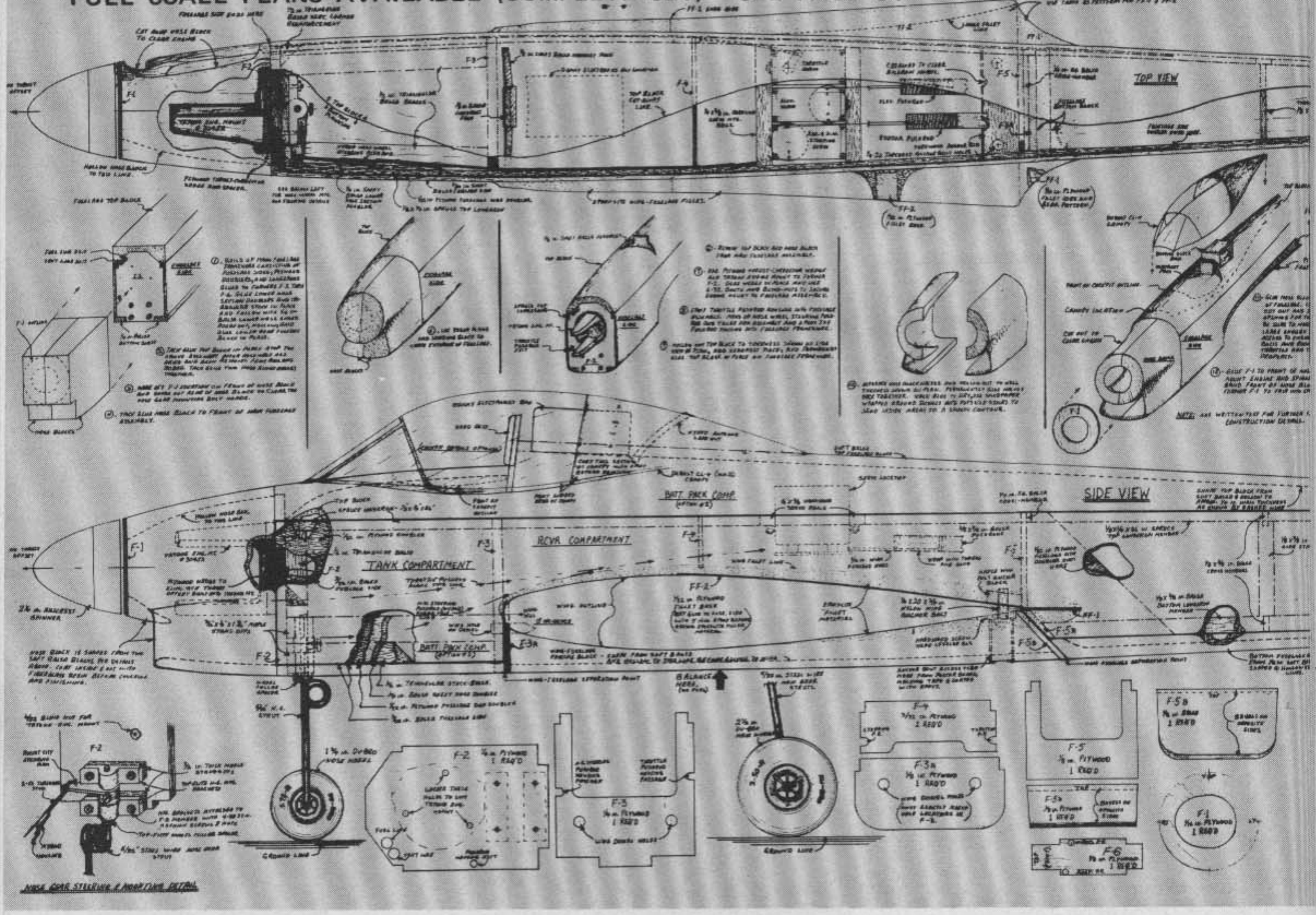
FULL SCALE PLANS AVAILABLE (COMPLETE SET) - SEE PAGE 84



And here we have the Champ with his ever present smile and the tools with which he picked up all the marbles for the second time. Jim is one of the warmest people that we know!

