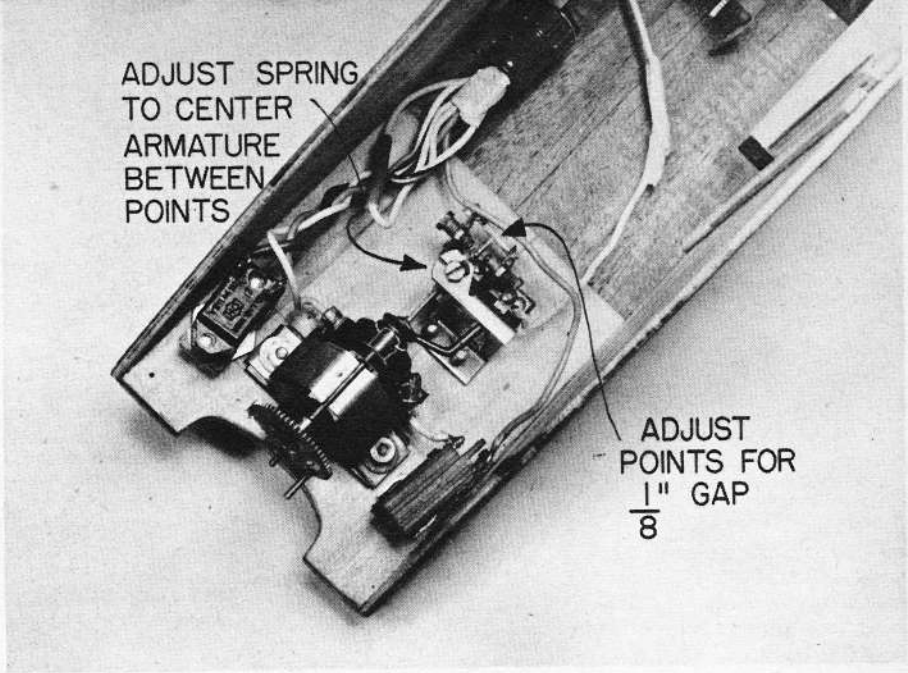
simpl-simul

by JOHN WORTH

Part 3

Inexpensive dual proportional control makes you a pilot with true "joy stick."

► The Simpl/Simul control system not only provides independent and simultaneous proportional control of rudder and elevators with single channel, but also is adaptable to the addition of other controls. Since the S/S system normally operates through variation of constantly pulsed signals, a momentary interruption of those signals can be used to trigger an escapement or other device. The trigger method used may be mechanical or electronic. The former seems simpler and therefore preferable but is trickier to get working reliably. Both, however, have been successfully used. In either case, the interruption of signals results in momentary full deflection of either or both control surfaces, but the time interval is so brief—only about a half second—that practically no lag is noticeable and model reaction is minimized.



Trigger switch (Sigma minus coil), Cerny's model, trips by actuator crank, to work the motor control actuator. Note the brass beef-up band over the actuator. System now quite reliable.

Mechanical trigger: This method requires removal of the stops that are normally used to limit travel of the crank on the control surface torque rod. Instead, actuator centering tension is balanced against actuator voltage and the system's lowest pulse rate (approx. 3 cps) so that despite full-up elevator and full-power rudder signals the crank will not swing beyond its normal 270 degrees total rotation. Then, upon a momentary solid signal, the crank drives beyond limits (*Continued on page* 39)

