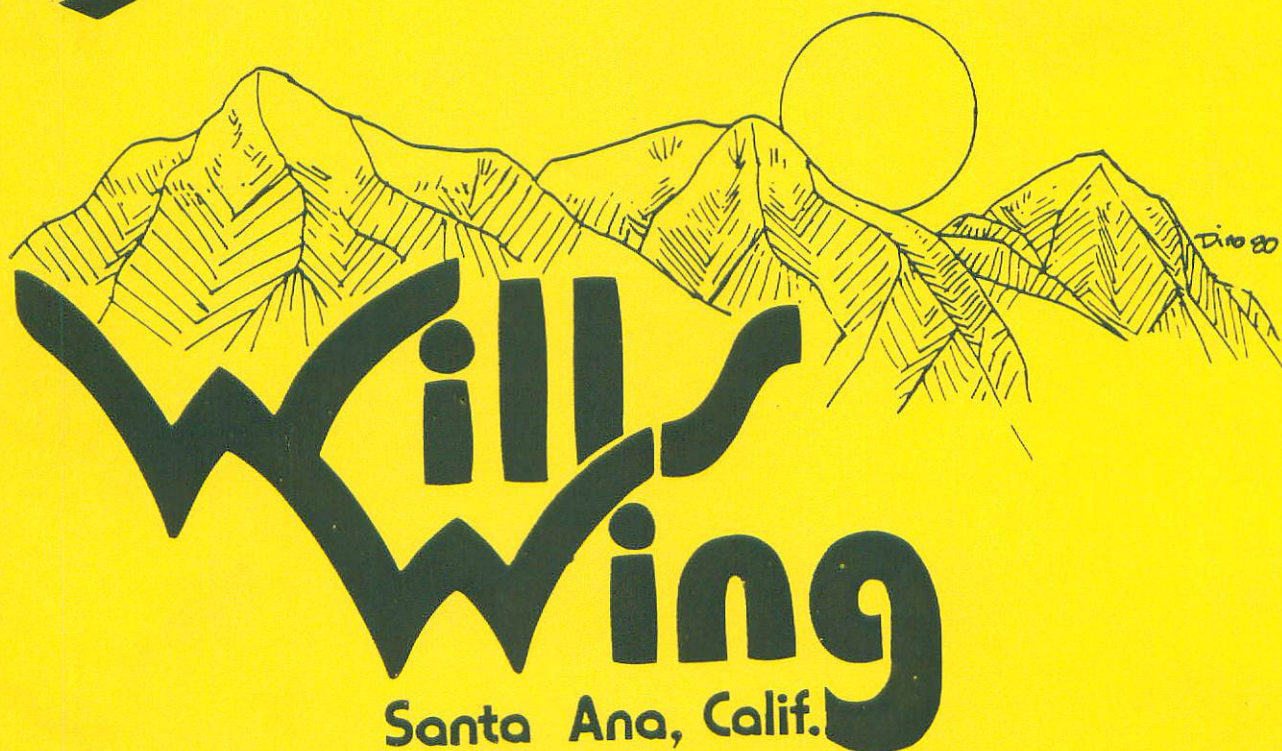
