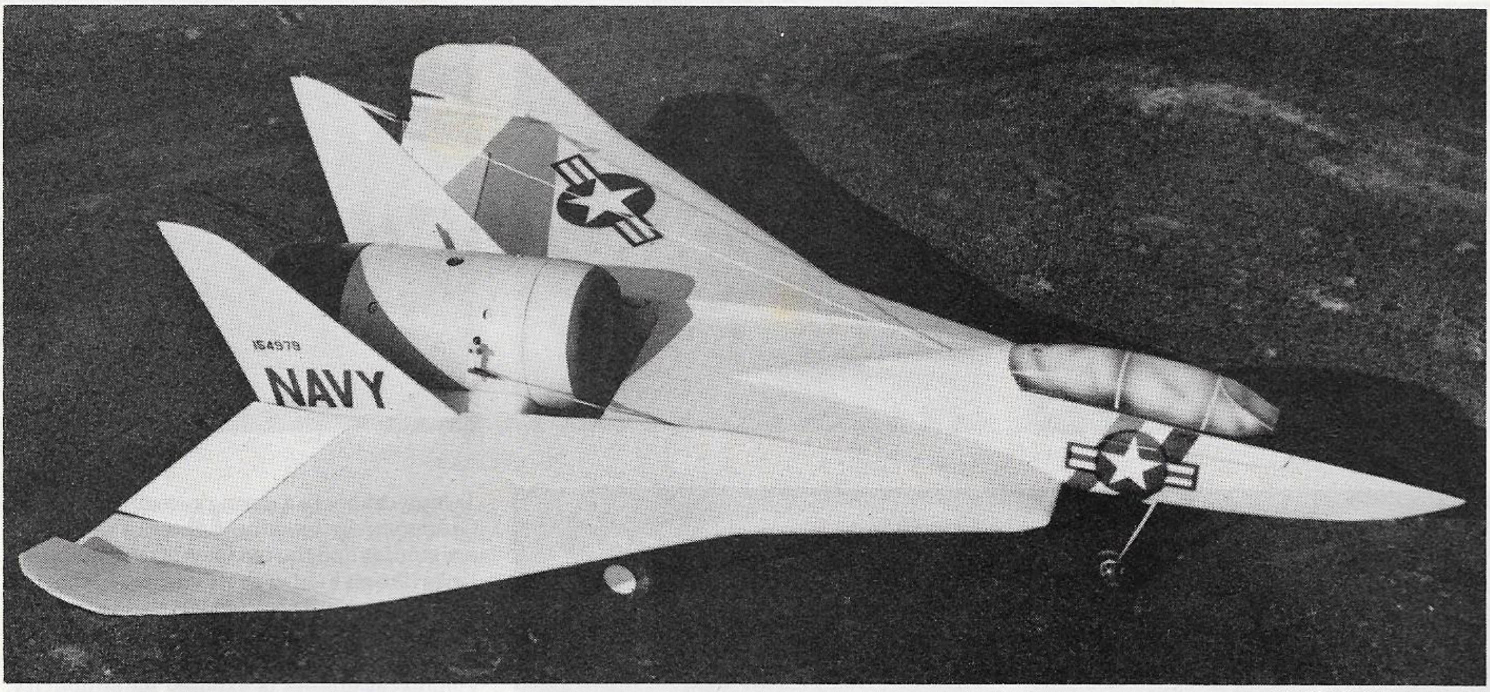


PHOTOGRAPHY: BOB ABERLE

Tommycat

Inspired by the F-14 Tomcat by Grumman and designed by Bob Kress, this ship is distinctly different in looks and performance. It uses the all new Axiflow RK-20B ducted fan and K&B 3.5cc engine/**Ron Farkas**

The Tommycat is the outcome of an attempt to combine the best of the aerodynamics of its big brother, the Grumman F-14 Tomcat, with a near-optimum, yet simple, ducted fan installation.

I had the good fortune to serve as the F-14 Engineering Manager from its design inception until its first introduction into U.S. Navy operations. In addition to having the sophisticated long range Phoenix missile system and Mach 2.4 speed, it is probably the best maneuvering dogfighter amongst today's crop of high performance aircraft due to its "swing wing". The fine maneuvering aerodynamics of the F-14 make it an attractive model for scale. On the other hand, it is structurally complicated and has difficult lines to model plus the complexity of the variable sweep wing. In spite of the foregoing, I know of at least one 1/10 scale project underway using two customized (slimmed down outer shell) RK-40 Axiflo fans. Simplification then was the keynote.

My first objective was to simplify the F-14 structure, lines and controls but retain its good aerodynamics. The key to the solution was to do away with the twin engine nacelles yet retain the aerodynamic top view, which is the major factor in the F-14's good maneuvering performance. The swing wing was fixed in its most stable 55 degree leading edge sweep, allowing a rather far aft c.g. to be used with safety. The wing tips were further extended to allow an even more aft c.g. with the added advantage of increased aspect ratio. The 55 degree sweep is also a good compromise between too high a leading edge sweep angle (max is 68 degrees on the F-14), which interfers with induced drag (too low an aspect ratio due to low span) and leads to too hot landings vs. a lower sweep which results in more high end drag due to a thicker wing section. The Tommycat wing sections which result are a thin 8 percent.