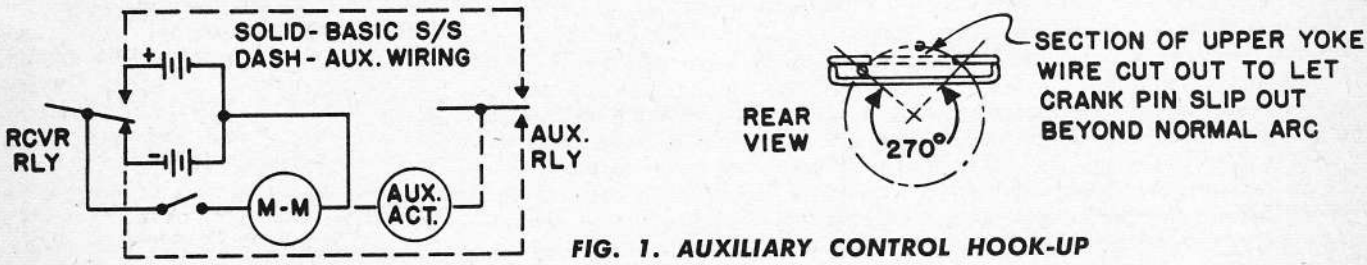


FIG. 1. AUXILIARY CONTROL HOOK-UP

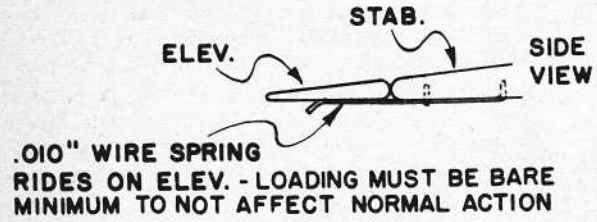


FIG. 2. FAIL-SAFE ELEVATOR DETAILS

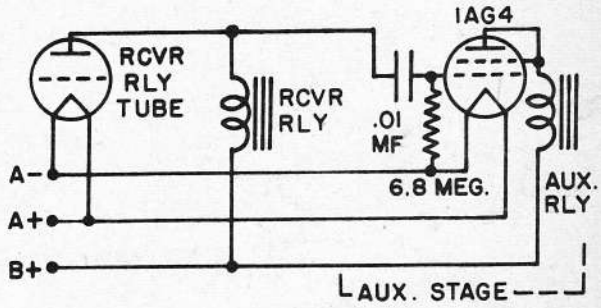


FIG. 3. ELECTRONIC TRIGGER

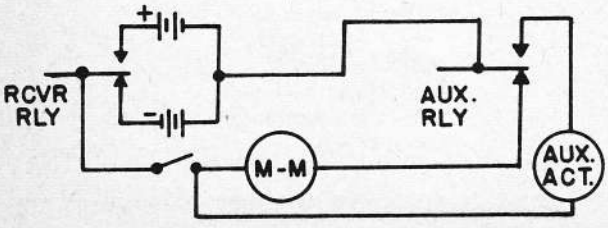


FIG. 4. F-S CONTROL HOOK-UP

AUXILIARY CONTROLS

of flying the airplane and compensating for the wind and thermal currents. The thermals would cause the airplane to rise rapidly, even at cruising rpm. We would then go to a minimum rpm, the airplane would sink back down, then we would go back up to cruising rpm until the next thermal started to carry the airplane aloft.

As we approached the three hour and six minutes mark of the Russians, the tension became great. We passed it without incident, and finally we passed the necessary two percent additional time required. We shook hands all around—that took care of the Russians. Now for the Belgians! We thought this might be critical since we had not put in a full load of fuel and the tanks looked very thin already. However, four hours passed, then four hours and fifteen minutes. At that time I let the airplane fly to a very high altitude, figuring that even if the engine were to quit I could exceed the required four hours and thirty-one minutes by gliding from thermal to thermal. As it turned out, this was unnecessary. We passed the four hours and thirty-one minutes, and droned on.

When we reached the five hour mark we could almost see the question marks over our heads. How much longer would it fly? We were now getting to the point where the number of usable commands left was questionable, the battery voltages were untried, and the worst thing that could happen would be to have the airplane fly away and thus nullify the entire record attempt. We decided to gamble another half hour, that is, if the engine continued to run. It did. At five hours and twenty-five minutes the airplane was high in the sky when I decided to terminate the flight. I put the engine into low speed and then did spirals and wing-overs to bring the airplane down. At five hours and twenty-eight minutes the engine quit. The airplane came in for a gentle landing 29 feet from the point of take-off. (The FAI requires a maximum of 500 meters).

