Dr. Lee Taylor's

1964 Nationals Winning Helicopter:

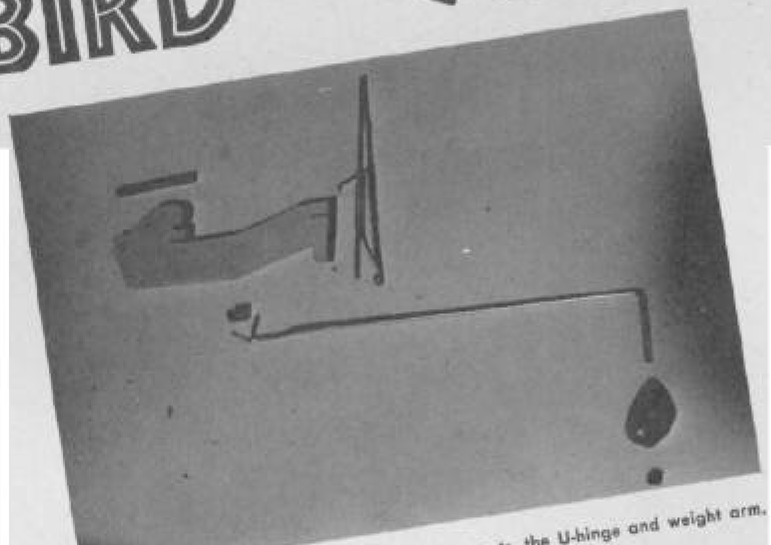
"WHIRL-BIRD" 'COPTER

When I received my first helicopter kit as a gift, my only intention was to use the balsa wood to repair my ukie stunt model in case of a prang. Fortunately the stunt model didn't crack-up, and out of boredom I decided to build the helicopter. Fortunate it was! I have enjoyed modeling more since I began building helicopters. I have found them, intriguing, challenging, different than what everyone else is building, surprisingly inexpensive and just plain fun. Discover a new dimension — try "Whirl-Bird" and see for yourself how much fun 'copters can be to build and fly.