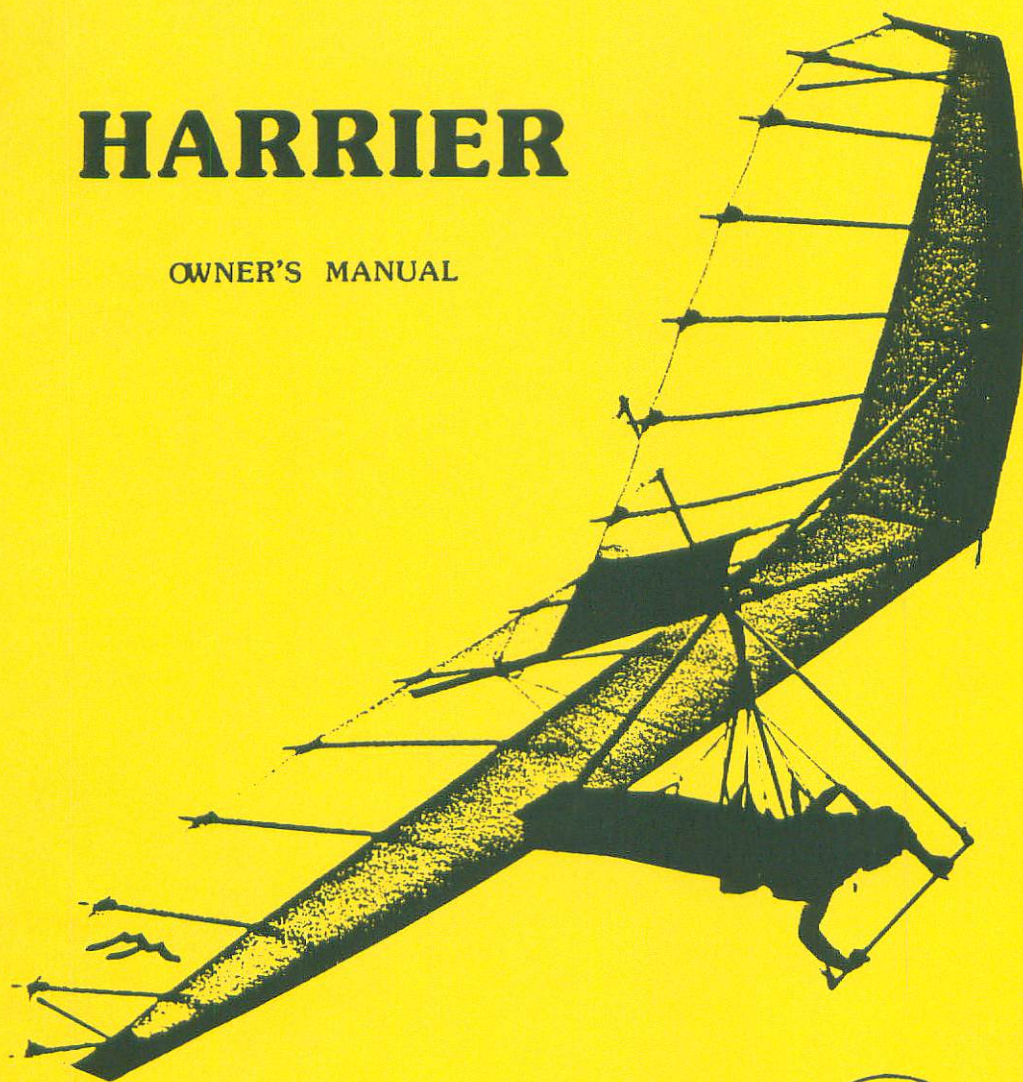