So, after two months of sweat, tension, trials, crashes, repairs, and re-rigging, we finally tasted success. We were probably the two happiest modelers in the world.

Simpl-Simul

(*Continued from page 22*)

to trip a switch or mechanism to operate the auxiliary control. Resumption of pulsing then restores crank oscillation within limits for normal control.

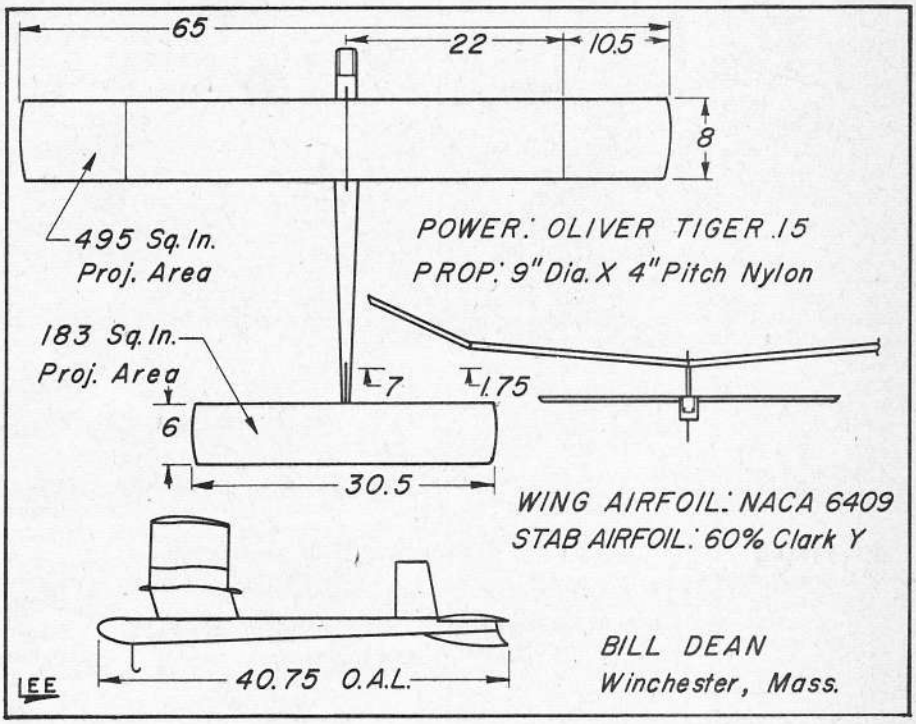
The balancing process is very sensitive to slight variations of the factors mentioned. Actuator voltage is the principal source of trouble and the use of dry batteries has not proved to be satisfactory. When new, dry cell voltage is high and there is a tendency for the crank to overshoot during normal pulsing so as to trigger the auxiliary control prematurely. When old, dry cells produce voltage too low so that the actuator cannot overcome the normal centering tension and the auxiliary control cannot be triggered. With dry batteries, the usable period of relatively stable voltage is too short unless an extra large capacity supply is used; weight and space penalty for this is excessive.

Further complicating the balancing process are rubber tension sensitivity to temperature and pulse-length signal limitations. In the first case, rubber tension may have to be adjusted differently for hot and cool weather conditions. In the basic system, with the crank stops, this is not critical but with the stopless overshoot type of triggering tension adjustment must be much more precise. In any case, note that some synthetic rubber bands are especially poor in cold weather; losing practically all