The horizontal stabilizer was then moved up to the wing plane and joined to the wing by filling in the remaining wing-tail gap, thus forming a modified delta-elevon configuration. The filled-in wing-tail gap does not significantly affect the aerodynamics. The wing tip is twisted 5 degrees leading edge down, just like the full scale article. The ventrals were somewhat enlarged in area for increased directional stability and modified to perform the dual functions of fins and skegs to prevent the tailpipe from hitting the ground. Stripped off the original nacelles, the model is about as clean as you can get and is capable of high maximum speeds. The bent-up wing tips were a final adjustment to yield positive spiral stability at high speeds.

From a propulsion point of view, a podded installation is best, having the best inlet and the shortest internal duct. Recognizing that the resulting delta-like F-14 is quite thin in the aft center area, it was possible to cut away a part of the wing and replace it with the ducted fan, which still acts as a sort of "ring-wing" lifting surface. The airfoil sections forward of the fan were then streamlined to that no separated flow would then enter the fan.

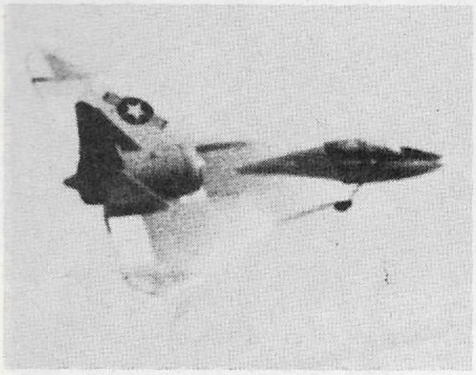
You might think that the fan would be swallowing "bad air" off the fuselage/wing in front of it and thus suffer performance losses. True, it swallows bad air, but with the highly streamlined body and airfoils, it is only a thin boundary layer. The momentum losses of this boundary layer are accounted as model drag. The layer passes through the fan without upsetting the fan airflow and thrust. Only at high angles of attack at or beyond stall do gross airflow disturbances enter the fan, but in that regime, you don't really care about thrust loss.

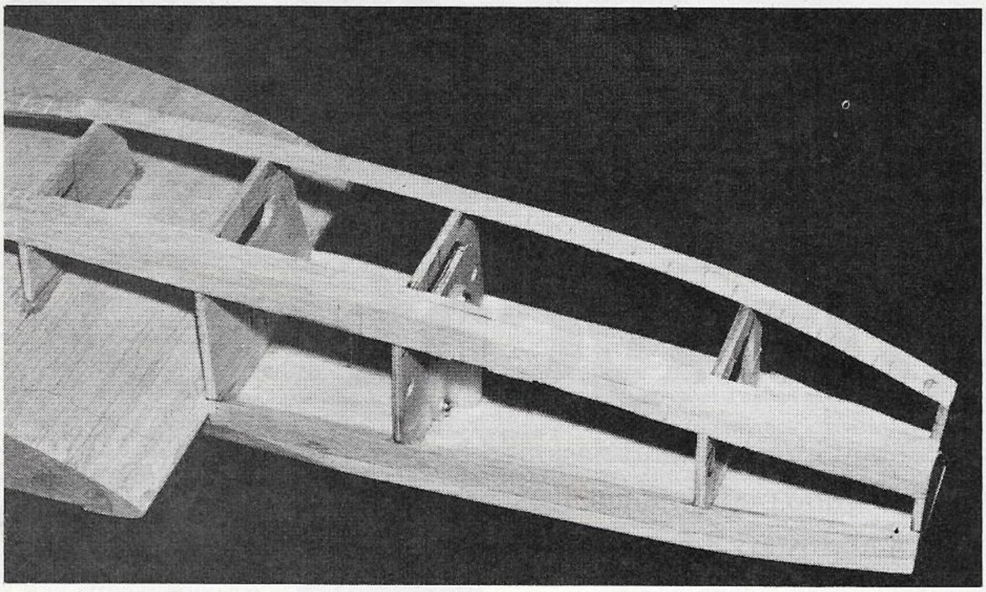
With a flight weight of 5 lb. and 4 lb. of thrust from a standard (no pipe or pressure) K&B 3.5 cc on 25 percent Nitro, the available thrust-to-weight ratio is high at .8 to 1. Furthermore, the thrust does not fall off as fast with speed as a prop, so high end performance is hot.

The only thing different about the Tommycat is the landing attitude which is a bit nose high, typical of deltas. But its flying qualities, like its forebear, are excellent at these attitudes so you can "drag it in" with confidence. With 430 square inches of wing area (excluding the duct), the landing speed is quite moderate at the 5 lb. flight weight.

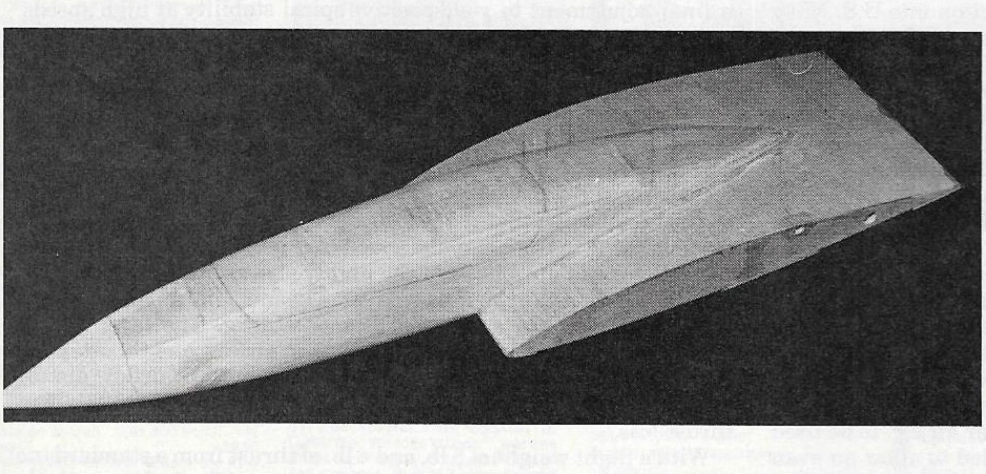
We did not use retracts on the prototype, but with such clean basic aircraft, the high end performance gain due to their use should be very dramatic—ROBERT W. KRESS.

