TERN

Take a turn with the Tern. A stilleto silhouette of aerial majesty whispers across the slope face.

A tern is not only a slender-bodied gull, but also any threefold or triple thing. This Tern resembles a streamlined gull, and offers top performance dividends by using three functions. Make three your lucky number with a Tern. / by Ralph Grose

Model sailplanes have been judged, for the most part, by their ability to sustain optimum duration in marginal lift. As a result, most of the popular sailplanes feature low wing loading (which permits low speed and a short turning radius) to stay in the smaller thermals. The Tern represents an effort to design a sailplane geared to average lift conditions. This results in marked improvement in glide ratio, speed, penetration and control.

It is my belief that the similarity between models and full-scale high performance sailplanes needn't be limited to appearance, but can be extended to the flight characteristics as well. The Tern is a step in that direction. It presents a more realistic flight mode.

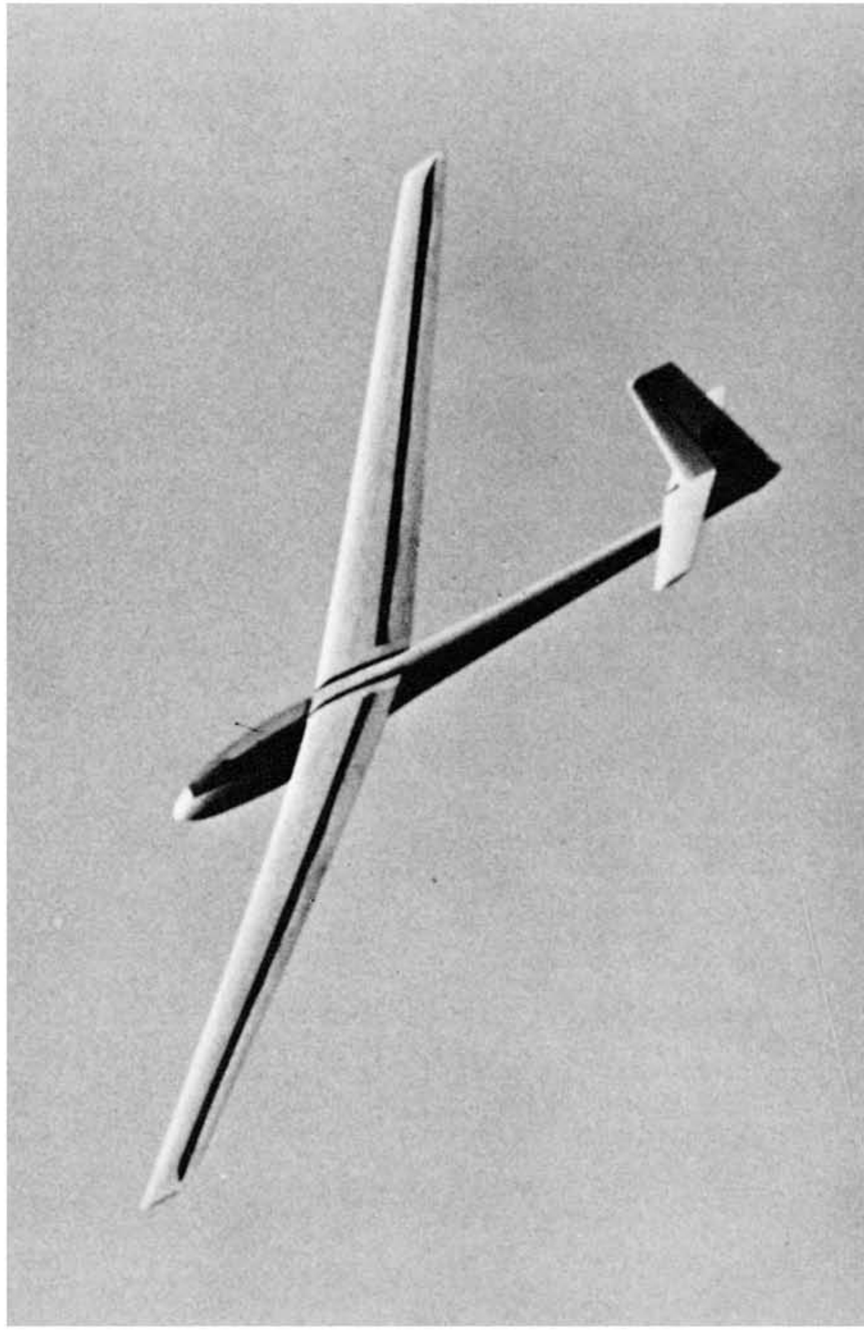
The single quality that improves all aspects of sailplane performance is low drag. With that in mind, drag reduction was a prime target for this design. The aspect ratio, concealed control horns, tail configuration, high wing loading, balsa wing skins, etc., were choices made to this end. In all cases, where a significant reduction in drag could be made, but additional weight was required to do so, the weight was added without hesitation.