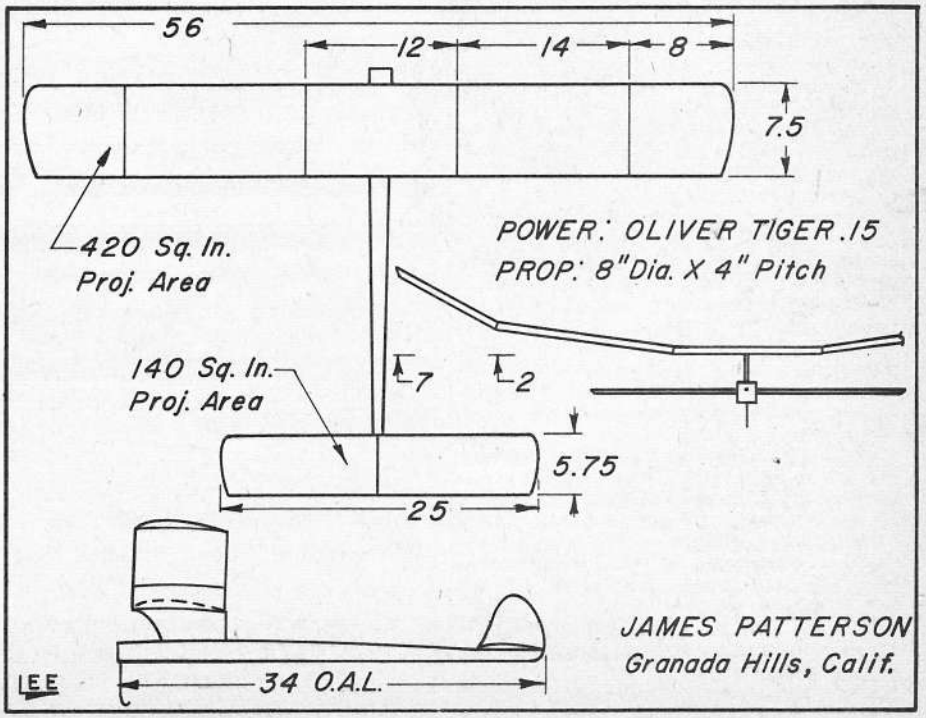
tension. Excessive pulse length variation for full rudder control signals also bothers the overshoot principle since it causes erratic and uncalled for triggering. Extreme pulse-length signals may approach closely a solid signal condition, making adjustment difficult to distinguish between normal and auxiliary control signals. Pulse length tolerance of the basic S/S system, using positive crank stops, is great, but with the stops removed maximum pulse-length variation may require limiting to no more than a 60%-40% differential.

Trigger switch: Despite the obstacles, a mechanically triggered auxiliary control offers versatility and simplicity of components. Note the photo which shows a switch adapted from a Sigma relay. The armature and contact point assembly is mounted so that when struck by the actuator motor crank the switch is closed on one side or the other. Solid off signal always drives the crank in the same direction so that the same switch contact is made each time this condition occurs. Likewise, solid signal on always drives the crank in the opposite direction to actuate the other contact. Therefore, auxiliary control operation can be selective, with signal off providing a fail-safe condition (low engine speed, for instance) and signal on a strictly command control (high speed). Fig. 1 illustrates a typical hookup of switch contacts to operate another motor or actuator such as might be used to drive an exhaust throttle or intake butterfly.

(*Continued on page* 42)



Three-views of two of the FAI free flight models to be flown by American team members in '58.



Note, too, that the arrangement provides a stop for the crank at about the neutral rudder position (approx. 180 degrees opposite normal neutral rudder crank position). Thus, auxiliary control triggering occurs with rudder in or nearly neutral, which is also a fail-safe condition for this control. The elevator, however, would be full up at this time, unless a special elevator yoke is used as shown in Fig. 2. By modifying the elevator yoke in this manner the crank can slip out of the yoke whenever the crank exceeds the normal control travel—a light spring is used to prevent the elevator from going to full down when the yoke disengages. The spring and slipstream combine to hold the elevator in neutral until resumption of pulsing automatically slips the crank back into the yoke to regain normal control.