Tommycat





The series of photos across the top of the page seem to suggest "official" type Air Force flight shots. The fuselage structure being built upon the center section (**above**). Note that the nose-wheel bearing is already installed on F-3. Triangle stock gets many shallow sawcuts to prevent it from breaking. Completed fuselage and center section after sanding to shape (**below**).



The Tommycat is the most unique airplane that I have ever built. The combination of the delta wing design and a ducted fan powerplant surely sets it apart from the rest of the crowd. While ducted fans are not yet commonplace at the flying field, the technology is here today to enable the sport flyer to try this new and exciting method of propulsion.

For the past year or so, Midwest Products Co. has marketed two sizes of ducted fan kits called the Axiflo RK-40 and RK-049. The Tommycat is designed to use the new all injection-molded RK-20B which should be available by the time you read this. The designer of the Axiflo fan unit is Mr. Bob Kress, a noted aeronautical engineer and model builder. Bob and I both work for Grumman and our common interest in model aviation brought us together for this project.

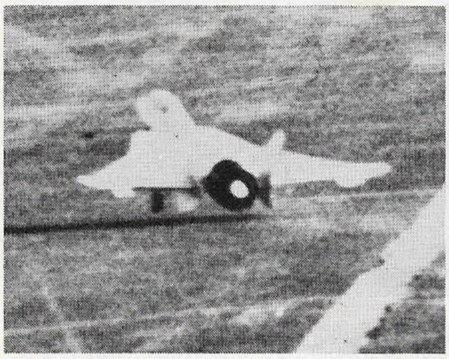
Bob also spent several years as the F-14 Engineering Manager so naturally the Tommycat bears a strong resemblence to the Grumman swing-wing fighter. The profiles are similar and the top view of the Tommycat looks like an F-14 with its wing swept back to an intermediate position. Of course the F-14 is not a delta wing configuration but its stabilators work like a delta's elevons. The Tommycat engine is exposed for simplicity, good inlet performance and ease of maintenance.

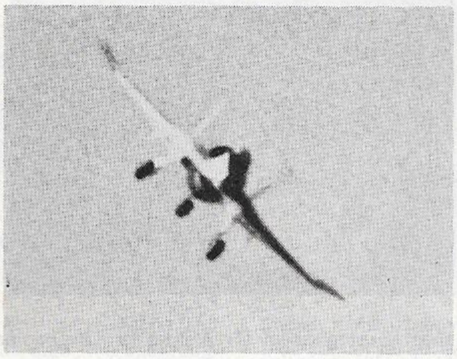
Bob performed all the design work, balancing the factors of configuration, flight characteristics and ducted fan installation. When he was satisfied that the design met his goals he provided me with full-size drawings in enough detail that I could start building. My task was to do the building and test flying. As it turned out, several design modifications were required during the flight test program and it was Nick Ziroli who performed the first completely successful flights. Later I resumed the flying chores and have done enough flying to indicate that the Tommycat can be handled by most competent pilots.

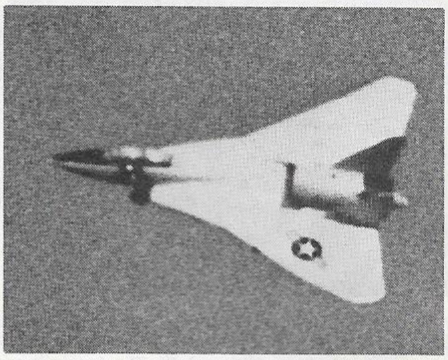
The Tommycat is best suited to pilots whose skills and reflexes are tuned to high performance aircraft. It is quite fast and maneuverable, so flying it is a full time job. Also orientation can be a problem since a delta does not give the same visual cues as a conventional planform. I solved this problem to a large extent by painting the wing tips with day-glow orange on top and black on the bottom.

During the flight testing we varied the wing tips, fins, ventral fins, center of gravity and control system until we could get successful and predictable flights. The final configuration is shown on the plans, but some of the construction photos show the original version. So, follow the plans and the text and use the photos only as a guide. Please don't make any planform changes unless you really want to do your own experimenting.

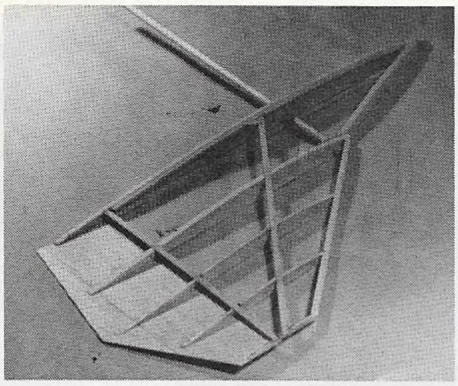
Before you start building it is necessary to decide upon your control linkages. There are three common ways to mix elevator and aileron functions to obtain elevon control. You can mix them mechanically via a sliding servo tray, which we did not try. You can use one of several mechanical mixing devices which installs between the servos and the pushrods. This was my first choice so I mounted the mixer in the center section and installed flexible cable pushrods in the wings. The nose gear was operated from the aileron servo output arm. Unfortunately the sum of all the mechanical looseness made the

