 100 RC models, almost all of which were single channel planes. To some, it is a source of amazement that anyone could construct this many without losing interest. But, being charmed with the conciseness and simplicity of form in single channel RC. I am working with it continuously in order to obtain the best possible performance.

The Tokyo Echo has been designed for single channel equipment employing only the aileron, instead of the rudder, for control. This departure from normal single channel practice came about when it appeared that aileron-only control seemed to correct many of the faults of rudder- only systems. Although the latter has been used with relative success on high wing, low wing, biplanes, and scale models, it is definitely limited in its scope of control.

In the case of low wing models, it is virtually impossible to obtain adequate control-power even if we made a minimum dihedral of more than ten degrees. Furthermore, in the case of scale models, it is a decisive weakness that single channel RC has been stuck in the mud in its development. On the other hand, multi-channel has made excellent progress, both at home and abroad, with the help of good designs and improved RC equipment. Today, with multi-control, even complexly designed scale models are capable of performing stunts similar to their full-scale counterparts. Therefore, with the idea of enlarging the scope and repertory of single channel, we present an aileron only, low wing design with a small dihedral angle — the Tokyo Echo.

We will say at the outset that this ship is not designed as a first model for beginners. The RC'er with a reasonable degree of single channel experience, however, will find an entirely new challenge and flight experience in this design. As you know, multi aircraft fly smoothly because we can use such controls as elevator and trim in addition to the aileron function. Without these additional controls, the multi craft would not fly smoothly. It is, therefore, necessary to note the characteristics of aileron-only control, its limitations, and the design measures necessary to compensate for the lack of other control functions.

As mentioned, the main advantages for aileron only control is that this system can be used for scale models, providing adequate control action without deviating from scale dihedral. On low wing single channel designs, smooth maneuvers can be performed, eliminating many of the undesirable characteristics of rudder-only control. Again, an exaggerated amount of dihedral is not necessary, as it would be in the case of rudder-only configurations.

The tendency of many multi ships to drop their nose in aileron turns, requiring up elevator to maintain altitude, can be overcome in single channel aileron-only by altering other forces in the airplane. For example, using a longer tail moment and moving the CG forward achieve this purpose. In this design, the CG is at 28%, with wing incidence at plus 2 «degrees.

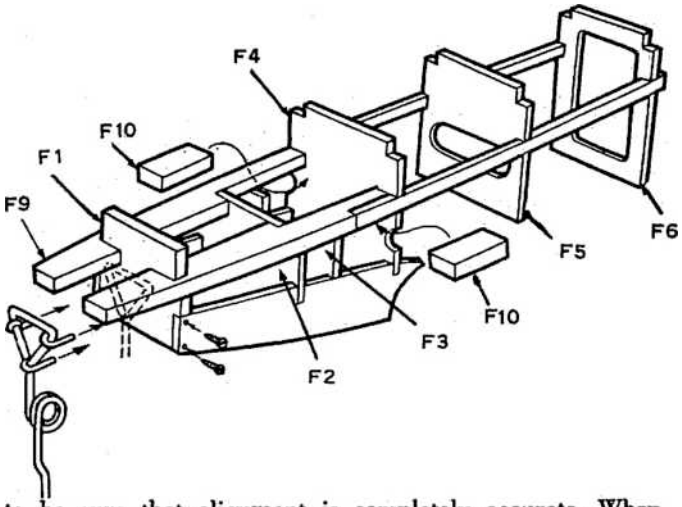
A small model, one designed for engines in the .09 and smaller class, is not adequate for wind penetration. Since the .09 to .15 class is the most popular for single channel, here in Japan, I decided on a .15 size engine for the Tokyo Echo. This, then, fixed the size of the airplane. The airfoil is fully symmetrical, 18% thick, with the maximum camber point located 25% from the leading edge. The airfoil is, perhaps, the singularly most important item for aileron- only control. A thick section is advantageous for controlling the speed of the model. Since the drag of the airfoil goes up as the square of the speed increases, the Tokyo Echo will not pick up speed when the nose drops. This design also has a very mild stall. The airfoil, itself, is based on U-control airfoil observations, with a straight line on the rearward section of the airfoil to keep the aileron action as effective as possible. This results in a constant speed airplane with effective control in all altitudes. Glide characteristics of the wing is as effective as a Glark Y section.