"Free" power: Still simpler than the switch arrangement is a fully mechanical auxiliary control set-up. Here, a Bonner or similar type air bleed selector valve may be substituted for the relay contacts. Instead, the crank flips the valve to one position or the other to provide two-speed engine control via a dual needle valve arrangement. Many other tricky set-ups have been dreamed up, but the foregoing is enough to suggest adaptation of your own pet scheme. One further hint: the crank can also trigger an escapement mechanism directly—no electrical energy is required if the crank is used to trip the escapement pawl. In fact, why not work two escapements: one for each solid signal condition?

Reliability answer: Now that the examples of mechanical trigger controls have been shown to be desirable, we're back to the original problem; a source of stable actuator voltage is required to assure consistent triggering. Wet-cell power is the natural answer since it provides practically constant voltage under varying load for most of the life of a cell. However, wet cells do require more care in handling, demand proper charging and involve more expense. But they do the job and make the overall system installation inherently more reliable. Sooner or later most R/C fliers go to wet cell power regardless of the type of control system.

Electronic trigger: However intriguing are mechanical triggers, most successful S/S auxiliary controls to date have been operated through electronic means. Here the principle is to have a relay held out (or in) during pulsing, then pull in (or drop out) on momentary solid signal. The relay is then used to switch whatever control device is preferred. The main advantage of the electronic trigger is that the basic control system need not be modified—the positive stops are retained to provide maximum reliability and ease of adjustment. One of the best circuits is credited to Bob Quick, of Florida. It adds a tube and relay stage to any receiver, as shown in Fig. 3. During pulsing, the tube is held at cut-off so the relay is not energized. On solid signal the tube conducts and pulls in the relay. The tube's low drain (40 ma for the 1AG4) is easy on the receiver's normal filament batteries and good current change (2-4 ma with 8k to 4k relays) assures solid relay operation. Grid condenser and/or resistor values can be varied to obtain the exact time delay desired (more resistance and/or capacitance for longer delay and vice versa—half second is about optimum). One important point: the circuit operates very reliably on signal on, but may be erratic with solid signal off when used with some receivers—others apparently are satisfactory. A bench check is advised before going ahead with model installation.

Electronic fail-safe: Neutral rudder on auxiliary control actuation on transmitter failure may be provided, if the basic S/S actuator is also wired through the auxiliary relay, as shown in Fig. 4. Pulsing maintains the normal control circuit which is closed when the auxiliary relay is not energized, but when this relay pulls in, the S/S actuator is disconnected since power switches to the auxiliary control actuator. But, when this happens, the elevator will be snapped to full down by the actuation centering tension—it might be tolerated as momentarily annoying during auxiliary control triggering, but could be disastrous on signal failure! Solution? Easy: invert the control surface crank! Now fast pulse must be used for up, slow pulse for down. Signal failure now gives neutral rudder with up elevator.

Reversed elevator: Momentary up elevator during auxiliary control operation is quite acceptable and the solid up elevator for fail-safe is usually better than an all-neutral flyaway or full over-control spiral dive. The reversed elevator control has another benefit also. With the usual high pulse rate at full down, rudder control is very delicate when the stick is shoved full forward. With reversed elevator signals, full down at low rate provides a very broad rudder control for precise steering at higher airspeeds. Yet, with full up at high pulse rate, rudder conrtol is sensitive and aids in providing quick corrections when the model is in an almost stalled or looping attitude. The reversed elevator rate set-up, however, is recommended only when used with the electronic auxiliary control which has the extra relay for fail-safe. Otherwise, if used in the basic S/S setup, signal off would result in full rudder and down elevator!

FLYING CONSIDERATIONS

Control limitations: For beginners, not too much elevator response is a good thing. Only a slightly effective elevator can be a big help and yet not be a dangerous control in the hands of novices. On the other hand, for the serious competition flier or the sport who likes to really wring out a ship, there is no such thing as too much elevator control. The S/S pulser, as presented in the first article of this series, does not provide a great range of elevator control through the control stick alone. Yet, with the trim knob, this range can be extended if needed. The pulser is thus fairly tame though still capable of considerable control. However, for violent flying the pulser may be lacking because, when adjusted for adequate up control, it may not provide sufficient down elevator for brute force maneuvers; such as, inverted flight, vertical dives, etc.