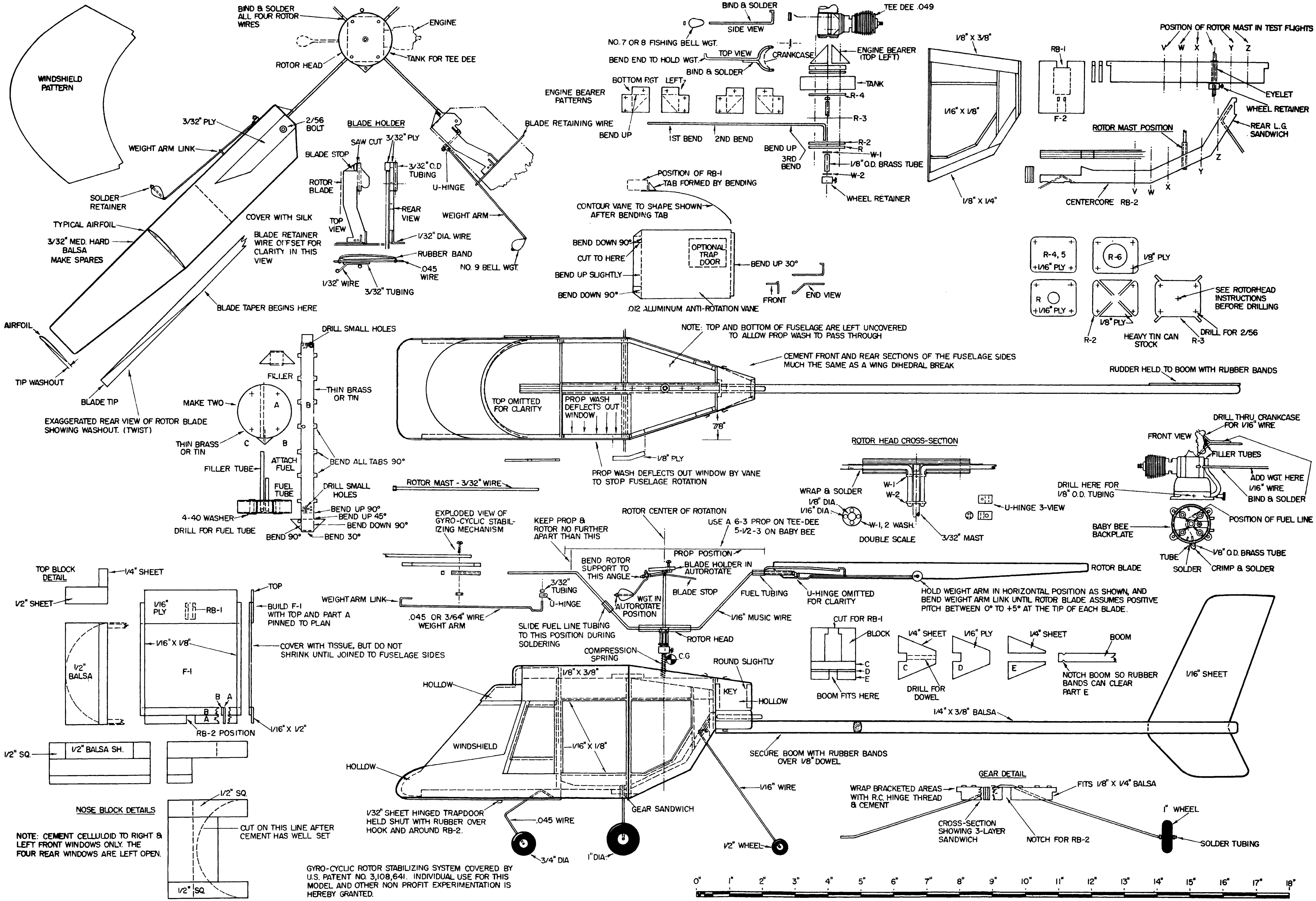
I endeavor to design scale-like fuselages for my 'copters because there is nothing prettier in the air than a model helicopter that looks and flies like a real prototype. "Whirl-Bird," as flown at the 1964 Nats, was the result of a gradual design evolution rather than a completely new design. The original intention when designing "Whirl-Bird" was twofold: (1) to improve general stability and reduce weight over my 1963 design, the "Huskie Pup III"; (2) to attempt to design a fuselage that would fly both forward and backward.

Reasonably good forward flight has been achieved with Huskie Pup III and quite accidentally a semi-scale model of the Hughes "269-A" helicopter does only one thing well, and that's to fly backwards.

First flights with the "Whirl-Bird" prototype fuselage were disappointing in that the 'copter was neither as smooth in the air as the Huskie, nor would it fly backwards. Continued fly flying resulted in a crack-up which was easier to repair by altering the fuselage design in a manner which had



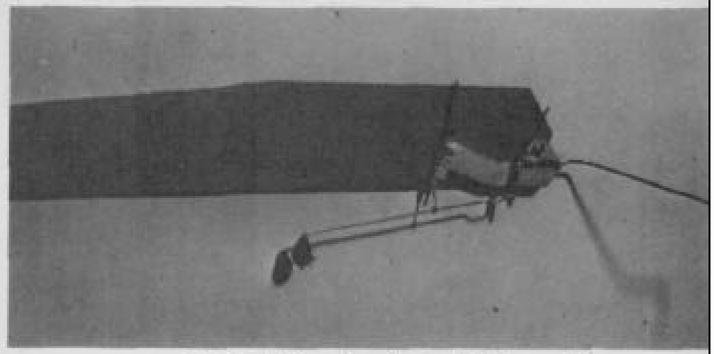
Blade holder parts, the U-hinge and weight arm.



D.J.M

"WHIRL-BIRD" DESIGNED BY D. LEE TAYLOR, O.D.

A close-up shows vane position, trap door open.



A typical bottom view of rotor blade assembly.

"Huskie Pup", 3rd '62 Nats. Baby Bee power.

The lift-off. Hold till rotor is up to speed.

... continued ...