# HARRIER

OWNER'S MANUAL





# WILLS WING HARRIER

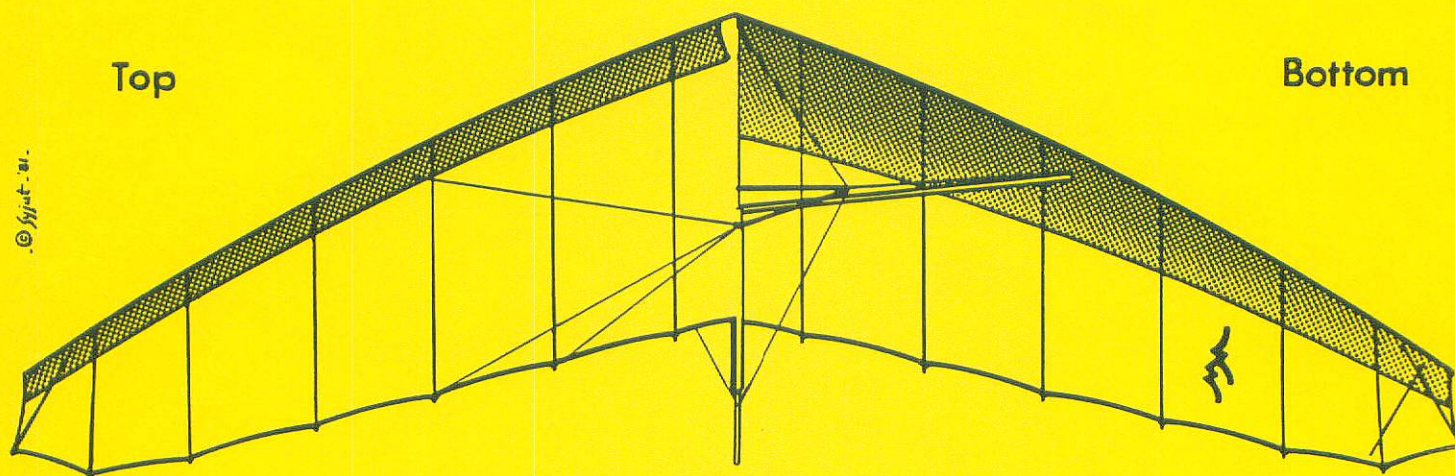
## TOTAL PERFORMANCE IN A SIMPLE ECONOMIC PACKAGE

With the increased sophistication of footlaunched soaring aircraft, has come a significant increase in cost. The **HARRIER** represents a solid investment for the serious pilot.

The **HARRIER** was released in a refined and polished configuration. The **HARRIER's** features include HGMA certification of both models, a uniquely versatile quick set-up system, mylar supported leading edge pockets, extensive reinforcement of high stress sail areas and protection of typical wear points, a comprehensive owners manual with full scale airfoil maintenance diagrams, batten bag, deluxe zipper glider storage cover and a conscientious test flight and quality control inspection by a professional factory pilot. The **HARRIER** is backed by the largest network of professional service centers in the industry.

The **HARRIER's** sink rate, L/D, and wide usable speed range provide you with a level of soaring and cross country performance previously unavailable in a flexwing. The **HARRIER's** advanced engineering gives you a strong, lightweight statically balanced aircraft that is highly responsive with light control pressures both in the air and on the ground. The **HARRIER** features a relatively high cruising speed with an excellent sink rate at higher speeds, yet it retains low speed launch and landing capabilities. The roll rate is quick, with light bar pressure and the **HARRIER's** response characteristics are extremely solid and comfortable in turbulent air.

The **HARRIER** will cost you \$1675. That's hundreds of dollars less than other high performance gliders. The quality of design and attention to detail that go into every **HARRIER** insure the value of your investment. If you're serious about flying, and you care about quality, test fly the **WILLS WING HARRIER**. We think you'll agree it's the best flying high performance recreational flexwing available at any price.



### HARRIER DIMENSIONS AND SPECIFICATIONS

Model Number	H-147	H-177
Area	147 Sq. Ft.	177 Sq. Ft.
Span	30'	33'4"
Nose Angle	130	130
Aspect Ratio	6.1	6.3
Glider Weight	51 lbs	63 lbs
Pilot Weight Range	110-210 lbs	150-250 lbs
Pilot Skill Rating	III	III

ALL HARRIERS ARE CERTIFIED TO CURRENT HGMA AIRWORTHINESS STANDARDS



## INTRODUCTION

Congratulations! You are now the owner of one of the finest high performance foot-launched soaring flex-wings manufactured today. Your Wills Wing Harrier is the product of an extensive design and development program aimed at optimizing your level of safety and confidence as a pilot, while providing you with a highly competitive level of sink rate and glide ratio performance.

Please read and be sure you thoroughly understand this manual before flying your Harrier. Hang gliding is an extremely demanding sport requiring exceptional levels of attention, judgement, maturity, and self-discipline. It is extremely unlikely that you will be able to participate in it safely unless you make a conscious and continual commitment to your own safety. Be sure you are thoroughly familiar with the set-up and break-down procedures as well as the pre-flight procedures which are described in this manual. Make sure you follow these procedures every time you fly. Never take anything for granted in flying; if you are in doubt about anything, stop and figure it out, consult your manual, your dealer, or Wills Wing, Inc.

We would like to welcome you to the Wills Wing family of pilots, and wish you a safe and enjoyable flying career.

Wills Wing, Inc.