Increasing elevator control: Substitution of a different rate control pot for the specified standard 250k unit is necessary for maximum control. The pot to use is the Ace 60-degree 100k pot (Ace R/C-Higginsville, Mo.), which provides a much greater rate change for the normal amount of stick travel. With this substitution, high rate is extended from a normal maximum of 7-9 cps to about double. This extra range will just about freeze the crank in the center position, providing a solid down elevator (with the inverted crank described earlier, the same range extension is provided: now up elevator is solid so that the linkage can be adjusted for more effective down elevator at lowest rate). Another means of obtaining a slightly higher rate in the pulser, though not as effective as the 60 degree pot, is to simply use CK5672 tubes in place of the 1AG4's specified—no circuit change necessary.

Trim tips: Even without the extra rate range, the original pulser can provide some wild flying, by making the most effective use of the elevator trim knob together with optimum airplane adjustment to get rid of excessive model stability which is a hindrance to maneuverability. With a 25% CG trim most models are gentle and can even be sluggish to control, but a 35% CG can make the same model a terror. Similarly, a model with three to five degrees difference between wing and tail incidence settings behaves much more tamely than one with only one to two degrees difference. Don't go less than this unless you like ulcers—zero/zero trim requires full up elevator just for level flight and only a twitch of the stick toward down can dump all lift immediately. My 7½-lb., .35-powered Live Wire Cruiser is set up with 33% c.g., two degrees difference between wing and tail.

Techniques: With such an overweight monster, take-off requires almost full back stick AND full up-elevator trim. Climb to altitude is made with lots of back stick and more or less rudder as needed to maintain a nice spiral—no low-level buzzing with this ship as the engine power is too marginal for quick recovery. As long as the model flies at reasonable airspeed, there is sufficient up stick control for most flying, even with full down trim. But if the ship should slow up near a stall, loss of altitude cannot be prevented. It can be seen that the same ship on rudder-only would be overpowered, but with dual control more power is required. Therefore, in this case, lots of altitude is mandatory for performance.

Upon leveling off, despite applying full down elevator trim, slapping the stick full forward results in only about a 30 degree dive is sufficient for easy looping. In a is needed for hot piloting. However, the dive is sufficient for easy looping. In a clunker such as mine a clean loop requires slapping full back stick and immediately rolling in full up trim (with a ship that has 16 oz. or less per sq. ft. wing loading loops are easy from level flight). For true vertical dives some trickery is required; from level flight the model is first rolled over by slapping full rudder followed almost immediately with full forward stick. Done right, having been previously set up with full down trim, the ship takes the straightest path to China! Pylon turns are beautifully made from level flight by yanking the stick diagonally back into the corner, then to neutral rudder and about half down stick for clean recovery—practice makes this a spine tingling but precise maneuver difficult to duplicate with anything except a dual-proportional control system.

Any time the nose is down in a turn, such as in a spiral dive, recovery may require unnatural reaction. The first tendency is to pull back on the stick, but on a model really heeled over the up elevator acts as a rudder and tightens up the turn further. Recovery technique is to first hit opposite rudder then up elevator. This is best practiced on early flights, with plenty of altitude. Note that the references to slapping the control stick around are literally true for hot flying—especially on entering maneuvers, stick action should be positive and quick. Recovery, however, is best with smooth exact positioning of the stick which experience teaches is just right for each given maneuver—practically all recoveries require some down elevator to kill off the zoom that results from excess speed build up. (*Continued on page* 44)