The tail moment arm is 2.6 chords, measured from the center of pressure or CG. The stabilizing area is 25% of the wing area. The long tail moment results in excellent longitudinal stability, but creates a slower dive recovery. It is for this reason that all stunts should be executed at a reasonably high altitude. In addition, turns should be pulsed and kept open to prevent dropping the nose in turns — particularly when close to the ground!

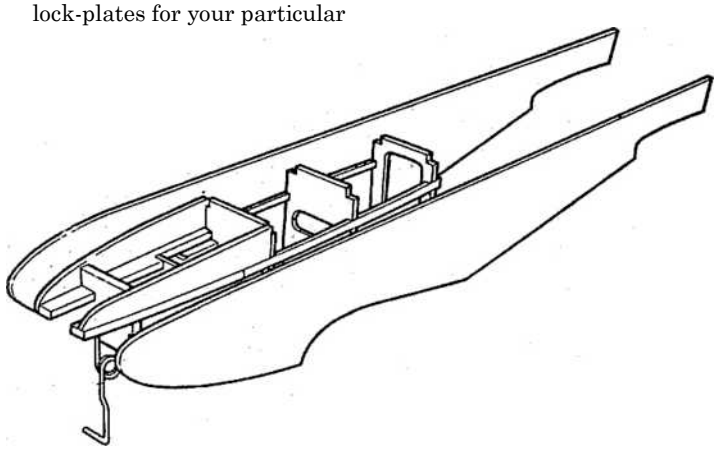
With 10 degrees of aileron movement the flight is smooth. With 15 degrees of movement stunts can be easily performed. The aileron throw is the same for up and down. Dihedral is five degrees, which is adequate both for control response and stability. The CG location is not critical but should be within ¼ of the location shown on the plans. Side and downthrust, two and three degrees respectively, may be varied for the particular airplane in order to obtain straight and level flight. The author has constructed and tested five Tokyo Echo prototypes, and each weighed three pounds four ounces.

Construction

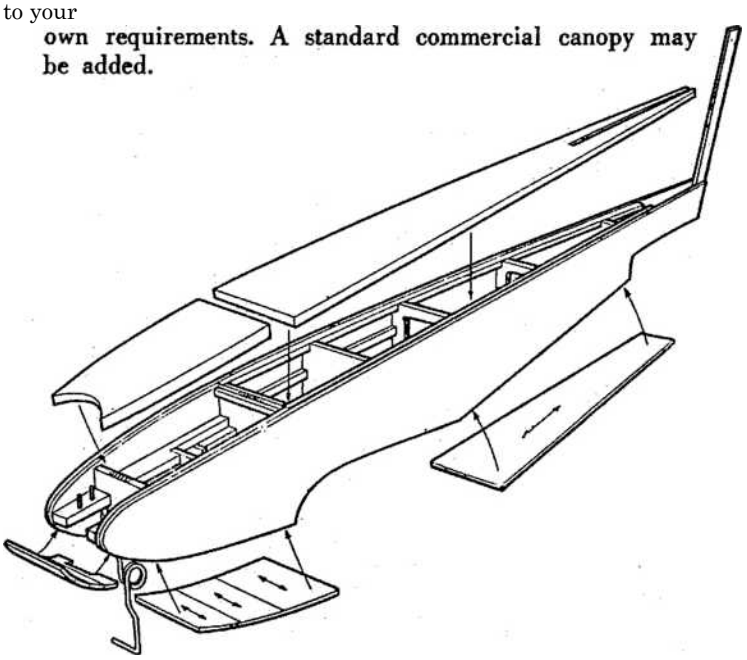
Construction procedures are quite standard and the experienced modeler should encounter little difficulty in duplicating the Tokyo Echo. Begin the fuselage construction by joining the motor bearers to their extension longerons with white glue. Form the coil-sprung nose gear and attach to the firewall with J-bolts. Assemble bearers and parts FI through F10. Check this assembly with a triangle