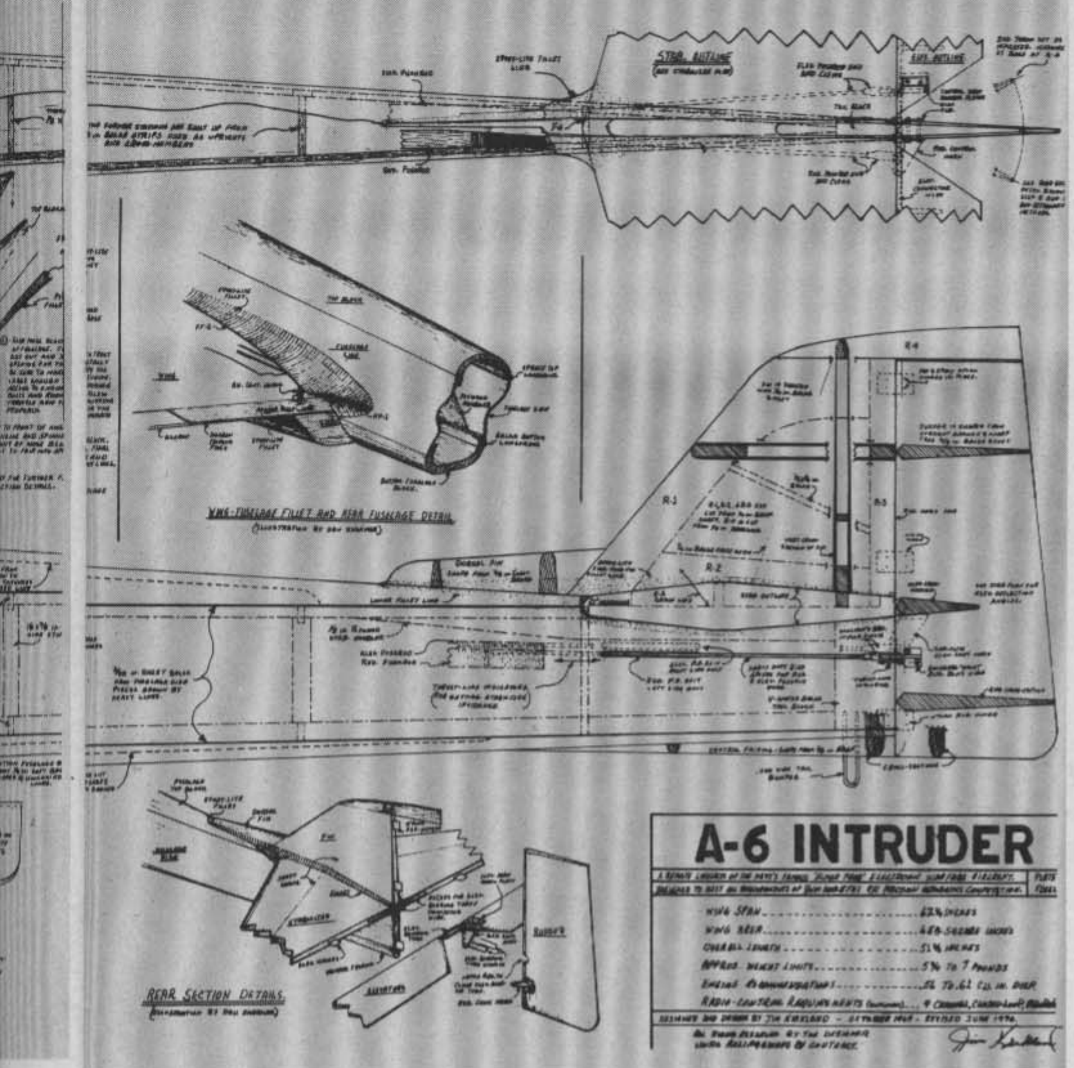
A-6

22.1 OBJECTIVE: To control by radio a model airplane so that various planned maneuvers may be accomplished. The criterion is the quality of performance, not the mechanism of control. RC competition shall be based on the excellence of performance of the model's maneuvers compared to similar maneuvers performed by a full size plane. Maneuvers shall be judged according to the AMA Radio Control Judges Guide.

The above is the lead-off paragraph under Section 22, Radio Control Pattern Event Regulations, of the AMA's

By James 'Jim' Kirkland

Part One of a Two Part series



1970 NATS-MULTI WINNER

Intruder!

official rule book. Essentially unchanged since the birth of official RC competition, this is what it is all about. The reference to a model's performance similarity with that of a 'full-sized plane' has been more or less lost in subsequent years of rule changes and revisions, etc., to the Judges Guide. Today's winning RC competition designs fly with jet-like scale speeds, fly some maneuvers like a full size jet aircraft, and fly some maneuvers that are common to only reciprocating engine, fully aerobatic aircraft. As a result our models must perform in a manner peculiar to both jet and reciprocating engine planes!