## TECHNICAL INFORMATION

Your Wills Wing Harrier was designed specifically for footlaunched soaring flight, and represents a state of the art execution of the concept of a high performance footlaunched, weightshift controlled, ultralight soaring aircraft. The Harrier has been tested and certified as complying with the Hang Glider Manufacturer's Association 1980 Airworthiness Standards for utility class flex wings. The Harrier was not designed to be towed, tethered, or motorized, nor flown by more than one person at a time. We specifically recommend that you not attempt to fly your Harrier in any of these ways. Should you decide to do so anyway, please proceed with extreme caution and avail yourself of the experience and expertise of those people who are qualified in that particular area. Please be advised that Wills Wing can in no way be responsible for the airworthiness of or applicability to any specific purpose of any Wills Wing glider, except as described in the HGMA Airworthiness Standards.

Stall speed of the Harrier at maximum wing loading is 25 mph.

Top speed of the Harrier at minimum wing loading is 40 mph.

Recommended pilot weight range for the Harrier, including harness, etc, is; 147: 110-210 lbs.; 177: 150-250 lbs.; 187: 165-265 lbs.

Flight operation of the Harrier should be limited to non-acrobatic maneuvers, i.e. those in which the pitch angle will not exceed 30° nose up or nose down from the horizon, and in which the bank angle will not exceed 60°. The Harrier will resist spinning, and will tend to recover from a spin without entering extreme or unusual attitudes.

The positive limit load of the Harrier is 3 G's.

The negative limit load is 1.5 G's.

Note: These are the maximum loads to be expected in normal flight operation, the ultimate strength of the Harrier is much higher than this.

A USHGA pilot proficiency level of [III] or expert rating is required to fly the Harrier. Flight operation by unqualified pilots may be dangerous and is prohibited.

## HARRIER SET UP PROCEDURE:

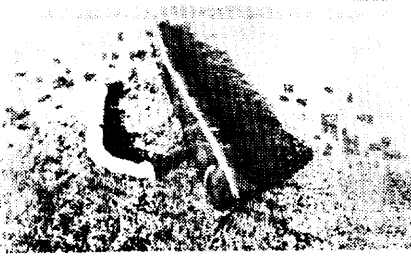
There are two different ways in which you can set up your HARRIER. In smooth winds of ten mph or less, it is best to assemble the glider on the control bar, so that you do not lay the sail on the ground.

In stronger or gusty winds, when you do not have someone to assist you, you can assemble the glider flat on the ground.

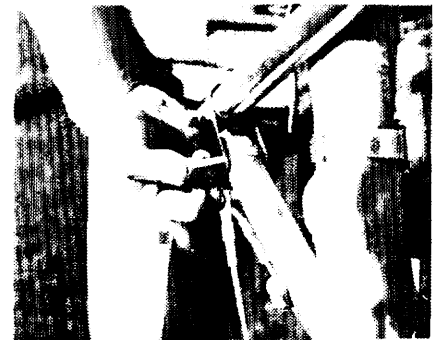
The procedure for the first method is as follows:

- 1) Lay the glider on the ground with the nose into the wind, and with the zipper on the bag facing upwards. (Picture 1.)
- 2) Unzip the bag and undo the velcro holding the pads in place at the rear keel and control bar. Lift the control bar uprights, allowing them to spread apart as you lift them forward. Attach the flying wires to the quick release at the nose, but don't snap the release shut yet. Swing out the base tube, and attach it to the upright as shown with the bolt, wingnut and safety provided. (Picture 2.)
- 3) Flip the glider upright and rest it on the control bar, nose into the wind as shown. (Picture 3.)
- 4) Remove the bag, and remove all the velcro straps. Spread the wings most of the way. (Picture 4.)