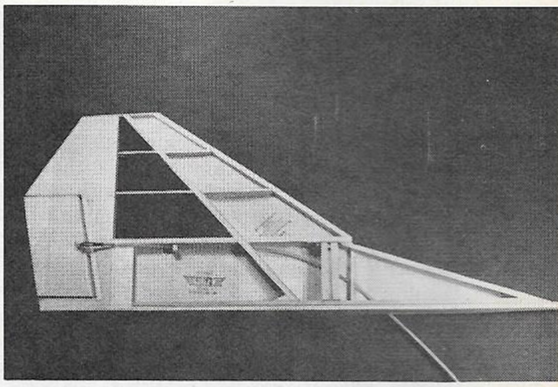




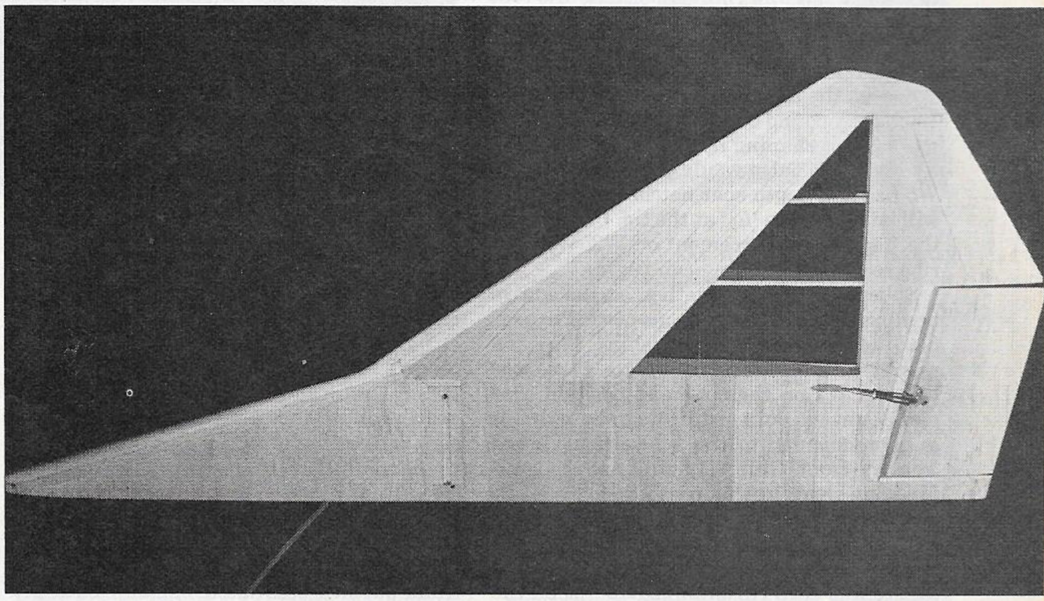


control pretty imprecise and the Tommycat proved to be rather sensitive to sloppy controls. The final control system that I tried was electronic mixing (Christy Mixer) utilizing a separate servo in each wing with a solid pushrod back to the horn. The nose gear was then operated by its own servo. This gave by far the most precise control and, in fact, cured some problems that had bothered us all through the testing. I still believe that a good tight mechanical setup is acceptable, and a lot cheaper. Choose a sturdy mixer unit and route your flexible pushrods as straight as possible.





Basic wing structure prior to sheeting (**above left**). Tube placed through ribs helps maintain alignment. Underside of wing before being completely sheeted (**above right**). Flex cable pushrod can be seen, along with several attachment points. Top of wing after all sheeting is installed (**below**).

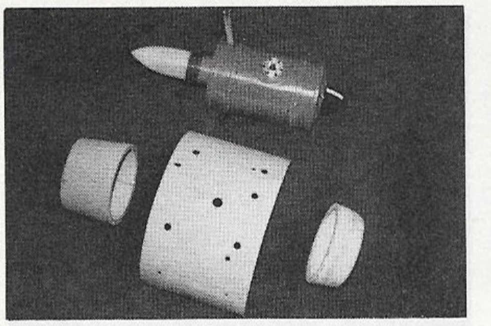


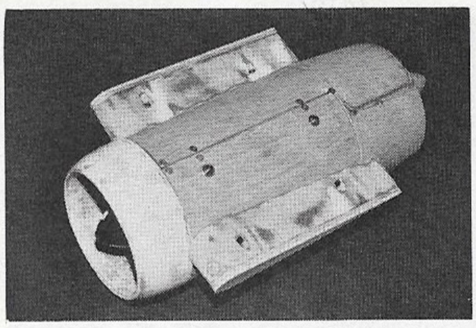
Construction

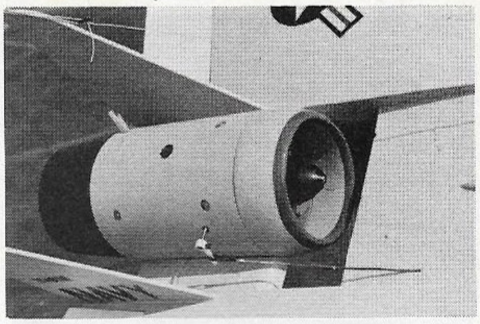
The construction is not difficult but some things must be done in the proper order to avoid problems later. Therefore the construction sequence is quite detailed. Note that some of the photos will show a slightly different structure since modifications were made between successive flights or during repairs.