The caliber of today's competition is much tougher than it has ever been in the past, with absolute and total perfection in each and every individual maneuver being the goal of every top competitor. With the margin of victory usually measured in fractions of a point, no compromise in model design is possible. Any model design that sacrifices one or two points as a result of design deficiency or compromise is a sure-fire loser in the majority of starts!

The current trend toward perfection is not a new trend. It has been underway for over ten years and growth seems to foster more growth. Year to year progress reaches almost unbelievable proportions in engines, RC equipment and flying skills. This progress towards perfection has led us to a point where latitudes in competitive model design are very restrictive. A tricycle gear is now considered a must; wing areas have stabilized; and after the experience some flyers had with the increased lateral area flap in 1970, it is a fair assumption that lateral area, and distribution, will now be rather stabilized!

The important thing for any would-be RC pattern competitor to realize, is that this stabilization of competitive RC model design parameters resulted from competition and the competitors. Just as in any sport, those who compete are the ones who determine what is necessary to win. The difference between a competitor and an armchair analyst is that the competitor uses the rules as a basis for his reasoning, while the armchair analyst uses the results achieved by competitors as his reasoning basis. The degree of design stability and performance we enjoy in this hobby today has resulted from the persistent model design efforts of the competitors. Those design features that contribute most to winning, resulted from competition experience and the ability to see ahead from the competition standpoint.

The ancestry of the A-6 Intruder rather closely parallels the progress of RC pattern competition over the past eight year period. Its oldest forerunner was the Beachcomber, the 1963 Nats winner, and an exponent of the then newly emerging zero-zero force set-up, using a 15 percent symmetrical wing with a symmetrical stab. Then came the first Citrons which were the fastest pattern models in the mid-60's with a .45 cubic inch engine no less! With the advent of the big .60 engines, and jet-like speeds, came the Triton. It not only moved like a jet but resembled one too! The emphasis now was on how to retain smoothness and maneuver perfection while flying at such high speeds. The Triton won a Nats second and a place on the 1969 FAI team. Many features from the Beachcomber through the Triton are incorporated in the A-6 Intruder design. Perhaps the most significant fact is that not a single *new* design feature appears in the A-6 Intruder. Ten years of experimenting with every variable applicable to this type of model has led me down many roads to what I consider dead ends!

The look-alike feature so prevalent in today's pattern models, is a direct reflection of the standardization reached

Continued on next page

Continuing Model Airplane News policy of presenting the Champions and winners of the really big ones. This is really big and so very complete, it is necessary that we run it in two parts so that our readers receive the full benefit of the total effort by this year's Nats winner. Just to read this article is a benefit!

The 'gutty' innards; Pro-line PLS-lo servos in a Kraft mounting tray. Receiver well protected in foam up front, flat battery pack under former F-4.

A-6 INTRUDER . . . CONTINUED

by the top competitors in their pursuit of design perfection. With design parameters the deciding factor, it is hard to achieve much in the way of a different look. Look-alike paint jobs on two different designs can cause total confusion among the modeling public!