"WHIRL-BIRD"

been previously contemplated. One of these changes resulted in closer juxtaposition of the vane and the front section of the fuselage, making the vane more efficient.

Test flights proved a pleasant surprise. Not only did "Whirl-Bird" now fly a bit smoother than the Huskie Pup III but become my first helicopter design to fly forward in right hand circles instead of the customary left hand circle. The full potential of this right hand circle did not immediately strike me. Just prior to leaving for the 1964 Nats, while working feverishly to complete my second "Whirl-Bird" fuselage, (the first one by now presented a miserable appearance and I wanted my Nats entry to look nice) I began to realize that I could now perhaps get the same helicopter to fly both left and right as a special maneuver. I was sorely in need of a special maneuver since "Whirl-Bird" for some reason became instable during backward flight about 75% of the time which made this unacceptable as a reliable special maneuver.

At the Nats on Monday and Tuesday I was busily test flying the new fuselage. As I began to develop confidence it would fly as well as the old one, I also tried cutting a hole in the anti-rotation vane and found now that I could get left hand circles using the vane with the hole in it and right hand circles when covering the hole up. It was now late Tuesday afternoon and the helicopter event was the next day. Tuesday evening was spent rigging up a vane with a trap door in it to be actuated by a dethermalizer fuse. This was not tested until it was time to fly the

(Continued on Page 28)

Huskie Pup III, each version improves design.

THE "WHIRL-BIRD"

(.Continued from Page 14)

special maneuver. Fortunately it performed satisfactorily and contributed significantly to "Whirl-Bird's" success in the helicopter event.

In addition to the vane, the design contains several unique features which have slowly evolved over a five year period. Among these are: the tank venting method; Gyro-Cyclic stabilizing mechanism; rotor blades which fold back under impact; the compression spring which cushions the rotor shock on the fuselage during landings; the open top and bottom which allows the prop wash to pass through the fuselage, thereby allowing more scale-like designs; the variable rotor mast positions which effect changes in the flight characteristics; and knock-off tail boom and rudder which reduce damage during landings or mishaps.

"Whirl-Bird" falls into the general category called torque-reaction helicopters. The majority of model 'copters seen in competition at present are torque reaction. Even so, the most often asked question by spectators, modelers included, is, "What makes the rotor turn?" For this reason I offer the following explanation:

We are all familiar with the 25c variety balsa rubber powered R.O.G. model airplanes. If you were to remove the wings, wind the rubber motor up, and release the stick fuselage, while holding on to the propeller, you would find that the fuselage and tail assembly rotate. You will also find that if you point the model up (without the wings) and release it, the propeller will turn one way and the fuselage and tail assembly will spin in the opposite direction. This turning of the fuselage is called torque-reaction and is caused by the drag imposed on the propeller by air. It is the same force which turns the rotors in a model helicopter. It has been found on the rotor system shown here that when the engine turns a 6" diameter 3" pitch prop at 17,000 r.p.m., the rotor speed is between 450 and 500 r.p.m.

Another question heard frequently is, "What are the weights for?" Since the weights are the main basis of the Gyro-Cyclic's stabilizing mechanism, this question will be answered by an explanation of how Gyro-Cyclic works.

A weight arm, usually of .045" music wire is hinged at one end with the lead weight attached to the other end, positioned so that the weight will swing up during rotation of the rotor and at flying r.p.m. the weight arm will assume a near horizontal position. About one inch from the hinged end, a wire link is attached at one end to the weight arm and at the other end to the rotor blade holder. The weight arm link is mechanically positioned so that the pitch (angle of attack) of the rotor blade is increased as the weight arm approaches horizontal and decreases as it drops down.

At flying r.p.m. of the rotor the inertia of the weight causes it to tend to remain rotating in the same plane.

Hold like so to start. Easy access to engine. Took 1st at 1964 Nationals, performed nicely.