Minimizing the model's weight was an objective, only to the extent that it would allow a wide lattitude in performance, by adding or removing ballast. Within limits, extra weight does not reduce the glide ratio. Weight is the glider's only source of motive power. If it doesn't have enough, it is underpowered. If it had none at all, it would float like a balloon.

Weight does increase the speed and, at a given glide ratio, the faster you go, the faster you are sinking. However, the Tern has a high glide ratio, as compared with existing designs, so the actual increase in sink rate is relatively small. As to what the glide ratio is, I don't know. A sensible calculation would require more information about its parasite drag.

While overall weight did not dictate design choices (except for strength reasons), weight distribution did. Weight, at a distance from the CG (such as outboard on the wing), causes inertia problems. It makes rotation about the vertical and longitudinal axes (yaw and roll) difficult to start and hard to stop. This is why a long glider wing needs to be tapered, and the spar needs to be tapered, or stepped.

The wing section was selected primarily for speed. At an all-up weight of six lb., the wing reaches its low drag range at 36 mph, and its best L/D range at about 23 mph. The straight ahead stall speed is about 18 mph with the



The Tern is uncompromising in its aerodynamics. Parasite drag is almost non-existent. Full-span flaperons (they're also spoilers) optimize the thermal capabilities.

PARTS LIST

Item No.	Name	Qty.	Item No.	Name	Qty.
1-35	Wing Ribs	1 ea.	51	Rudder Spar	1
3a	Aileron Rib	6	52	Fin Spar	1
18a	Aileron Rib	2	53	Fin Butt Rib	1
36	Wing Butt Plate	2	54	Fuselage Joint Rib	1
37	Spar Assembly	2	55	Fuselage Stiffener	2
38	Blade Stack	2	56	Rudder Horn	1
39	Skid Doubler	1	57-64	Fin & Rudder Ribs	1 ea.
40	Aileron Crank	1	65-74	Elevator Ribs	2 ea
41	Fork	2	75	Compensator	1
42-43	Rudder Hinge	1 ea.	76	Main Bulkhead	1
44-45	Hook	2 ea.	77	Tray Assembly	1
46	Aileron Horn	2	78	Forward Bulkhead	1
47	Elevator Horn	1	79	Skid	1
48	Elevator Spar	2	80	Slide Board	1
49	Rudder L.E.	1	81-82	Spar Blocks	2 ea.
50	Web Doubler	4			

flaps neutral, and 15 mph with the flaps full down.

For thermal flying, a short turning radius is an asset. Turning radius is determined by angle of bank and speed, with the minimum radius limited by the stall. So, to make use of smaller thermals, it becomes desirable to lower the stall speed. This is why the Tern has full-span camber control (flaperons). Lowering a few degrees of flap is like changing to a different airfoil section. As the flaps go down, the stall speed and the minimum turning radius are both reduced. When flying in the high sink air, the flaps can be returned to neutral to get speed and penetration. They can be trimmed at 2-3^{o} to get the best glide ratio.