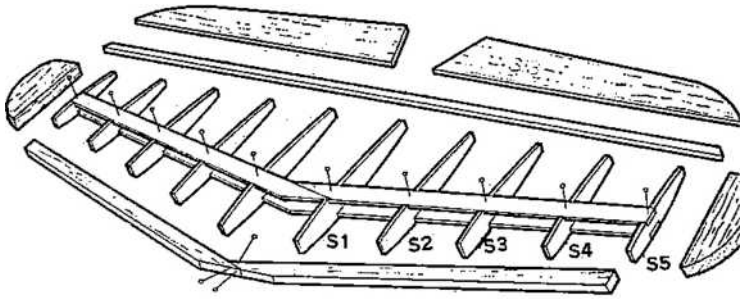
to be sure that alignment is completely accurate. When thoroughly dry, add the doublers on top of the motor mounts, followed by the fuselage sides. Add lower nose doubler blocks, rear longerons, rear cross-braces, and rudder post. Add all lower sheeting plus front and rear top blocks. Before sheeting the nose area, be sure to install blind nuts or mounting lock-plates for your particular

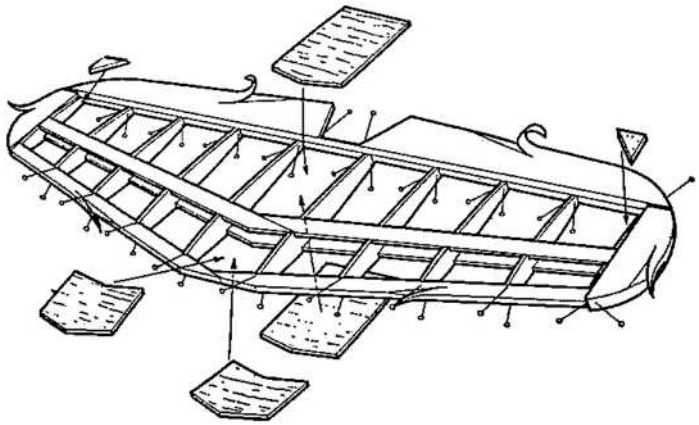


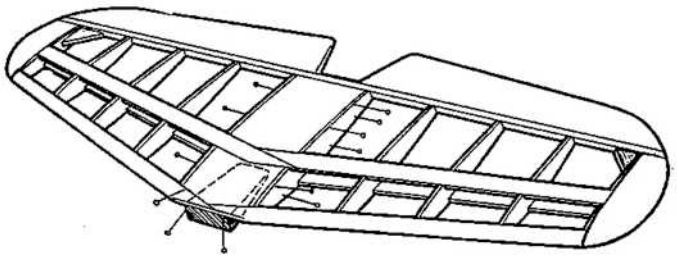
choice of engine. Add wing and stabilizer fairing strips, fin and dorsal, then sand well. The heavy sectioned rear longerons will enable you to sand the Tokyo Echo to a pleasing contour. Cover and finish according to your own requirements. A standard commercial canopy may be added.