If the helicopter should tip so that the rotor plane is not parallel to the plane of the weight, the blade pitch on the high side is decreased, hence less lift; and the pitch of the blade on the low side is increased, hence increased lift. This raises the low side and lowers the high side of the rotor system, bringing the helicopter back to level. After power is shut off, the drag of the rotor blades reduces the rotor r.p.m. until the weight drops down and effects negative pitch which induces autorotation. If rotor r.p.m. increases too much the weight swings up and increases the pitch to again slow the rotor r.p.m. Therefore this system seeks its own r.p.m. lift ratio during autorotation.

The main advantage of Gyro-Cyclic is increased stability coupled with greater lift, since all four blades stabilize and, due to definite positive pitch, all four blades lift.

Building Instructions: Study the plans and instructions carefully. Choose materials according to the engine to be used. When using a Baby Bee, or engine of comparable power, total gross weight of the finished helicopter should be no more than 9 ounces. Weight may be saved by using softer balsa, omitting the reinforcing nylon and plywood from the rotor blades and using no colored dope on the model until the final weight has been checked.

Maximum total weight for the Tee Dee .049, .051, or engines of similar power should not exceed 11½ ounces.

While no special tools are needed to build this model, if you have or can borrow a Dremel Moto-Tool, it will be handy for cutting the pieces of steel wire and brass tubing with 1/64" emory disks.

Fuselage: 1. Cut out the front and rear sections of the fuselage sides on their outline only. (Do not cut out for windows yet.) Pin each section flat on a board. Cut the 1/8" x3/8" and 1/8" x 1/4" balsa strips to proper length and cement in place on the inside of each side. Next cement the 1/16" x 1/8" balsa pieces in place. When sides are dry, cut window openings out.

If you wish a light weight method of adding color to your model, and if you want to have the inside of the open fuselage the same color as the rest of the helicopter, you can dope colored Japanese tissue to the balsa wood. This point in construction is the best time to do so.

2. While the sides are drying, begin construction of F-l and F-2. Note: The sides overlap with the top and bottom to give a better cement joint at F-l. Let dry thoroughly for about 12 hours, and then remove from the plan. Next join the front and rear sections of the fuselage sides by pinning the front section to your work table and cement the rear section to it while blocking the rear section up at its small end, much the same as putting dihedral in a wing.

3. Cement sides to F-l and F-2 and pin to a board upside-down to keep

THE "WHIRL-BIRD"

it square and true while the cement is curing.

4. At this point begin the assembly of RB-1 and RB-2. On the Baby Bee version, make center core of balsa and of spruce on Tee Dee Powered models. (RB-1) The center core of RB-2 is balsa on either version. Front and rear landing gear wire should be built into RB-2 at this time, noting it is advisable to wrap the front sandwich with R. C. hinge thread at the places shown on the plan.

Carefully drill for the rotor-mast tubing and additional optional positions if desired. If additional mast positions are to be used, W, X, and Y are most important. Positions V and Z should be strictly for experimentation only.

For optimum strength, cement and wrap a layer or two of nylon around the laminated beams after at least 24 hours has been allowed for the cement to cure. This is most important on RB-1. When the cement from the nylon wrap is dry, cut holes in the nylon for the rotor mast tubing. Do not cement the mast tubes in place yet.

5. Cement balsa blocks together as shown in detail on the plans. Cut the curved line for the windshield. (F-3 can be used as a template.) "Tack" cement the block in place (so the block can be removed for hollowing later.) Carve or plane the block to the shape of the 1/32" fuselage sides. Round the corners as in the top view and then contour to a clean compound curve. Remove the block and hollow it out. (Hollow more for the Baby Bee version.) Cement back in place permanently and add the 1/32" sheet bottom or optional trap door. Do your final sanding and bevel carefully for the celluloid windshield. For extra strength the nose and top blocks can be covered with silk or nylon.

6. Next cement F-3 in place. Cement the 1/16" sheet top in place and "tack" cement the top block in place". Carve to shape, allowing 1/32" overhang above F-3, then remove and hollow. For a nice looking cockpit you may at this point wish to paint the inside of the cockpit black. Cement the windshield in place, trimming to fit. Permanently cement the top block in and sand after masking the celluloid to prevent scratching it.