Negative flaps have the same effect as spoilers. If the landing is planned, such that a nominal amount of negative flap can be used throughout the approach, the glide angle can be increased or decreased as the pilot pleases. The elevator trim is coupled to the flap servo to maintain a more or less constant airspeed as the flaps are used. The amount of couple to use depends on a number of variables, so it must be found for each plane by trial and error. When shooting a spot landing, the glide can be extended at the last moment by lowering the flaps. The plane then continues to fly past the original touchdown point, as it slows down to the lower stall speed. *(With my luck, the original touchdown point would probably have been, for once, the spot—Editor.)* The long flaperons also give the Tern a very responsive roll rate, which is not a common trait for sailplanes with high aspect ratios.

MATERIALS LIST

Item	Quantity	Used To Make
Soft Balsa*		
3/32 x 2 x 36	34	1-34, 57-74, spar webs, wing skins, skin doubler
3/16 x 2 x 36	1	3a, 18a, 35, 36, 53
1/16 x 2 x 36	4	37, fin skins, elevator skins
1/4 x 5/8 x 36	1	49, 54
Hard Balsa**		
1/8 x 1/2 x 36	6	51, 52, wing leading edge
1/4 x 1/4 x 36	1	pushrods
1/4 x 5/16 x 36	1	fin & elevator leading edge
3/16 x 5/8 x 36***	9	aileron hinge spars, rudder & elevator trailing edge
Spruce		
1/8 x 1/4 x 48	8	37, 77
1/8 x 1/4 x 36	5	37, 77
1/8 x 1/8 x 36	1	77
3/32 x 1/4 x 36	1	48
3/16 x 3/16 x 36	1	37, 76
3/16 x 3/8 x 36	1	39
Plywood		
1/8 x 12 x 12	1	37, 47, 76, 77, 78, 80, canopy frame
1/16 x 12 x 12	1	36, 37, 39, 47, 50, 55, 77, 80
1/32 x 6 x 12	1	aileron hinge pads
Aluminum		
1/16 x 3 x 15	1	40, 41, 46, 56, 75, 79, 80
1/32 x 1/2 x 3****	1	42, 43
Brass		
1/8 O.D. x 15 tube	1	40, 47, 75, elevator hinge, aft wing socket
3/32 O.D. x 10***	1	rudder hinge
1/8 dia. x 6 rod	1	aft wing attachment pin
1/16 dia. x 10 rod	1	rudder hinge pin
Music wire		
1/8 dia. x 12	1	elevator attachment pins
3/32 dia. x 12	1	wing attachment hooks (44 & 45)
Steel		
1/2 x 11 x total stack of 3/16		38
Pushrods		
12 links, 8 rods		
Round Head Mach. Screws		
No. 3 x 1/2	2	
No. 3 x 1/4	1	
No. 4 x 1/2	2	
No. 4 x 1¼	2	
Flat Head Mach. Screws		
No. 2 x 1/4	4	
No. 2 x 3/4	1	
Sheet Metal Screws		
No. 4 x 3/8	20	

*4-6 lb./cu. ft.
**12-16 lb./cu. ft.
***trailing edge stock
****brass or aluminum optional

A three-channel system, with four servos, will operate the controls nicely. Couple the aileron and rudder by plugging both servos into the aileron output of a receiver. Most radio manufacturers make a tandem plug set for this use. To get the correct couple, set the rudder to travel at one in. while the ailerons are at a total travel of 9/16". Observe the plane as it rolls into a turn. If it skids, reduce the rudder travel. If it slips (outside wing seems to hang back) increase the rudder travel. Elevator travel should be 1/4" each way, measured at the trailing edge. For the first flight, be sure the balance is within the limits shown on the plan, and that the neutral elevator position is parallel to the thrust line.

The Tern was not intended as a trainer. . .lighter and slower planes are better for that. If, however, you have flown enough to feel confident with a slower plane, I think you will find it a pleasant and exciting experience to fly a Tern.