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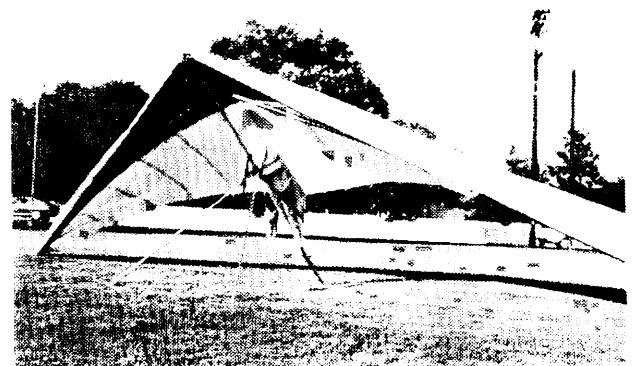
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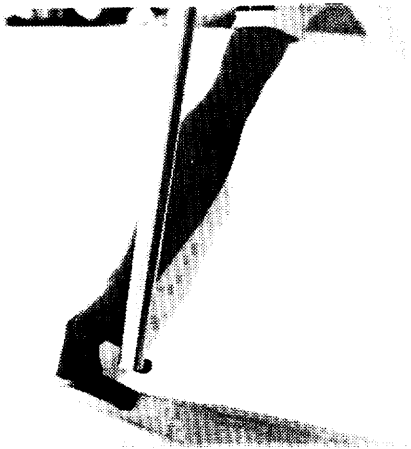


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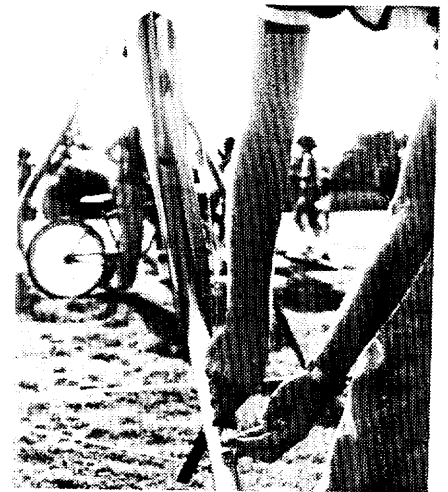


- 5) Lift the kingpost, and fit over the plug on top of the keel, taking care not to pinch the sail in the process. You must have the leading edges pulled out equal amounts,( i.e. the keel centered between the leading edges,) when you install the kingpost. (Picture 5.)
- 6) Attach the rear kingpost wire to the tang on top of the rear of the keel as shown. Fit the reflex support post over the protruding stud on top of the keel. ( Picture 6.)
- 7) Insert the battens into the sail as shown. ( Picture 7.) Order of battens is longest to shortest, from the root outwards. Be extremely carefull when inserting the battens. Go slowly and do not allow the batten to cock sideways and slide against the seam at the side of the pocket. If it does, gently pull it out a little, apply a gentle torque to the batten to turn the tip away from the seam, and reinsert it. If you are having trouble inserting the battens, try folding the wings in a little, or out a little to change the spanwise tension on the sail. You MUST insert the battens before you push the crossbar back through center; otherwise there will be too much tension in the sail. If you are careless inserting the battens, you will likely ruin your sail, or at the very least, alter the camber in your battens.
- 8) After each batten is inserted, pull the bungee back and fit it over the end of the batten as shown. ( Picture 8.)

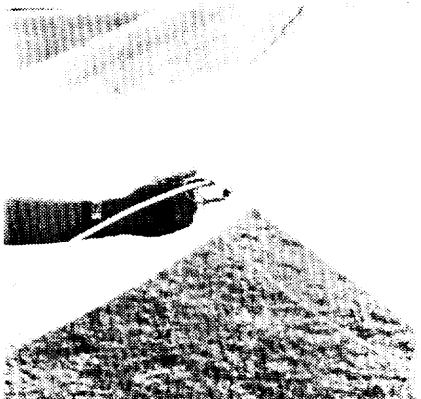
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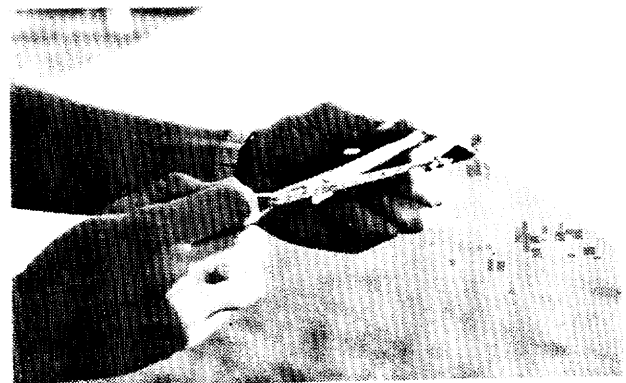
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- 9) Fit the washout tips over the plug on the leading edges, and slide the tips up against the leading edges. (Picture 9.)
- 10) Spread the wings all the way, and check that there are no twisted thimbles or tangs. (Picture 10.)
- 11) Check for twisted thimbles on the front to rear wires, and then snap the quick release at the nose shut. Slide the safety sleeve over the quick release. (Picture 11.)
- 12) Push back on the crossbar center section until it goes past center and rests against the kingpost. (Picture 12.) Note: YOU MUST NEVER PUSH THE CROSSBAR BACK, OR RELEASE IT FORWARD, WITHOUT THE PROTECTOR BAG IN PLACE OVER THE CROSSBAR CENTER SECTION. If you do, you will score the keel deeply, and it will have to be replaced.