The center section should be built first since the fuselage will be built upon it. The center section ties the whole aircraft together so it must be built strong. The beefy ribs and the tubular spar are the key to its strength. The spar used on the original Tommycat was a piece of 3/8" titanium tubing. If you must use something else at least don't go any smaller than 3/8" diameter. The titanium tubing can be ordered from Kress Technology Inc. (more on this later). Cut four C1 ribs from 3/16" hard balsa and two C2 ribs from 1/8" plywood. Laminate C2 to C1 and add the 1/16" plywood scabs, observing left and right hand parts. Lay bottom 1/8" by 1/4" spruce spar over plan and pin down with crossed pins to avoid splitting it. Slide the ribs onto the tube and position on the spar over the plan. Block up ribs so that the trailing edge is 5/8" above the workbench. Glue ribs to lower spar and glue the upper spar in place. Do not glue the tube to the ribs now, since that is one of the very last things to do. Glue the 1/2" square leading edge in place and carve to shape. Sheet the top using 1/16" ply from the spar to the leading edge and balsa from the spar back to the trailing edge. Remove from the board and add the trailing edge filler pieces. If you are going to mount a mechanical mixer then install the false ribs C3 and the plywood plate. Before sheeting the bottom make the necessary holes in the ribs for the pushrods. For now only sheet the forward section of the bottom. The rest won't be covered until the wings are installed and the tube is secured to the center section ribs. Sand the leading edge to its final contour.

The fuselage is assembled on the center section. Cut out all formers and draw centerlines on them. F3 is 1/8" ply and the rest are 1/8" balsa. Install the nosegear bearing on F3. Draw centerlines on the 1/4" balsa fuselage bottom and the center section. Place the center section on the plan and block up the trailing edge 5/8". Carve and sand the concave portion of the fuselage bottom until it fits well against the center section, then epoxy it in place. The formers can now be glued in their respective places. F3 can be shifted a bit to accommodate the size of your servos. Glue the lower 1/2" triangle stock in place. Make enough shallow sawcuts in the upper pieces to prevent breakage and glue them in place. Block sand the triangle stock flush with the formers. Saw through F3 along the hatch parting line. Contact cement doublers to

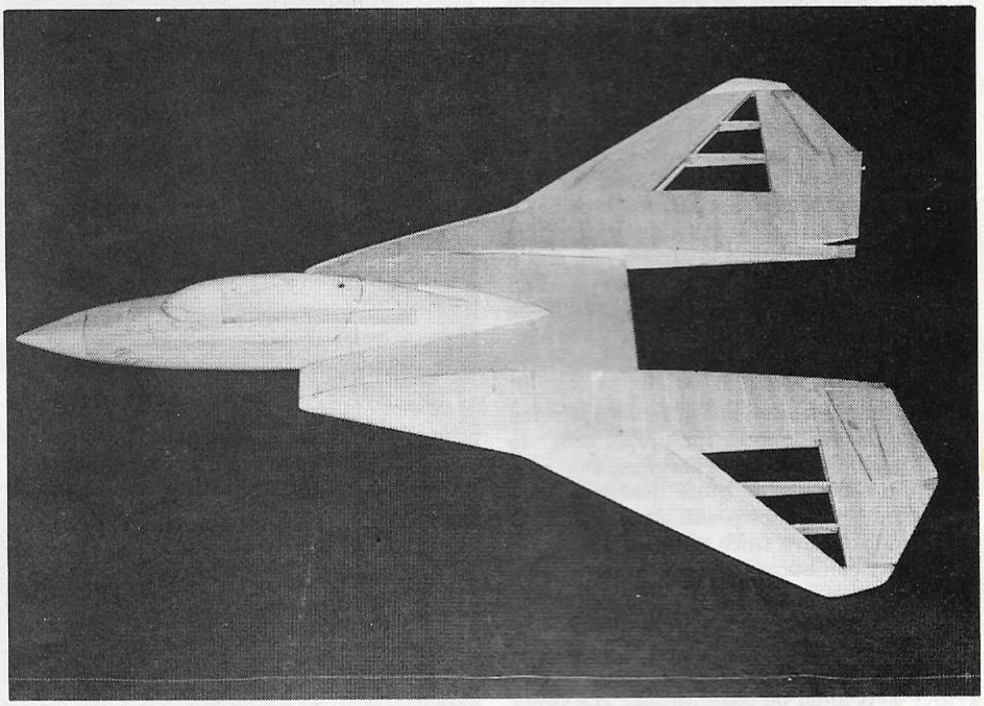






The Midwest RK-20 Ducted Fan unit and the plywood sheet housing assembly are shown here (**above left**). The fan unit assembled to it's mounting pylons and ready for assembly to airframe (**above center**).

A close up of the ducted fan unit showing the throttle linkage (**above right**). The assembled airframe without the ducted fan assembly is shown here (**below**). Note the hatch separation line through the canopy.



their respective fuselage sides and install sides using lots of clamps, tape or rubber bands. Square up the top with a sanding block and glue the sheeting on crossgrain. Now carve and sand to achieve the proper cross sections. The canopy can either be carved from a block or built up in the same manner as the fuselage. After shaping the canopy you can slice the hatch away. Remove the center section sheeting in the mixer area. Mount the mixer and pushrod sleeves now, leaving plenty of excess to be routed through the wings during final assembly.