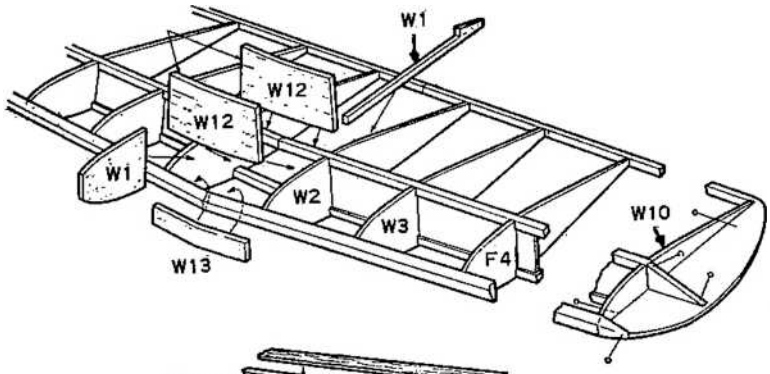


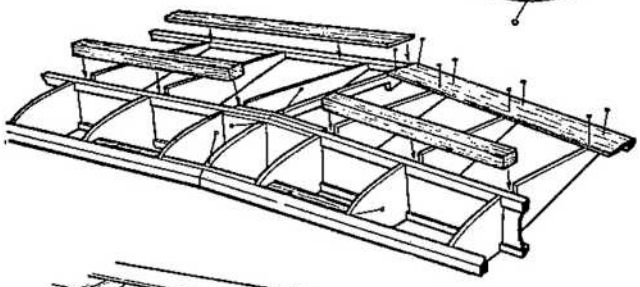
Wing construction is conventional, and a jig may be constructed for its assembly, or a Magna-Jig employed. Do not omit the vertical grain webbing between the two main spars------ they add immeasurable strength and rigidity to the structure. Small commercial landing gear clamps can be used to secure the main landing gear in the gear slots, in much the same fashion as standard multi practice. Λ standard single channel servo (Royal Products Catalog #7) is used for aileron control. A simple V bend can be made in the aileron linkage for adjustment purposes, or one of the standard adjustable multi linkages employed. Be certain that ailerons are not reversed and that the throw is equal, both up and down. It is recommended that you start with ten degrees of movement, increasing to a maximum of fifteen degrees as experience is gained with aileron-only control.

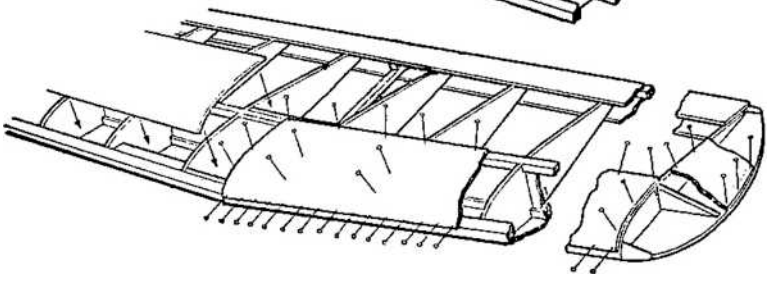


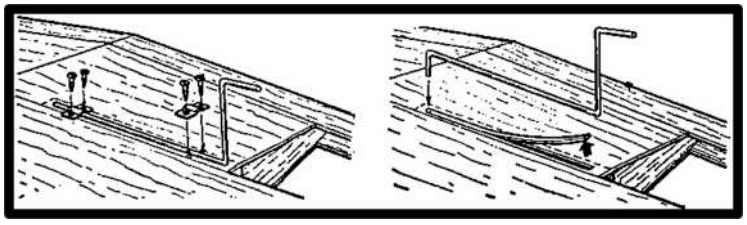












Stabilizer construction is begun by joining the two halves of both the top and bottom spars. Place the ribs in place on the bottom spar, then add the top unit. Add leading and trailing edges, tips, elevator area, and top and bottom sheeting.

Equipment Installation

The Enya .15 R/C engine shown can be coupled to a two or three position escapement, although there is adequate room for the three-position single channel motor servo that is a companion unit to the aileron servo employed. (Royal Products Catalog #7A). If these two servos are used, the battery complement will consist of three pencils plus the 9V transistor battery used with many of today's superhet single channel receivers. Wrap the battery pack securely and encase the receiver loosely in foam rubber. Relocate equipment as necessary to obtain the desired CG point.