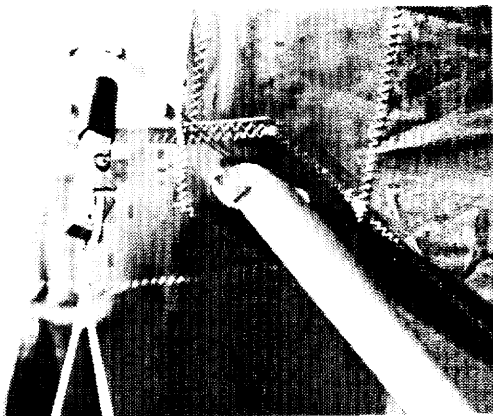
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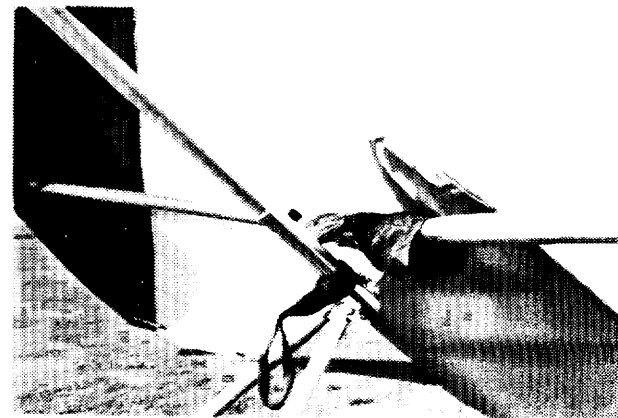
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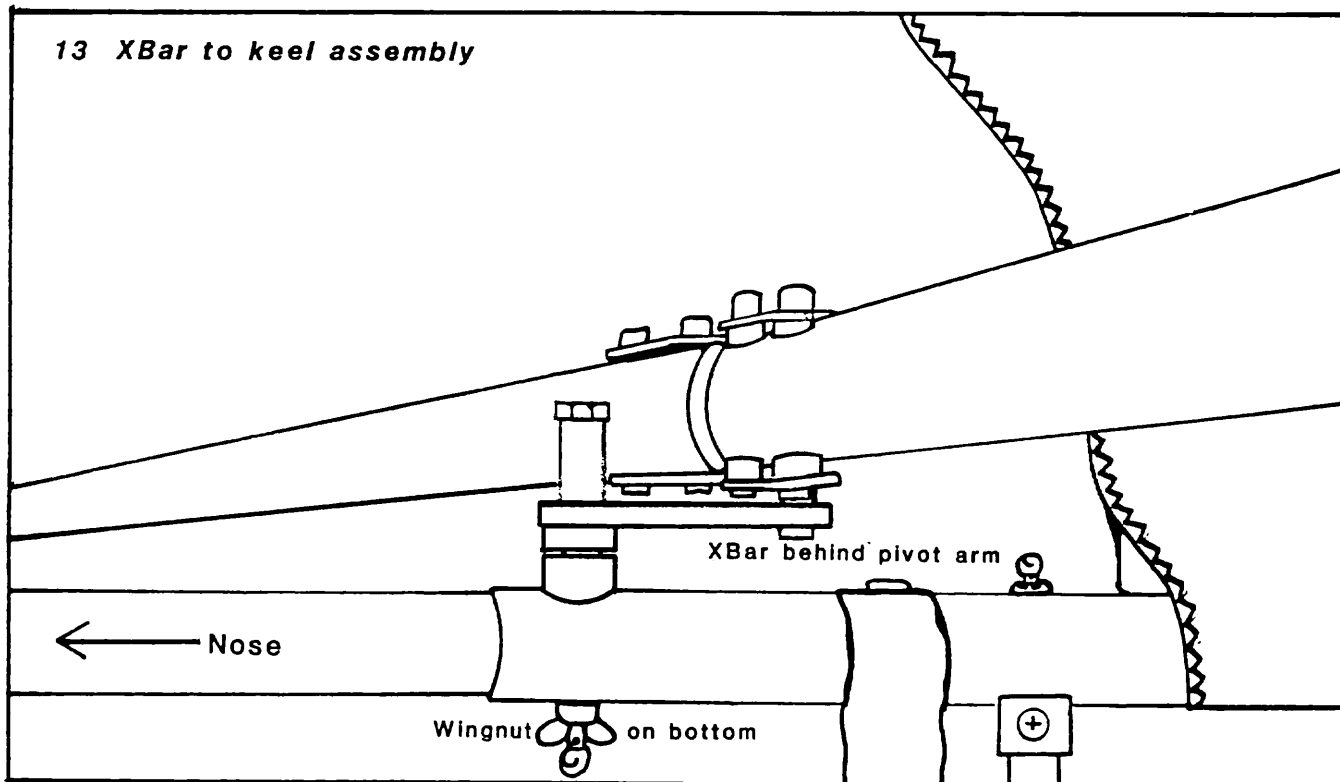
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13) Slide the crossbar protector bag to one side, pull the crossbar forward, and secure the crossbar pivot arm to the keel as shown. (Figure 13) The anchor bolt is stowed in a small pocket in the crossbar protector bag.