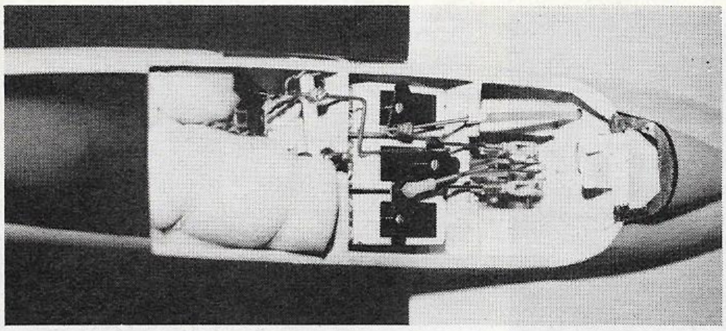
The wing is built on a flat surface using a wedge at the tip to provide built-in washout of five degrees. Cut out all ribs, noting that W1 and W1A do not have spur notches. When laminating W1 to W1A use epoxy and be sure to make a left and right side. Since the root rib takes all the bending loads it is beefed up with 3/16" sq. hardwood caps, installed on the plywood side and flush with the edges. Before sheeting, the top must be beveled to account for the compound curve, and it is eaiser to do most of this shaping now. Use ⅛" ply for the tip rib W5 as balsa would probably crumble. W5 has half depth spar notches so the spars will be tapered to 1/16" at the tip. Don't forget the 1/16" ply reinforcement on W2. With all ribs ready the building can begin.

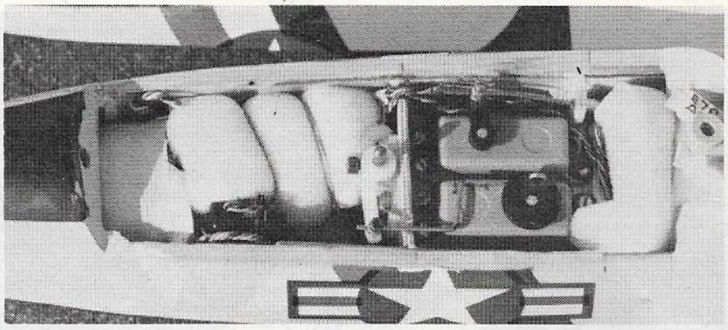
Splice 1/16" sheet together so the entire trailing edge can be cut in one piece. Pin over plan without the washout shim. Glue the rear ¼" x ⅛" spruce spar in place. Place ribs W1 and W2 on the tube and position over plan. Cant W1 outward 2½ degrees so that it is perpendicular to the tube when viewed from the front. Glue W1 and W2 to the trailing edge sheet in this position, followed by the remaining ribs. Do not glue the tube to the ribs yet. Remove the assembly and pin it down with the washout wedge in place and the front of each rib shimmed up 1/16" off the board. Make sure that the tube is still perpendicular to W1 from the front and above. The leading edge still be made from three laminates, the first one now and the other two after all sheeting is in place. Glue the two piece ¼" balsa leading edge spar, paying particular attention to the fit at rib W2. Glue both top spars in place. The forward one has a gusset at the root rib. Sand the leading edge to rib contour and apply sheet only between W2 and W5 with grain following the spar. Chamfer trailing edge sheet to give a 1/16" seam and glue in place. Sheet the remaining area between W1 and W2 with the grain at right angle to the ribs.

Remove the panel from the board so you can work on the bottom. At this point the structure will hold its shape without being pinned. Add the forward bottom spar and the vertical grain shear webs. Epoxy the landing gear block in place after trimming as necessary to clear the tube. Trial fit the wing onto the center section to insure that the pushrod sleeve can be routed to the elevon location. If you have chosen to use electronic mixing then make provision for a servo to be mounted on its side just aft of the tube and frame out an access hatch. I installed a ⅛" ply plate in the wing and used a side-mount servo tray. Now sheet the remaining areas of the bottom as you did the top. Square up the leading edge and glue on the last two ¼" laminations. Sand to proper airfoil shape. Slice out the elevon, trim and cap all exposed edges, and hinge with three hinges. Cut the wing tip from ⅜" soft balsa and sand to match the airfoil at W5. Glue on at a 12 degree angle. Cut out the trim tab and glue it back with the trailing edge raised 11 degree. Assemble the other panel in the same fashion.