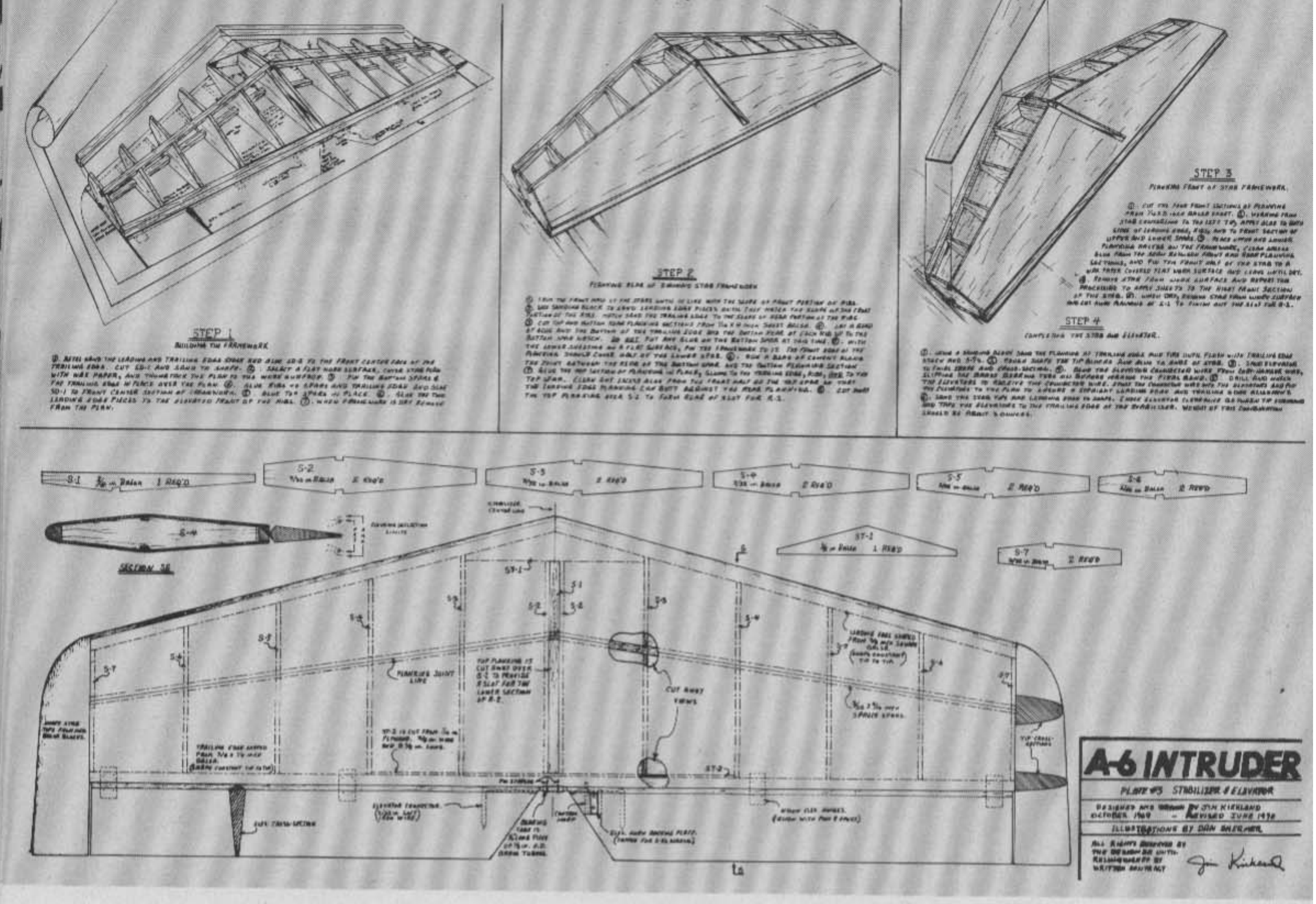
I prefer my designs to resemble an existing full-size aircraft. I try to achieve such an over-all appearance even though the model itself is in no way even semi-scale!

Fifteen years of experimenting with airfoils and planforms has led me to believe that aerodynamic theories applicable to full-size planes have almost no place in model wing design. The scale-effect is so prevalent in a wing with even 750 square inches of area that airflow and reactions are more a result of thickness, high-point location, and leading edge shape, than of a specific curvature of the airfoil. A thick wing will fly slower, have a lower stall speed, but with a substantial loss of effectiveness prior to reaching the actual stall point, and will slow down quickly when power is reduced. A thin wing is fast, reluctant to slow down, and normally has a very sharply defined stall point while remaining very responsive right up to the stall point. A wing of a given thickness, with a rounded and blunt leading edge, will have a lower stall point than the same wing with a sharper leading edge. Also, a wing with a reflex airfoil will have a considerably lower stall point than the same wing without the reflex. Using the 33 percent point as a reference for the high-point location on a given airfoil, that airfoil will stall at a higher speed if the high point is moved further to the rear, and at a lower speed if moved further forward. A tapered wing with a constant airfoil shape will experience tip stall at a higher speed than the stalling speed of the root section due to the increase in scale-effect caused by the smaller tip section. These features of model airfoil reactions are based on symmetrical airfoils, but would probably be mostly applicable to semi-symmetrical shapes also.

While flying airfoils from 13 to 17 percent sections, it became apparent that the 15 percent section was better suited to today's top class of competition. The 17 percent section would have to have an edge in the lower classes of competition, especially in Class A, because of its lower speed. The 13 percent wing is fast and graceful, but needs flaps to achieve any degree of realism in the landing maneuver. If heavily tapered, the 13 percent wing needs a reflex section at the tip in order to control tip stall. Hence the reason for the 15 percent section used on the Intruder.