IMPORTANT: 1) You MUST assemble the crossbar to the keel BEHIND the pivot arm as shown. This proper assembly puts about  $5^{\circ}$  of negative sweep in the crossbar, and provides a restoring force to return the crossbar to center.

2) You MUST install the wingnut on the bottom of the keel, as shown. If installed on top of the pivot arm the wingnut may possibly snag one of the bolt heads on the bottom of the xbar plate in flight, locking the crossbar off-center. FAILURE TO FOLLOW EITHER OF THE ABOVE ASSEMBLY PROCEDURES MAY RESULT IN AN UNRECOVERABLE SPIRAL DIVE. Do not overtighten the wingnut.

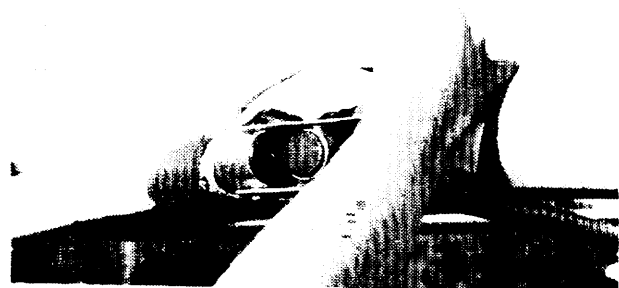


14) Insert the nose batten as shown and secure it with the velcro at the nose.  
(Pictures 14a and 14b)