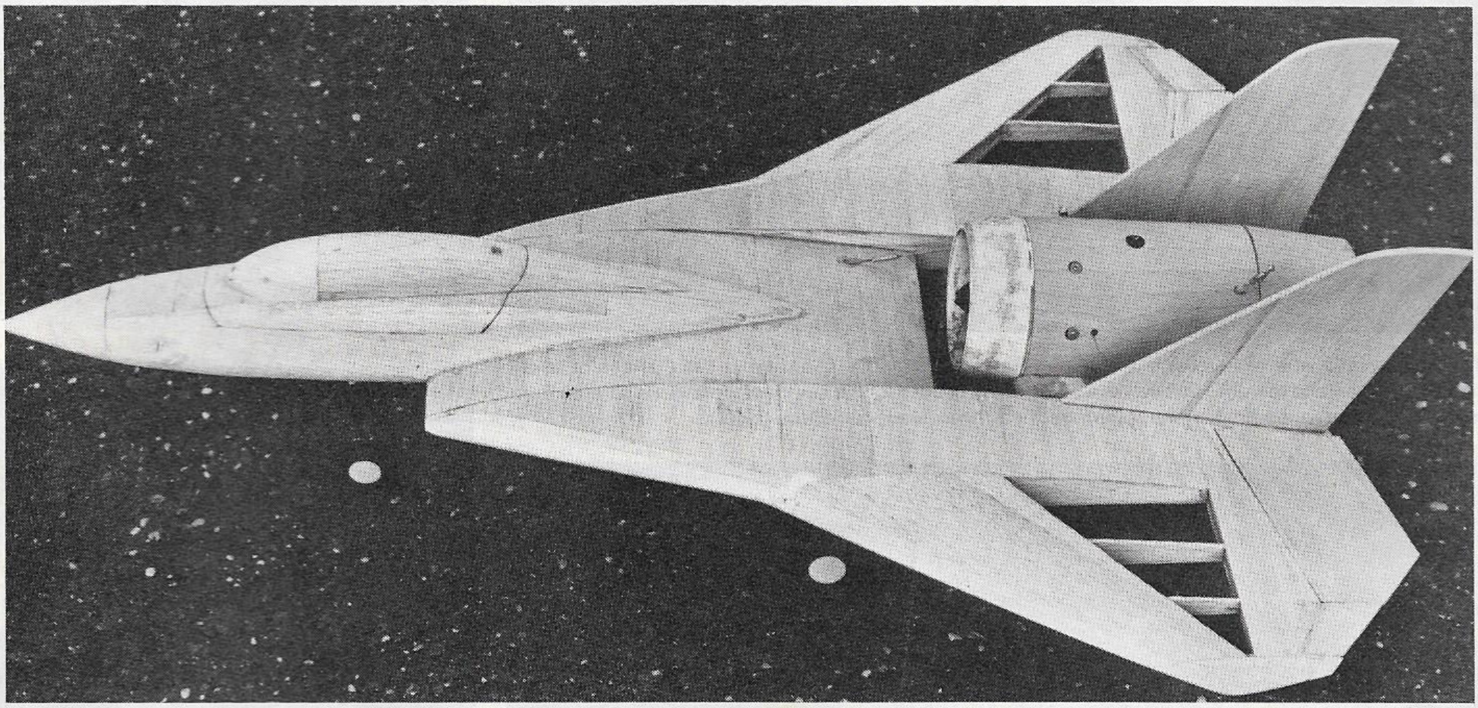
Slip the tube through the center section and trial fit the wings. When viewed from the front each wing panel should have 2½ degrees of dihedral, and W1 should fit tight against C1. Remove the wings and plug each end of the tube with about an inch of dowel. Epoxy the tube into one wing panel. Now slide that panel into place and epoxy to the center section. When cured, mount the other wing panel. Install the throttle sleeve so that it exits the top of the center section and a little outboard of the duct location. Glue in shear webs and sheet the rest of the center section. Drill through the landing gear blocks and the tube. All gear legs are 5/32" music wire. The nose gear was made extra long on top so the steering arm could be mounted above the bearing. Cut fins and subfins from 3/16" balsa and install at a 15 degree outboard angle. The airframe is now done except for mounting the duct.

I used one of the prototype Axiflo RK-20B units which was assembled (by Bob Kress) from plywood rings and shell with molded stators, like its predecessors the RK-40 and RK-049. The production RK-20B that you will buy is entirely molded and has the stators built-in. For more information see Bob Aberle's RK-20B review in the June 1979 issue of Flying Models. The fan unit





The first radio installation, employing an Ace flight pack and a mechanical control mixer (**above left**). Only three channels used here. The final radio installation, employing a Kraft flight pack and Christy electronic mixer (mostly hidden) (**above right**). Full 4 channels used. The aircraft fully assembled but not yet covered (**below**). Due to final developmental changes some changes have been made to the plans.



comes with a comprehensive set of instructions and plans showing typical mounting and throttle hook-up. The K & B 3.5 cc model aircraft motor is the ideal powerplant for this unit.

A molded foam inlet is attached to the front of the duct and a rolled 1/64" plywood tailcone is attached to the aft end. A skin of 1/32" ply gets wrapped around the duct and fastened with small wood screws along the seam. The inlet and tailcone are necessary to achieve optimum performance and the skin is for streamlining and appearance. A set of four hardwood blocks must be epoxied to the root ribs and contoured to the duct at the attachment points. The duct is then screwed down to the blocks with machine screws and blind nuts. The blocks should be faired into pylons using scrap balsa and 1/64" ply skin. The molded inlet and a pair of ready-made pylons (and the titanium tube) can be ordered from Kress Technology Inc., 27 Mill Rd., Lloyd Harbor, New York 11743. To form the tailcone cut a ring of 1/8" ply and roll the 1/64" ply inner shell to fit inside. Then wrap the whole assembly with the outer shell and trim. The throttle arm was extended outside of the duct and actuated via a 1/2A size steering arm, as shown on the RK-20B plans.

Finishing

The wings were covered with silk and all other wood surfaces covered with silkspan. Nitrate dope was used to fill the weave. Final color coats were Perfect polyurethane military flats. Their Japanese Grey PC-36 is a good approximation to U.S. Navy Gull Grey. The underside is flat white with a fogged line separating the colors. Decals are by Midwest Products Co., sheet number 130. The canopy was sprayed to simulate the glass areas using Howie Applegate's technique in Sept. 1978 FLYING MODELS. For increased visibility Testors fluorescent orange No. 1273 was sprayed on the wing tips, followed by clear polyurethane for fuelproofing.