When the Triton was first designed, early in 1967, the only really accepted way to control tip stall in taper-wing planforms, was to increase the thickness percentage of the tips. The Triton wing made use of a practice long established as the way to prevent tip stalls in the old rudder-only models without having to build in washout. This consisted of gluing triangular stock to the center-section of the wing's leading edge, thereby creating a sharp leading edge in the center of the wing, while the tips retained their rounded leading edge configuration. This method was as effective as wash-out in the rudder-only designs and a heck of a lot easier to control! These rudder-only wings were usually constant chord sections, and the change in leading-edge shape was very effective. It was reasoned that a *constant* leading edge radius in a *taper-wing* planform would have the same effect. Thus the radius of the leading edge of the smaller tip section, while being identical to the radius of the leading edge of the root section, would be blunter and rounder because of the reduced size at the tip section. Just as additional insurance, the tip section was changed to a very slight lifting section. When the Triton wing

FULL SCALE PLANS AVAILABLE (COMPLETE SET) - SEE PAGE 84



was built in this manner the results exceeded expectations, and was as stable as any straight wing that I had ever flown. This wing never displayed *any* tip stalling tendencies! It was only natural to carry this basic wing on to the Intruder design.

There was a change made in the planform to a straight trailing edge, with all taper in the leading edge. This was to allow the drag coefficient of the wing tips to be moved still further behind the center of gravity, thus increasing directional stability. The modified, constant chord strip ailerons were used for two reasons. First, there is no loose play between the servo and the ailerons when this type linkage is used so no flutter or sloppy centering problems. Second, this type of strip presents very little in-board drag during rolls, yet is almost as effective as barn-door types on slow speed landing approaches.

Horizontal stabilizers have bugged me almost as much as wings have, and for almost as long! There is something about the stab's small size that just yells for inattention, especially after working on a wing! The natural tendency is to build it flat and get it over with! However, after many hours of flight evaluation it became obvious that a flat stab just couldn't measure up to a symmetrical section. About all that I can say today about a flat stab is that it is adequate for horsing around!

Subsequent evaluation of various symmetrical stab sections, together with experiences with the flat sections, turned up a key fact: the leading edge shape seems to be as effective as stab thickness, or elevator cross section, in controlling elevator sensitivity. For a given stab section, a rounded leading edge decreases elevator sensitivity around neutral, while a sharper leading edge shape increases sensitivity around neutral. Stabilizer thickness governs the elevator's sensitivity away from the neutral zone, contributes to the tail drag coefficient, and is a factor in determining the *amount* of elevator deflection requirements. The particular curvature of the airfoil did not seem to matter very much!

This determination posed a real dilemma! Why bother to jig-up and build a symmetrical airfoil stab, when the airfoil curvature apparently played so little a part in the overall performance? Well, the flat stab was out because of performance characteristics, and the only real advantage that appeared to result from the use of the airfoiled section was primarily in its thickness. So why not a thick flat stab; but how in heck to streamline such a slab! The result of such frustrations became the diamond stab section used first on the Triton, and further refined for the Intruder.

There is no intention here to claim originality in the use of a diamond stab on the Triton. Ed Kazmirski used a diamond section on the Taurus, and I suspect for the same reason that I finally selected such a section for use on the Triton. No doubt many others have used a diamond stab.

There is a degree of uniqueness in the diamond section used on the Triton and the Intruder. Going inboard from the small tip rib, each succeeding rib is an exact projection of the angles from the preceding rib, and retains the same width at the leading and trailing edges. This feature requires constant width leading and trailing edge pieces (same as a flat stab), and also allows the stab to be built upon a flat work surface in much the same manner as a flat stab. As such, no jig is required during the building process and it is as fully warp resistant as an airfoiled section.

The diamond stab has better flight characteristics than any previous airfoil stab I have used in the past! I do not know why, but the diamond stab *seems* to make a pronounced difference in the

Continued on next page

Not a tail dragger as it would seem with tail skid, this is only for those nose high main gear landings and touch and goes! Note rudder pushrod.

Nose section showing Lee Super Custom .61 engine, slightly recessed Silencaire muffler, homemade nose wheel drag brake & Navy markings.