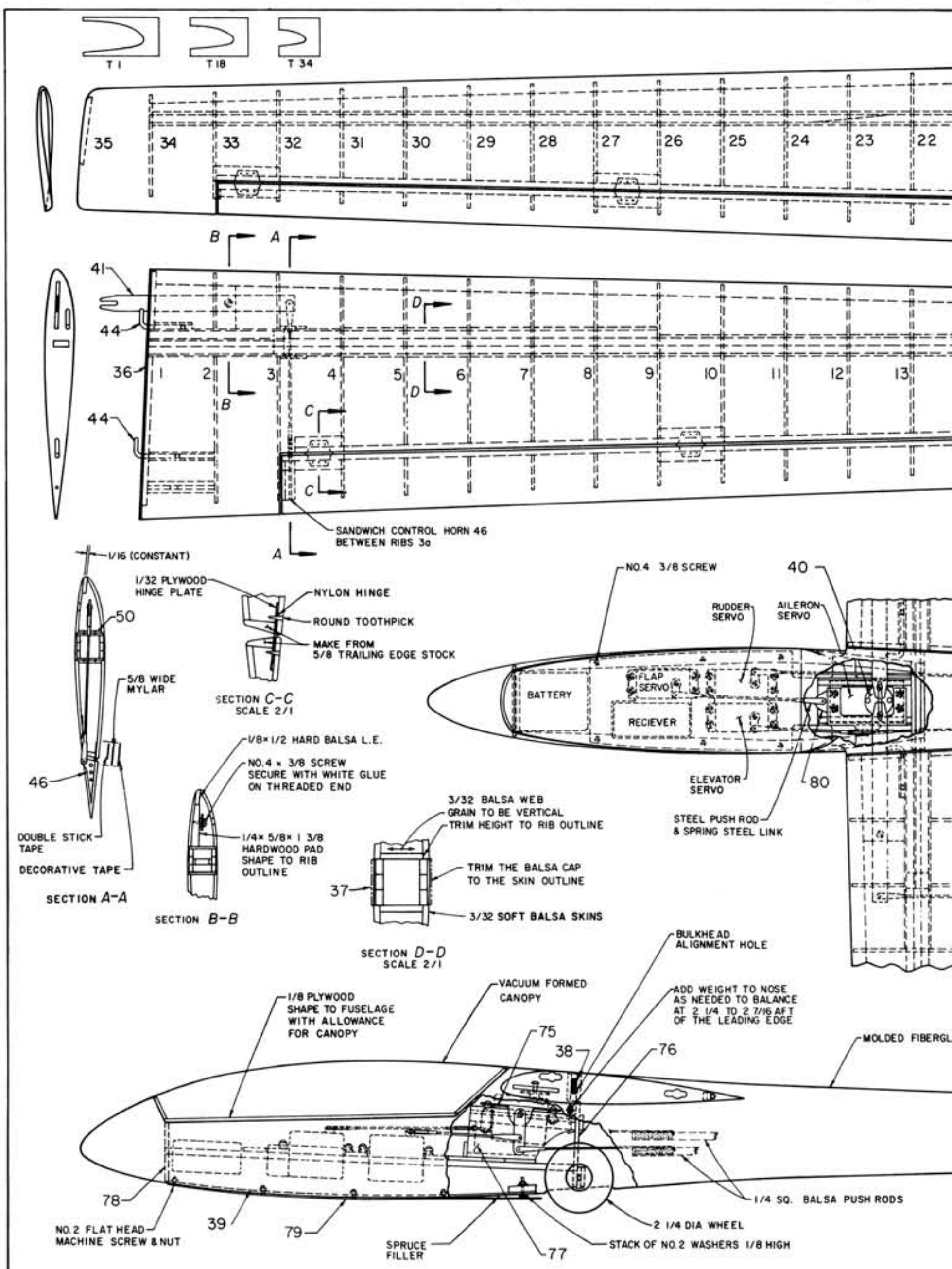
Konrad Nierich built the prototype. He finished it just one week prior to the North-South Challenge Meet at Bakersfield, California. As a rule, one would think that a week is not enough time to gain contest proficiency with a new plane. . .but Konrad is an exception. He won the Speed event, placed 5th in Precision, and 12th in overall points. The contest hosted 96 scoring contestants, from 15 participating clubs.