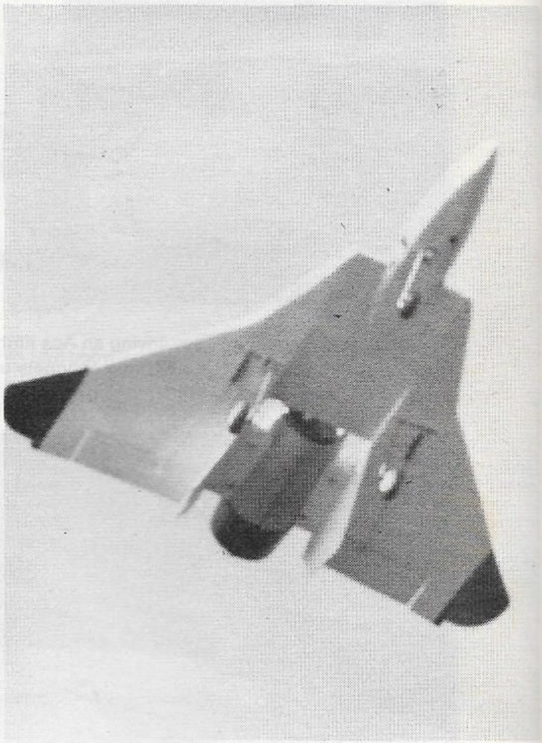
Radio installation

The original control system used an Ace airborne pack with three Bantam servos abreast in the fuselage. Aileron and elevator servos were connected to an Airtronics Vector Director mixer. The receiver was between F2 and F3 and the battery was ahead of F2. If you choose this setup then look for a more husky mixer to insure positive control. The Du-Bro mixer looks like it may be a good choice. The second control system used a Kraft airborne pack with KPS-14 servos. There was an elevon servo in each wing, with throttle and steering servos in the fuselage. Electronic mixing was done by a Christy Mixer located where the mechanical mixer had been. Servo extension cables were used and are best left in the airplane whenever the radio is removed.

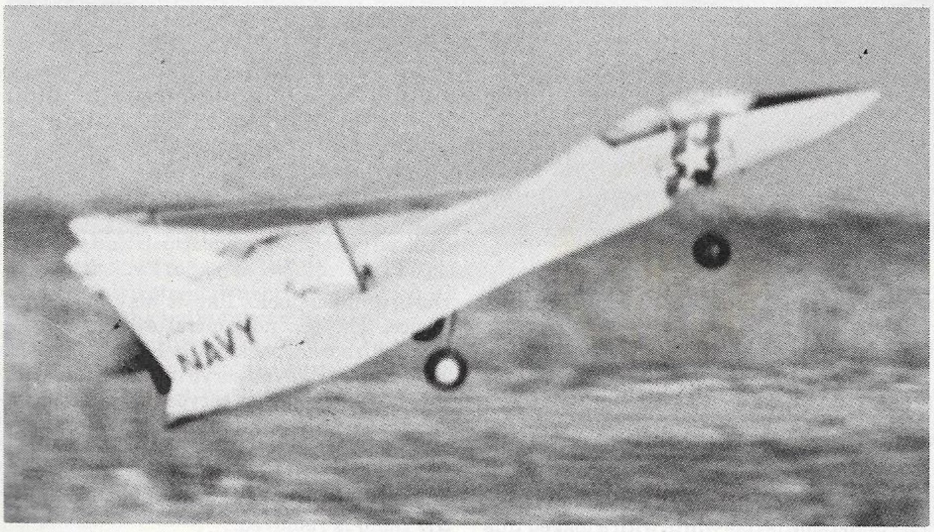
Set the neutral position such that the trailing edge of the elevon lines up with the trailing edge of the outboard portion of the wing. The best combination of throws has been one inch of elevator each way and 3/8" of aileron in each direction. Using a mechanical mixer you can arrive at the correct combination of control arm lengths to give this ratio. Using the Christy Mixer requires changing some resistor values to get a ratio of 70 percent elevator to 30 percent aileron. If you have a super duper transmitter than use your built-in adjustments. In any case don't fly with more aileron than elevator.

Balance the Tommycat 1/2" behind the center of the tube without fuel. As it turned out this is where mine balances without any additional ballast. Total weight has not

Tommycat



The Tommycat is shown here with it's builder, Ron Farkas (**above**). Tommycat has the look of a real fighter in the air (**above right**). Deltas take a little getting used to for the new pilot (**below**). Be careful! Here is the Tommycat in it's final configuration on the runway ready for action (**right**).



proved to be a problem. After modifications and repairs it weighs 5¼ pounds. This is more than you would expect for a model of this size, and a lot more than you would hang a .21 size tractor engine on. Yet the Tommycat carries this weight easily and the Axiflo fan provides startling performance. You can probably keep the weight to under 5 pounds with no trouble.

Flying

The Tommycat is fast, about like a Quickie racer. You can make gentle turns or haul it around as tightly as you could ask for. Roll control is very quick and precise, yet it is stable enough to fly the length of the field with just a few control inputs along the way. It has been looped and rolled but elevon control does not really permit a wide variety of aerobatics to be accomplished. Because of its speed, responsiveness and different appearance it requires your full attention while flying.

Take-offs and landings are a bit different too. The Tommycat accelerates rapidly but will stay firmly on the ground until you use the elevator. After a hundred feet or so start pulling back on the stick and the nose wheel will lift off. A little more elevator will increase the angle of attack and the plane will begin to climb out. Landings are made with the nose held quite high while controlling the rate of decent with the throttle. Sink rate is rather high with the throttle cut back so keep the power up until you are over the runway. Hold this attitude, reducing power gradually, and set it down on the main gear. In case of a dead-stick landing keep the nose down until about a hundred feet from the field. Then pull the nose up to kill off speed. A steep decent at high angle of attack will not cause a tip stall. Try to avoid hot landing approaches because the quick roll response could get you into trouble.

If you regularly fly with ailerons and feel comfortable with a fast airplane then the Tommycat will not give you any problems. It is very rewarding to fly something so out of the ordinary, and this ship is guaranteed to attract attention at the field. Good luck with your Tommycat.