A-6 INTRUDER. . . CONTINUED

Continued from page 33

way the Triton and Intruder handle just before landing touchdown. It is as if the stab helps tremendously in holding the model off until the last instant, and then holds it just a bit longer! The phenomenon must be experienced to be fully appreciated. In flight, while performing various maneuvers, I can tell no difference between this stab and a symmetrical airfoiled section of the same thickness and with the same leading edge shape.

The amount of lateral area in a model, and its distribution, has never had much discussion outside designer circles until the 1967 and 1969 Internats, especially after the 1969 Internats when reports led the modeling public to believe that a *lot* of lateral area was now a necessity. Suddenly everyone was lateral area conscious! This sudden publicity did not change the lateral area requirements for RC pattern models one iota from what it was before! *If* there was a rule requirement for a ten degree climbing knife edge flight for a ten second time period, *that* would change lateral area requirements. No such rule now exists and, based on the current rules' outlook, such a rule is not likely. After all, what full-scale aircraft can perform such a comparable maneuver?

Lateral area has a direct relationship with how a model reacts to the slipstream created by the propeller. If the center of lateral area is too far in front of, or behind, the center of gravity location, some weird characteristic will be noted in some maneuvers. It is impossible to trim these weird characteristics out of that particular maneuver without having something just as bad show up some place else in a different maneuver! Too much lateral area will only give the pilot ulcers when forced to compete under crosswind conditions! Too little lateral area is hard to get and still mount the engine, tank, and radio in the fuselage!

Ideally, the amount of lateral area will be about that required to house the aforementioned components in the fuselage in the conventional manner. The center of lateral area should be five to ten percent of the fuselage length *behind* the center of gravity, and concentrated as much as possible in this area. Fortunately, this is *not* a hard and fast requirement, or all competition designs would be even more similar in appearance! However, extreme deviations in distribution of lateral area can be most troublesome to the perfectionist flyer. For instance the correct amount of lateral area could be present in a design, but concentrated at the front *and* rear of the fuselage with a corresponding *correct* center of lateral area location. This arrangement can play havoc in crosswinds and in some maneuvers requiring simultaneous rolling and looping actions.. Lateral area that is massed mostly from the center of gravity rearward, causes the rudder to act like ailerons *and* rudder in some attitudes. Lateral area that is massed mostly to either side of the center of drag (usually considered as the wing location) will cause very noticeable dutch-roll characteristics.

The lateral area distribution in the Intruder fuselage and fin layout represents a degree of compromise from the ideal in order to achieve the appearance features of the Navy's A-6 Intruder. The amount of lateral area is enough to perform the required knife-edge in four-point rolls, knife edge flight, and the slow roll. Very little rudder is required in these maneuvers when speed is sufficient. Despite the small compromise, the amount and distribution of lateral area seems to be just about right in the Intruder. Some self-compensation is apparent in crosswind loops, yet the Figure M can be done with repeated success in crosswind conditions from

Continued on page 54

full length is not required) would have to be sent by freight. Further details from: Ronytube, 23 Ivy Road, Newcastle-upon-Tyne, NE6 4PU, England. ■

A-6 Intruder

(Continued from page 34)

either side.

The original Intruder was built to use the KDH retract gear system, however, only a fixed gear installation is shown on the plans. The reason for both actions is quite basic. It was determined that retracts were an evil necessity for top level competition, so the original had retracts. Most builders probably would not want to be bothered by these monstrosities. (I hope). Those that do could select any one of the many different types available (all mount differently) and drawings for one type installation would help only a very few. Besides, if a builder wants retracts he should be able to work them into the basic model as easily as I did; which was not that easy! So if retracts are considered a must, be prepared to add a couple of weeks to the building time. While retracts do add to the performance of the model at the present 'state-of-the-art', they require too much maintenance to be practical for anything less than top level competition. Hopefully, the manufacturers of these units will soon overcome this major deficiency.

The sidewinder engine mount used on the Intruder is canted just slightly upwards. This makes priming through the venturi a bit easier. It also helps the Silencaire muffler to clear the side of the model *if* a long type muffler is used. If the short type Silencaire is used, as on the original, the lower right section of the nose has to be gouged away to half bury the muffler body and pipe. This was the result of an oversight when the original was built and it is a safe bet that this extra work will *not* be necessary on another Intruder! I will use the long Silencaire muffler!