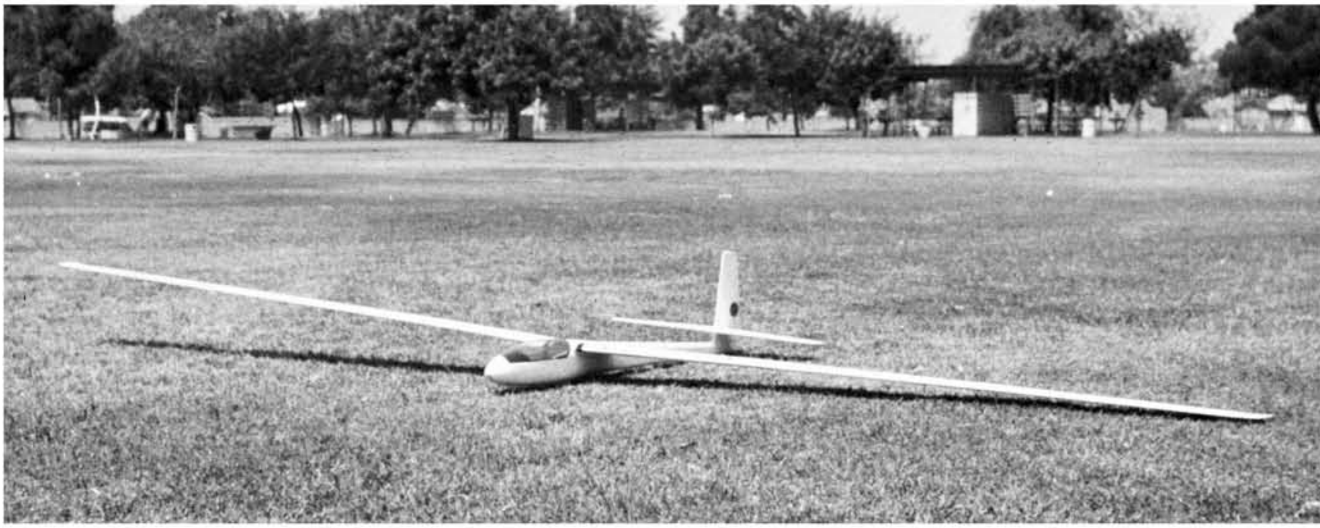
Konrad is a long time advocate of high wing loading to improve performance and flyability. His experience was repeatedly called upon to help make decisions for the design and construction of the plane.