7. Main landing gear sandwich should be made of three strips of 1/16" x 3/8" balsa wood. The strips are all the same shape except the center one is cut to enclose the landing gear wire. Cement the sandwich together, cement and wrap with R.C. hinge thread at the points shown on the plans. After the cement is thoroughly dry, carefully cut the notch for RB-2. I find that short pieces of brass tubing soldered on as keepers for the wheels work very well and are neat in appearance.

8. Add finishing touches to the fuselage. Cement the celluloid to the front window frames and adhere the finished window to the fuselage. Note that the four rear windows remain open and have no celluloid on them.

9.Cement RB-1, RB-2 and the main landing gear sandwich in place. After RB-1 and RB-2 are in place, adhere the rotor mast tubes using a piece of 3/32" diameter. wire through the corresponding tubes to maintain alignment while the cement dries. If control-line lead-out eyelets are used, the small end may have to be drilled out to allow free movement of the 3/32" wire mast. Do this prior to cementing in place.

Rear Block: The rear block is made in two sections and serves to hold the tail boom in place, as well as to add a realistic touch with the simulated jet turbine exhaust. The top section is carved out of one piece of balsa block. Hollow out for the section which fits the key cemented to F-2, tack cement to F-2 and carve to shape. Cut parts D and F out of balsa. Cut part E out of 1/2" ply. Plywood for part F was found quite helpful in keeping the 1/8" diameter dowel from being pulled out of the block. Cement parts D, E, and F together, making sure enough room is left for the tail boom to fit snugly into its slot. After the cement is well dried, drill for the 1/8" diameter dowel and cement in place. If Japanese tissue is to be used to add color to your model, cover the top and bottom blocks before cementing them together. Cement the hooks (made from straight pins) onto the fuselage. Rubber bands lash the rear block in place on the fuselage and rear block. Round corners of the tail boom and notch for the rubber band as shown on the plan. When banding the boom to the rear block use the following procedure: select a dethermalizer size rubber hand, wrap it around the notched section of the boom three times. Then using a small screwdriver or other implement, slip the screwdriver between the top of the boom and the rubber band. Lift the rubber band off the boom and stretch it over the front part of the dowel. Let the boom into its slot and use a second rubber band around the boom and rear dowel.

Rotor-Head: The rotor-read is designed to be used with either the Tee Dee or Baby Bee engine. Make the washers W-l and W-2 identical to each other as follows: ream or drill the hole of a 4-40 brass washer to a snug fit over a piece of 1/8" O.D. brass tubing. Carefully mark centers for the 1/16" holes and center punch to facilitate drilling. Drill a 1/8" hole part way through a piece of scrap pine or other wood and place a short piece of 1/8" tubing or wire into this hole.

Slip the washer over this and drill the 1/16" holes. After the first 1/16" diameter hole is drilled, slip a short piece of wire through it into the wood to keep washer stationery while drilling the-rest of the holes. A small pilot hole drilled before the 1/16" diameter holes makes the job easier.

An alternative to the 4-40 washers is to drill one 1/8" diameter and four 1/16" diameter holes, as above, in a piece of 3/32" or 1/8" plywood and use it to keep rotor support wires in position while soldering them to the brass tubing and R-3. The plywood can then be removed.

Using the exploded view of the Gyro-Cyclic stablizing mechanism or a square, true up each of the four rotor support wires to as exact a 90° angle bend as possible. This will pay off in a true-running rotor; so we advise you to spend a little time on this detail.