Finishing

Silk or Silron can be used to cover the entire model. The prototypes used colored silk followed by several applications of clear butyrate. After fine sanding, apply several coats of colored dope to the fuselage, fin, and rudder area, followed by colored trim on the wing and stab.

Flying

Straight Flight

Without signal the plane will fly in a large counter-clockwise circle, and with a slight pulsing, will fly straight. Adjust and trim for this feature.

The author and a Tokyo Echo prototype. A new standard in single channel performance with aileron-only control. Has been flown 6-channel with slight modification.

Circling

Bank the plane either to the right or left approximately twenty degrees. To regain level flight, apply opposite control until the Tokyo Echo resumes a level attitude. You must reverse the control if the plane loses height while turning. It is impossible to make a small circle without hanking. You should keep in mind the minimum size of the circle that is possible before losing altitude.

Barrel Roll

This is the favorite stunt of the Tokyo Echo — how you can assemble and adjust your model for this stunt is the barometer of your skill. Key your motor control servo for high speed and obtain sufficient altitude before commencing this maneuver. Fly dead against the wind and then signal either right or left, allowing the plane to gradually bank and fall. Just before the model faces directly toward the ground, release the signal. The Tokyo Echo will regain speed and recover to level flight, regaining altitude in the direction of the wing. This much is the preliminary demonstration. Next, give a right or left command and hold — the plane will go into a large roll. To regain level flight, release the signal before the model is completely level. A slower roll may be more pleasing when conducted in the direction of the wind.

Split-S

The preliminary action of the slow roll is, in itself, a Split-S movement. Considering that the nose is raised, and the motor in high speed following the stunt, apply control either to the right or left. If you experience any difficulty due to the inherent stability of this design, correct with one or more of the following adjustments:

(a) increase the power from a .15 to a .19.
(b) adjust angle of wing incidence.
(c) move the center of gravity rearward a maximum of ¼".

After applying any of the aforementioned adjustments you may note some minor difficulties in level flight, or a tendency for the nose to raise in a slightly strong wind.

Immelmann Turn

Apply either left or right along the current of the wind and reverse the rudder just before the nose starts to drop. The plane will gain speed gradually, and when it reaches the summit, direct it into a semi-circle, then regain level flight in the direction of the wind.

Cuban Eight

This can be described as two Immelman turns connected together. Be certain to gain enough power at the end of the first turn or the second one may end in just an upward pitch!

Wingover

In practice and in order, you may copy standard rudder only procedures for this maneuver.

Spiral Dive

Be certain to gain enough altitude before commencing this maneuver. Three turns are made at a time.

Conclusion

Here, then, is the Tokyo Echo — a proven aileron-only design for single channel. When you have completed the model and flown it a few times, you will, I am sure, have gained a whole new outlook on the future of single channel R/C aircraft. It will be a challenge, and a new experience you will thoroughly enjoy. The current image of the large, boxy, cumbersome, and overpowered single channel ship that wallows through maneuvers will become a thing of the past as you progress from the Tokyo Echo to new aileron only designs of your own.

The Tokyo Echo has also been flown as a six channel multi ship, simply by extending the wingspan one rib section and lengthening the tail moment by two inches. Too, the Tokyo Echo has been flown as a twin-engine single channel ship by adding small auxiliary rudders about one-third the size of the main rudder and located on the stabilizer directly behind each engine of the twin configuration. The torque of the engine, when one engine stops, is counteracted by the fact that these auxiliary rudders are offset twenty degrees and that the right engine is run in a clockwise fashion.

The author will appreciate your comments and inquiries on this design. Simply address your correspondence to Azuma Kudo, c/o R/C Modeler Magazine, P.O. Box 487, Sierra Madre, California. ■