CONSTRUCTION

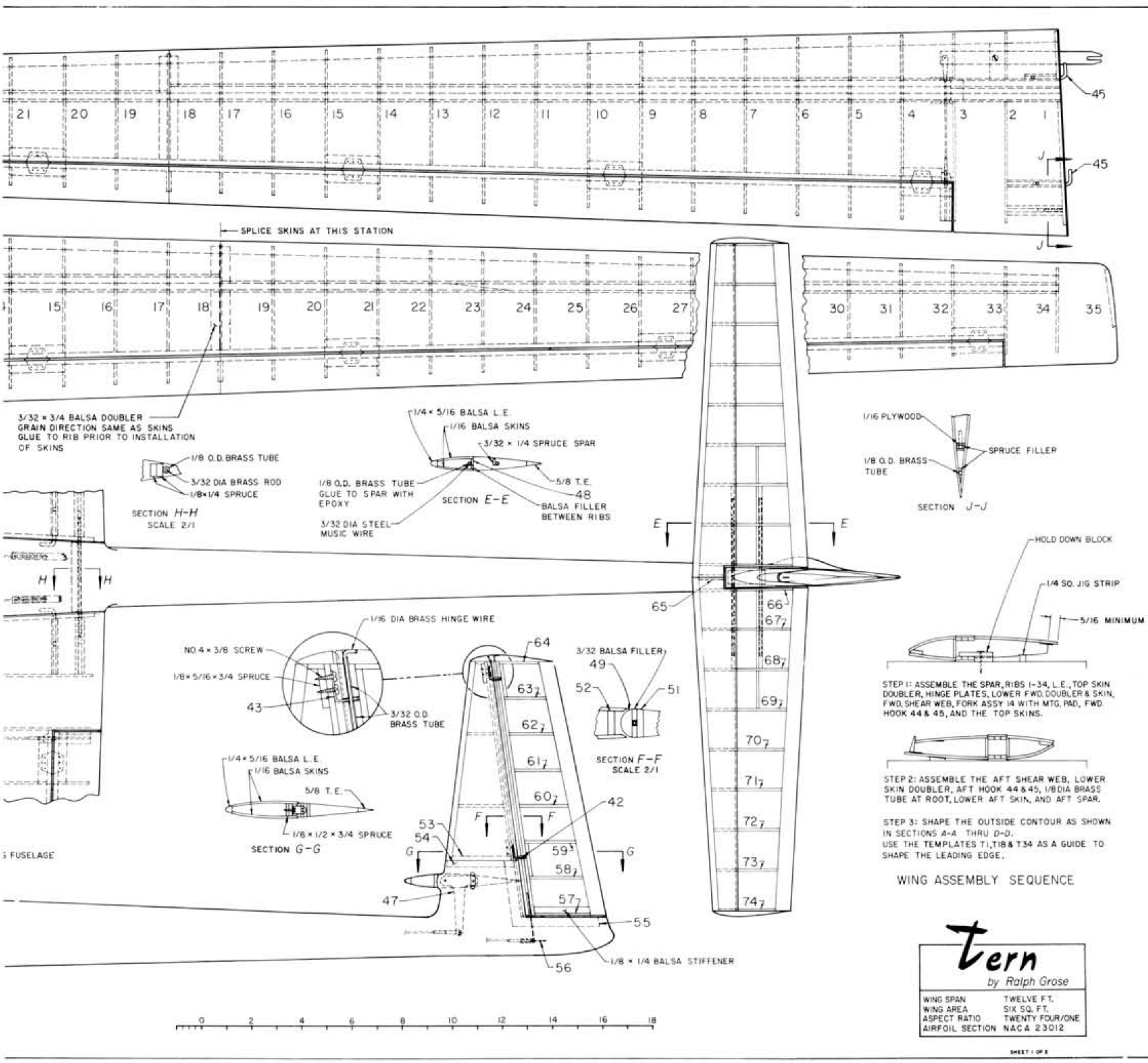
A fiberglass fuselage is available from Denovo Models, P.O. Box 2145, Westminster, California 92683. Fuse $35; canopy $4.

Begin with item 38 (on smaller plan sheet), blade stack. The strapping





Just as impressive at rest, the Tern looks like soaring personified. Fiberglass fuselage and steel reinforced wings make for durability.



material referred to is the kind used on shipping boxes. Material thickness is optional, providing the total stack height is about 3/16."

Use epoxy glue for all spruce to spruce joints. For spruce to fiberglass, epoxy glue or polyester resin is a good choice. Small strips of fiberglass cloth can be used to form fillets, such as around the edge of a bulkhead. Cured resin should be roughened with coarse garnet paper, prior to bonding. If 48-in. spruce is not available for the spar flanges, additional splices may be made without loss in strength. However, the spar glue joints are critical, so use care when fitting and don't spare the epoxy.