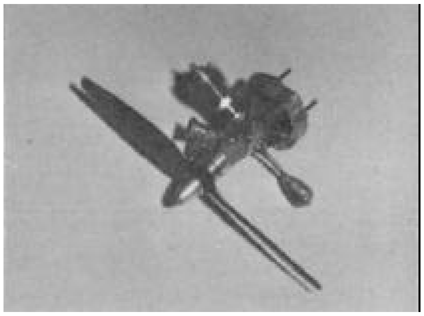
Cut out R-3 carefully, and drill the center hole to a snug fit on a piece of 3/32" diameter music wire. Drill the other four holes for 2-56 bolts (on the Tee Dee version use R-3 at this stage to drill five holes in a piece of pine for use in assembling the tank. Use of a drill press for this is advisable.) Slip a piece of 3/32" diameter wire through the center of R-3 and place rotor support wires, brass tubing and washers W-l and W-2 in place. Wrap rotor wires to flanges on R-3 with fine wire and solder rotor support wires to washers, brass tubing and R-3. Cement R-2 and R to this assembly. Use R-3 as a guide to drill through R and R-2 to true up holes for 2-56 bolts. (Note if 2-56 in length required for Tee Dee version are unavailable, substitute with 3-48. Proper length 2-56 bolts are available at A and I Nut and Bolt Co., Denver, Colo.)

Now drill center hole in R-3 with a 5/32" diameter drill to provide clearance for the rotor mast, which may now be inserted. You may have to file the outside of the brass tubing end on the rotor mast to clear the rotor support wires so that it revolves freely. R-4 can be drilled to match. Remember, do not drill a hole in the center of R-4. It's there to keep the rotor mast from punching a hole in the tank on hard landings. Put in place with engine and tank. R-4 may have to be hollowed slightly in the center to clear the rotor mast. Do not cement R-4 to R-3 so that the rotor mast may be removed for replacement or service.

R-6 is only used with the Tee Dee version. R-5 is used only if a Cox muffler is used on the Tee Dee.

The fuselage under construction, note eyelets.

(Continued *on Page* 43



Tee-Dee showing tank mounting, Sullivan filter.

THE "WHIRL-BIRD"

(Continued from Page 35)

The rotor head is now ready for installation of the Gyro-Cyclic mechanism.

Weight Arm Link: A vise was used to bend the loop in the weight arm link as follows: put a piece of .045 diameter music wire in the vise vertically near the left side of the vise. Then insert a piece of 1/32" diameter wire nearly horizontal with one end in the right side of the vise, using a piece of aluminum sheet or other material to compensate for the difference in the wire sizes. Wrap the 1/32" diameter wire around the .045 diameter wire, remove from the vise and cut at the proper spot with a file or emory disk on a Dremel Tool to preserve the loop.

Bend the weight arm link to the shape shown on the plans.

Blade Holder: This blade holder is designed for a minimum of metal work. Cut to the shape shown on the top view. The .045 diameter wire is used to retain the rotor blade in place by passing a rubber band around the .045 diameter wire and over the rotor blade. The rubber band releases and allows the rotor blade to fold back under impact and reduces blade breakage.

To assemble this blade holder, bind or sew very tightly and cement the tubing to the plywood by passing heavy thread such as R.C. hinge thread through the saw cut. Bend the weight arm link to shape. Wrap with fine wire and solder to the .045 diameter wire. Then sew and cement to the plywood using the saw cut, two small holes shown on the plans and the front protrusion of the plywood. Next cement the triangular blade stop in place.

Assembly: Slip the fuel line tubing on to the rotor support wire. Next slip the blade holder in place followed by the short piece of tubing. Slide all back against the sandwich and carefully bend at point marked "1st bend here" on the rotor support wire to angle shown on side view. Bend all four wires exactly as possible; in so doing the necessity of balancing the finished rotor will be minimal. Next, slide the small piece of tubing and the blade holder against this bend and check for lack of bind. When action of blade holder is smooth, make the second and third bends at the appropriate points, (be sure blade holder is in proper position.)

The weight arm can now be inserted through the weight arm link and then connected along with the U-hinge to the rotor support arm. Bind with wire and solder blade stop in place. (Blade stops are not imperative but will show their value as you become familiar with all phases of flying your model.)

Rotor Blade: Covering rotor blade with silk or nylon and using plywood reinforcing is not imperative, but will extend the blade life. Wash-out of the blade is simple once you understand the procedure. When one has finished the rotor blade carving, it should look slightly twisted like a propeller from the trailing edge. You will note that at all points near the blade tip the propeller has a flat bottom airfoil. Your rotor blade should too. Easiest way to get this twist is to carve it in. Begin at the point where the blade begins to taper and draw a line from the bottom of the blade at this point to the top of the blade at the tip. Draw this line on the trailing edge and use it for a guide in serving the wash-out (twist) in the bottom of the blade. Sand with a flat block and then carve the rest of the blade to the recommended airfoil.