One final word about fuel tank location before beginning construction. The centerline of the fuel tank (a 12 ounce Sullivan slant style) should be located even with, to one-quarter inch below, the level of the venturi's dead center at the fuel jet location. If the engine goes leaner when doing outside loops, lower the tank. If the engine goes richer when doing the outsides, raise the tank. The tank should have foam rubber on either side, top, and bottom to prevent fuel foaming that can result from tank vibration. Adjust the tank level to suit your particular engine.

Pre-flight checkout and flight trim procedures follow construction details. So let's get to cutting balsa!

GENERAL CONSTRUCTION NOTES

At the speeds which dominate today's pattern model performance, it is more vital than ever that accurate building and alignment practices be strictly adhered to. Anything less will only serve up a disappointment. The little extra time needed to achieve perfection, over that required to 'just build', is the difference between the zircon and the diamond!

The A-6 Intruder is relatively simple when compared with other winning designs of the current times. There is a simple jig in which to build the all-balsa wing. Foam templets can be made from the root and tip cross-sections shown on the plans if foam wings happen to be your 'thing'. The diamond stab is built on a flat surface and requires very little more effort than the inferior flat-type stab. The diamond stab will not warp and has characteristics equal to, and even superior to some symmetrical stabs. The fin is a simple balsa covered framework that is highly warp resistant. The fuselage is a rather straight box that gets its shape from the carved top and nose blocks. The Epoxy-Lite fillets serve to blend things together and gives the finished product that 'molded' look.

About the only thing that could be considered difficult about the building process would have to be the balsa block shaping and the fillet work. To ease the task of sanding, shaping, and hollowing out balsa, the following tools are very helpful: a razor plane and a spoke-shave, a large X-Acto handle, a set of gouges, and two or three sharp Y router blades. Make up three sanding blocks from three-quarter inch soft pine shelving materials, two and one-half inches wide and nine and one-eights inches long. Take some #40, #80, and #100 grit garnet paper sheets, cut in half (crosswise), and use six thumb tacks to fasten the half sheets to the three sanding blocks. You will be pleasantly surprised at how fast these blocks can shape a balsa block. Be careful with that #40 coated block! It will not be used very much!

Wing-Jig Layout In laying out and building the temporary wing-jig, it is best to have a carpenter's level and a 36 inch straight edge available. These tools will enable you to overcome any slight irregularities in the work surface on which you plan to build the wing-jig. Accuracy is very important in cutting the wing-jig stations from the balsa sheet. Proceed carefully, with accuracy, and your finished all balsa wing will be second to no model wing ever built! The small amount of time to lay-out and build the wing-jig pays off in a big way for you.

After laying out the reference and station lines on the work surface, glue the WJ-1 pieces together and then to the work surface with one on either side of the center station line. Use the level chordwise across the WJ-1 pieces and shim, front or rear as necessary, to get a level bubble indication. Glue the WJ-6's in place; again use the level and shim as necessary to get the same bubble reading as at the WJ-1 stations.

Glue the remaining wing-jig stations in their proper place on the lay-out, using the 36 inch straight edge as a guide across front and rear station tabs in the following manner. Place station vertically over its proper location on the lay-out and place the straight edge from front tab on WJ-6 to front tab on WJ-1. The front tab on the intermediate station should just touch the straight edge when it is held vertically over its proper location. If not, either trim or shim until it does. Repeat across the rear tabs, correcting level of the intermediate station as described above. When intermediate station has been properly leveled, glue into position. Repeat this procedure for all intermediate jig stations in both wing panel cradles.

Now look down the finished wing-jig from either end. The cradle formed by the individual stations in each panel should appear smooth and consistent with no station breaking the 'consistency' of the cradle. The wing-jig is now both level, true, and ready to build the wing in.

The Wing The construction of the wing is well detailed in the illustrations on the wing plan. It is recommended that a sandable white resin glue, such as Franklin's Tite-Bond or Ambroid's Se-Cur-It, be used to glue the sheet balsa together to make the wing skins. I also use white glue to do all framework gluing between W-6's. For the outboard of W-6's, I use standard Ambroid glue to minimize the weight factor in the wing tips except along the leading edge where sanding must be done after basic construction is finished.

When the wing has been completed to the point shown in Step Five of the wing plan illustrations, shape the ailerons from three-eights inch sheet balsa. Drill hole for the aileron key wire, and cut the groove for the torque rod. Now ailerons can be slipped into place on the torque rod assembly end and taped to the wing trailing edge with masking tape. After a 72 hour curing period the wing, at this stage, should weigh from 14 to 20 ounces, depending on the density of wood used.