A close fit between the wing attachment socket and item 38 can be made as follows. Glue item 81 (filler block) between the upper and lower spar flanges. Shape the tapered dihedral wedges to match the blade stack height and width. Wrap one layer of waxed paper around the blade stack. Glue Glue and clamp the wedges and item 82 (filler block) in place around the blades. When the glue has set, remove the blades by pulling the center one first. To remove the waxed paper. push the stack back through. Complete item 37 (spar assembly) as shown, prior to starting the wing assembly.

The wing is assembled using the sequence shown on the plan. You will need about six hold-down blocks, as shown in Step 1. The ribs are notched to provide 2½° of wash-out, when the wing is built on the 1/4" sq. jig strip.

Note that the skins are spliced at rib 18. When gluing the 3/32" doublers to the rib, align them with the wing thickness taper so that the skin will lie flat. The skins are installed in individual 36-in. lengths, rather than the more normal splicing prior to installation. The forward lower skin will have to be held against the ribs with a 1/32" shim while being glued.

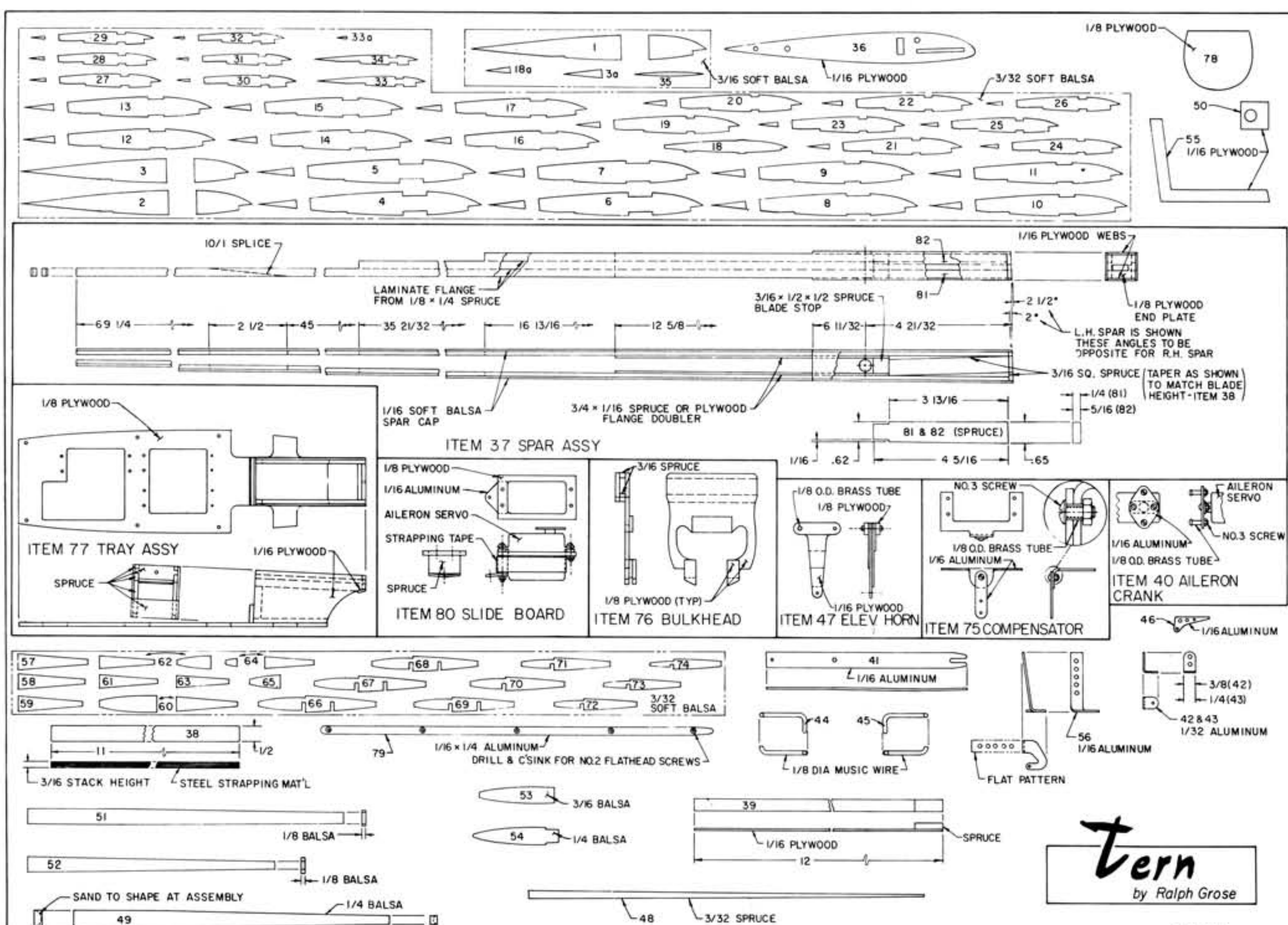
Pockets for the nylon hinges are made by wrapping a one-in. piece of waxed paper around the 1/32" plywood hinge pads. These cover the hinge area while the aft top skin is being attached. When finished with Step 1, remove the wing from the hold down blocks by pushing forward. Build both wing panels to this point; then compare them for wash-out. The exact amount is not critical, but they should be alike. Corrections can be made when the lower aft skin is attached, but that will be the last chance, so particular care must be exercised at that time.