Tee-Dee Tank: Begin cutting part A (two required) which is a circular piece of tin or brass shim stock 1-5/8" in diameter. These can be made exactly round by cutting over size, drilling a hole in the center to bolt the metal between two pieces of scrap plywood and chucking-up the bolt in a drill or Moto-tool. Run this against a coarse file or emory paper to size. A small piece of metal can later be soldered over the center holes to seal the tank.

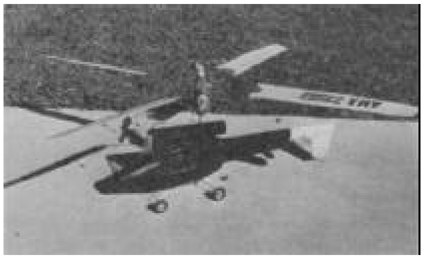
Carefully mark four U-control lead-out eyelets (large size by Perfect work well) for the position of the 4-40 washers. Carefully ream or file out four washers to fit snugly over the eyelets. Insert short pieces of 3/32" diameter wire or tubing in the holes you drilled in the scrap pine during assembly of the rotor head. This gives you an assembly jig.

Put the eyelets on the four wires of the jig with their flanges against the wood. Slip one of the parts marked A on next, and solder to the eyelets to form a fuel seal. Slip the other part A on, and then slip the washers over the eyelets to the position previously marked. With scrap balsa used to separate the two part A's, carefully slide the loose one up to the washers, (checking carefully that the washers remain where they are supposed to be) and solder the washer, eyelet and part A together. Remove from the jig. Solder part B to this unit using the tabs to keep in place. (The narrowed end of part B goes inside the tank to serve as a baffle.) Solder the filler tube (3/32" diameter brass) in place. Next solder part C in position and then the fuel line tube. Cut eyelets flush with the washers using a Moto-Tool, razor saw, or other tool. Immerse in water and blow into tank to check for leaks. It is advisable to boil and flush tank to remove the solder flux and other debris. Assemble with engine and bend filler tab close to the engine. When filling, turn 'copter on its side with fuel tube on the top and allow air vent through the needle valve. If you wish to avoid possible flooding of engine, remove the fuel line from the needle valve during filling.

Tee Dee Mounting: Patterns are given for mounting brackets. Make of 23 or 24 gauge steel or soft 3/4" crating strap. Also make a strap of tin can stock to hold the cylinder counter balance to the engine by the mounting bolt. One also might adapt a Tatone radial mount. If so, keep the engine as close to the tank as possible.

Baby Bee: A view of the tank back plate is shown. Carefully drill a hole for the 1/8" brass tube. Crimp one end of a piece of 1/8" O.D. Brass tubing at least 1/4" long and seal with solder, (sparingly) If the plating is fairly new, solder will stick to it well. Solder the brass tubing in, making sure it is flush with the inside wall of the tank. Use a piece of 1/16" O.D. brass tubing on the end of the fuel tubing so that it picks fuel up inside the 1/8" diameter tubing. This arrangement will give you a clean quitting engine. Put a piece of

(Continued on *Page* 47)



An earlier version, Uncle Igor, won '61 Nats. An Arden .099 installed. Takes time to develop.

THE "WHIRL-BIRD"

(Continued *from Page* 43)

fuel line on each of the filler tubes and run them up under the counter weight wires. Note the arrangement used to secure the counter weight in the top and side views of the Baby Bee. An increase of power can be obtained by using a Tee Dee head and/or a double-ported cylinder on your Baby Bee.

On whichever engine you use, careful counter balancing will pay off. Turn the crankshaft so that the piston is half way to the top. Put a propeller on the engine so that it is 90° from the cylinder centerline. Using a knife blade on each prop blade about 1" from the hub, carefully file counter weight until the engine hangs level from the prop (start with counter weight slightly too heavy.) The finished rotor can also be checked for balance this way.