F-3A, the fuselage fairing block, and lower fillet sections will be added to the completed wing during the final alignment and assembly process.

The Stabilizer Refer to illustrations on the stabilizer plan to build the diamond stab.

The Fin Build the fin over the plan. Glue R-1, R-2 and R-3 together and glue in the cross-member. Cut the planking on a bias and glue it together. When dry, remove framework from plan and glue sheeting to both sides. Pin to flat surface until dry. Sand the rudder cross-section shape into rear of R-4. When fin is dry, glue R-4 to top of fine pieces R-1 and R-3. Tack glue rudder to R-4 and R-3. When dry, use a sanding block to sand fin and rudder to proper shape. Remove rudder and sand double bevel to leading edge.

The Fuselage Glue the main plywood doubler to the main fuselage sides with contact cement. Do not use a water base contact cement and be sure to make a right and left side as determined by rear push-rod exit hole locations. With doublers glued in place, use white glue to glue the spruce longerons to the top of the fuselage sides. Now glue the balsa longerons to the bottom rear of the fuselage sides. Glue in the plywood stab seat doublers, and the balsa side stiffeners between the top and bottom longeron members as shown on the plan between F-5 and F-6.

A sort of crude, but adequate jig is used to assemble the fuselage sides, formers, bottom sheeting and bottom rear block. Take a piece of flat board about forty-four inches long and at least six inches wide. Draw a straight centerline the length of this board and use the top view of the fuselage plan to mark off former locations perpendicular to this centerline, with the back of former F-2 flush with one square-cut end of the board. The fuselage is built up-side down on this jig board in the following manner:

Tack the top overhang of F-2 to the end of this jig-board, leaving clearance for the top longerons between the top of the board and bottom of the longeron notches in F-2. Use small spots of Ambroid to cement and glue the remaining formers to this jig board at their proper locations. Be sure each former is vertical over its location. Include the servo rails, the crossmember on F-5, and the balsa crossmembers at the two stations between F-5 and F-6.

Glue the fuselage sides to F-2, applying glue to only the lower half of F-2 (upper half as it is during this inverted build-up period) and be sure that the rear of each fuselage side is in contact with the surface of the jig board. Use epoxy on this joint. The new five minute epoxy glues by Hobbypoxy and Dev-con are excellent adhesives and will speed up the building time considerably. When the joint at F-2 has thoroughly set-up, glue the sides to the lower sections of F-3, F-4, F-5, and F-6. Glue F-5A in place. Mark the location of the servo rails and balsa cross members on the top longerons but do not glue them in place yet. Glue the V-shaped balsa tail block in place.

Cut the rear bottom fuselage block from one-half inch sheet balsa, rough shape it, hollow to outline shown on side view of plans and glue in place to rear of fuselage. Add the one-quarter inch sheet balsa lower nose doubler between F-2 and F-3. Glue the triangular stock to the lower side of these doublers. Fasten the Top Flite nose gear mounting brackets and standoffs to F-2. Glue the one-quarter inch sheet balsa to bottom of fuselage between F-2 and F-3. Sand flat across bottom of the rear fuselage block until its shape is the same as shown on side view of the plan. Glue the balsa ventral fairing to the rear of the bottom fuselage block. Let this assembly thoroughly dry.

Pull tacks from that part of F-2 that overhangs the jig-board, and use a pocket knife blade to pop the spot-glued formers from the jig-board. With fuselage structure and jig-board separated, glue the fuselage sides to the upper portions of F-2, F-3, F-5, and F-6. Use a toothpick to wedge glue down into crevice as fuselage sides are pulled slightly away from these former stations. Glue the servo rails and balsa cross members in place. Glue the vertical triangular stock in place behind the upper section of F-2.

Follow the steps illustrated on the fuselage plan to shape, hollow, and attach the top fuselage block and the nose blocks. Cut the wing-fuselage fairing block to outline shape, but to fit between *F-3* and F-5B. Tack glue in place between these formers, with F-5B tack glued to F-5A. When dry, sand the bottom of the fuselage to shape (flat with rounded corners at the front between F-2 and F-3 to a near semi-circular shape just in front of the ventral fairing). Remove the wing fuselage fairing block from the fuselage proper, remove F-5B from the block, and hollow to approximately three-sixteenth inch wall thickness. Glue F-5B back in place. Glue the hardwood wing-bolt anchor-block in place between the fuselage sides and against F-5 with white glue. ■

To be continued next month

Round and Round