Rib No. 1 is extra thick, to facilitate sanding to a good fit with the fuselage. Attach it with a 1/16" excess thickness past the end of the spar. Prior to adding item 36 (end cap), trim rib No. 1 to match the fuselage. When the wings are properly aligned, the aft edge of the spars forms a straight line from tip to tip.

The item 36 (end cap) can be used as a template to match the location of items in the wing to corresponding items in the fuselage, then attached to the wing. This part helps strengthen the wing socket, so epoxy glue should be used.

(Continued on page 82)

Just get a feel for the size of this bird. Twelve feet is nominal these days. . .but six lb. ain't. There are good reasons for flying at this weight, however.



TERN

With Speed growing in popularity as a soaring event, this bird is a guaranteed winner on the contest trail.

To build the aileron, butt splice the top skin first. Leave extra width at the leading edge, to be trimmed later. Bevel the trailing edge so it will match the underside of the ribs when they are in place.

Mark off the rib spaces and the leading edge spar location so the extra thick rib (18a) is centered on the splice. Install all parts, except the lower skin and the hinges.

Wash-out is built into the aileron as follows. Temporarily install the hinges and mount the aileron on the wing. Hold it in alignment with tape at each end, and at each hinge location; then attach the lower skin, a half length at a time.

The brass tube and spacer, shown in section H-H, should be the first part installed in the fuselage. No special sequence is needed for the remainder of the parts. To locate the main bulkhead, drill a 1/16" dia. hole through each side of the fuselage at the small indentation provided. Align the edge of the bulkhead on the center of the holes. The lower edge of the bulkhead should fit flush with the ends of the mounting rails. After the glue sets, the rectangular blade holes can be enlarged to match the socket in the bulkhead.

When gluing the three pieces of 3/32" tubing in the rudder assembly, as shown in section F-F, use 1/16" brass hinge wire to hold the tubes in line. With this type hinge, the rudder can be easily removed by pulling the hinge pin, thus providing access to the control horns and pushrods.

FLYING

A few hand launches are recommended. It's best to have an assistant do the launching, since it takes a hefty push to get six lb. up to flying speed.

A 12-volt winch should be used. Hold the plane down a little at the start, and don't pulse the winch until the last half of the launch. Control is similar to a full-scale plane, responsive at normal speeds with a loss of aileron control just prior to the stall.

Needless to say, a large field, with a minimum of obstructions, will help take the pressure off for the first landing. A properly trimmed Tern will give you a definite edge, whether you're completing, or just chasing that elusive thermal.