Rotor Mast Positions: On the plans, the most stable position of the rotor mast is shown. If your model is not too heavy and the engine is running right, the model will fly forward with rotor mast in position X. If this does not work try position W. Position V, Y, and Z are optional for experimentation only. The wheel retainer on the rotor mast under RB-1 allows changing rotor mast position and removal for transporting and maintaining it.

FLYING — Pre-Flight Check-Up: Re-check to make sure your engine and rotor system are in good balance. Make sure the 'copter is not over-weight. Oil all hinges and bearings and be sure they all are free.

By holding the 'copter in flying position, raise the weight arm to a horizontal position and check each blade to have the same pitch (by eye.) The recommended pitch in this position is 0° to 5° positive angle of attack at the blade tip. Bend the blade stop to allow a total of 10° positive angle of attack at the blade tip.

Use a 6" diameter 3" pitch propeller on both the Tee Dee and Baby Bee engines. A 5½" or 5¼" diameter, 3" pitch can also be used on the Baby Bee.

As with any free-flight model, it is highly advisable to put your name and address on your 'copter before your first flight.

Flying: Full power run-ups should be made before releasing your 'copter for its first flight. Do not use an old worn out or sick engine. The more excellent condition your engine is in (and kept in) the better your chances of success. *Filter your fuel.* Notice in the photos that I also use a Small Sullivan Fuel Filter in my fuel line.

Make sure your engine has the best possible needle valve setting during the run-ups and that it does not get too lean or sag near the end of the fuel supply.

Limiting the amount of fuel by measuring with a syringe is highly recommended. Use 4 to 5 cc. with the Tee Dee and 2½" to 3 cc. with the Baby Bee on first test flights.

When you have gained sufficient experience and feel confident of the proper needle valve setting, start the engine and hold overhead until the rotor builds up maximum r.p.m. then release model at the moment it feels balanced in your hand. R. O. G. is no problem at all, especially if your model has been flown successfully by hand-launch. Make sure your engine is giving out its best before releasing for flight. Do not try to push your model into the air or toss it, but rather, let it rise out of your hand.

Trouble-Shooting: The best trouble-shooting I know of is careful observation. If a mishap occurs, try to observe and analyze what happened. If the Bird dives, try to remember if it turned or started spinning first and what weather conditions or misalignment might have caused the crash.

A standard torque-reaction helicopter such as "Whirl-Bird" generally spins in to the left. If it does so, the rotor r.p.m. is usually too slow. To increase rotor r.p.m., check the balance and alignment of the rotor system, check the prop-fuel-glow plug-needle valve setting combination. I had the experience of trying to help a friend get an .074 Cub powered helicopter to fly. We met with failure until I loaned him an Arden .099. His 'copter now flies beautifully.

All rotor blades should be in the same plane, parallel to the plane scribed by the propeller. With a wobble-free prop on your engine, make sure each rotor blade is the same distance below the prop tips. Check the rotor to be sure there is no dihedral or anhedral in the rotor system.

This 'copter is extremely stable as long as it is not underpowered and not overweight. With the set-up shown on the plans, the 'copter should rise straight up and not fly forward. If it does fly forward try moving rotor mast to position Y. Unstable condition only occurs from too slow a rotor r.p.m. which can be due to a sick engine and/or too much rotor vibration due to an out-of-balance rotor, from a sticking feathering hinge, or from too high pitch on the rotors. This 'copter is insensitive to fore and aft C.G. shift, but is more sensitive to up or down C.G. positions. If your model spins in or flips upside down under power, shorten (first) or lengthen (second) the length of the compression spring above RB-1 to lessen or increase the subsequent distance between the rotor head and the fuselage.

Although model helicopters have come a long way, there are many things still to be learned about them. The field is wide open and merits the attention of the modeler wishing to broaden his aeronautical knowledge.

Any questions possible will be answered by writing the author. I hope "Whirl-Bird" will give you as much fun as I have experienced with it. Best of luck.

This is the tank for Cox Tee-Dee. It works fine.