Next Issue M.A.N.
EARLY BIRDS
By Doug Rolfe

Landing: When the engine cuts, full up trim is rolled in for assurance of adequate flare on touch-down, if necessary. But on the approach, stalling and ballooning is avoided with sufficient down stick to keep the model flying fast and nose down. Keeping the nose down provides the excess speed which enables a landing to be stretched—a stally approach usually falls short and may end up with the model dropping out of the sky. To prevent overshooting, "S" turn back and forth as needed, always being careful to keep the nose down. Those used to full deflection elevators are often surprised to learn that proportional control landings can be so precise. This is because elevator corrections are made continually right down to the ground, in contrast to the comparative lack of elevator control on approaches with full thrown systems for fear that a careless blip will ruin the maneuver. With S/S you fly all the way—the control stick links you directly to the model with just the amount of response you call for.

Conclusion

The kind of flying you can do with Simpl/Simul takes lots of cash and complexity to do otherwise. Several thousand S/S flights have been accumulated among a number of groups across the country. Therefore, the system is not just an idea still in need of development. If you want more performance and satisfaction from your old radio gear, or if you feel that the pro-priced equipment is out of reach, look to S/S for a big step nearer to true piloting.

Bebe-Jodel

(*Continued from page* 23)

the top of the fuselage and 1/32" sheet planking on the bottom. Except for final sanding and covering the fuselage is complete.

It would be a good idea at the present time to carve the nose block. Cement a ¼" sheet plug, which has been cut to fit inside the front of the fuselage, to a 1" x ⅞" x 1⅜" balsa block. Drill a ¼" diameter hole through it as shown on the plan. Plug the nose block into the fuselage and carve it to match the contour of the fuselage and fair it to ⅜" round at the front. Sand it smooth and add the thrust buttons, the scrap balsa air intake, and the dummy motor, which is also made from scrap balsa. Note how the cylinder fins are simulated by wrapping with heavy thread.

The wing is of standard construction. Cut out 9 W-1 ribs and two each of W-2 and W-3. Note that five of the W-1 ribs have an extra notch for a 1/16" x 1/8" spar and the two W-1 ribs at the dihedral breaks have an enlarged notch to accommodate the spar and dihedral brace. Next, cut to proper length and carefully notch the trailing edge. It is standard ⅜" trailing edge and if none can be obtained you can taper a 3/32" x 3/8" strip. Just carve it to shape roughly with your razor blade or modeling knife and finish by sanding. Always sand across the strip and not along the length of it. Sanding along the length will tend to squash the wood fibers instead of removing them and will cause the strip to bow.

The spar is cut to proper length now and tapered as shown for the wing tips. Place wax paper over the plan and pin the spar and the trailing edge in place. Cement the ribs in place after this and then the leading edge, which is set on edge, is cemented in place. Don't stick pins through the leading edge but along the front of it to merely hold it against the ribs. Slanting the pins back will hold the leading edge down and back against the ribs.

After the wing has been allowed to dry thoroughly, preferably overnight, lift it from the board. Block up the tips 1¼" and cement the wing panels together, add the dihedral brace and the 1/16" sheet corner gussets. The 1/32" wire landing gear is bent at this time. Just two 90° bends are required. Exactly 2" of wire must extend from the bottom of the wing. Don't bend the axles for the wheels yet. Bind the landing gear to a 1/16" x 1/8" spar cut to proper length from the plan. Cement the spar to the wing and carefully stick the 1/32" wire into the 1/16" x 1/4" main spar. Cement this spar in well and add the 1/16" sheet corner gussets. Cement the ⅛" sheet wing tips in place. Use the W-3 rib outline to cut out the tips. Now sand the wing lightly to remove all rough spots and check the cement joints.

The tail surfaces are constructed by first pinning the 1/16" x 1/8" outline down to the plan and then filling in with the 1/16" sq. strips. Take care to let the tail surfaces dry thoroughly because they are prone to warp easily and lifting them from the board before the cement dries will only aggravate this condition. The tail surfaces could be cut from very light 1/16" sheet. A quarter-grained (resists bending) sheet of 1/16" x 3" x 36" that weighs ¼ oz. will do nicely.