14a



14b

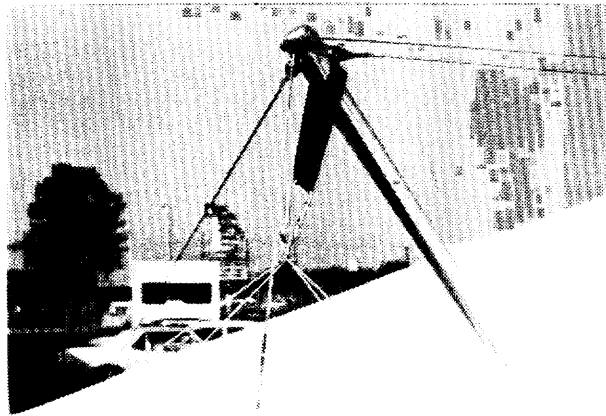




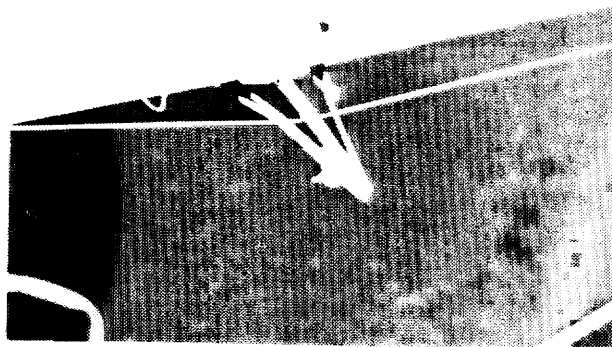
- 15) Attach the reflex support bridle system as shown.\*( Picture 15.)
- 16) Do a complete preflight inspection of the glider, checking every part, nut, bolt, cable, assembly, etc. Check each seam in the sail carefully for tears or wear points. Inspect your suspension loop and safety. These should be replaced at least once a year, or immediately if they show any signs of wear. Check your bridles for wear, and make sure that the outboard bridle is not hooked underneath the #6 batten. ( Picture 16.)

( \* You may find this easier to do before you tension the crossbar.)

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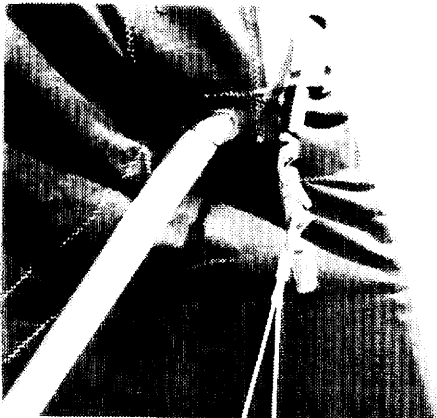
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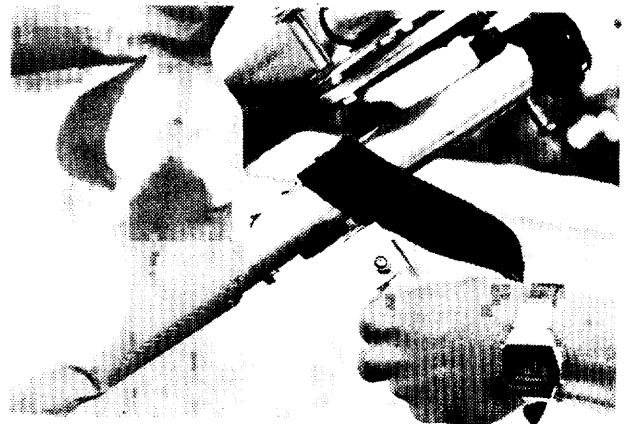
Once your HARRIER has been set up, you can lay it flat on the ground, if you wish, by using the following procedure:

- 1) With the nose of the glider facing into the wind, slide the safety sleeve off of the quick release latch handle at the nose and undo the release. ( Picture 1.)
- 2) Remove the safety and nut from the bolt which holds the control bar bracket to the keel, remove the bolt, and lift on the keel while pulling the top of the control bar to the side and then forward. ( Picture 2.)
- 3) Lay the control bar down, and lay the glider down flat as shown. ( Picture 3.)

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## ALTERNATIVE HARRIER SET UP PROCEDURE:

Your HARRIER may be set up flat on the ground, using the following procedure:

- 1) First read through and be sure you understand the set up procedure detailed earlier in this manual. Begin with the glider on the ground, nose into the wind, zipper facing upwards, as in the other set up procedure.
- 2) Unzip the bag and assemble the control bar as previously described.
- 3) Remove all velcro straps from the glider, and fold out one wing part way so that you can reach the nut on top of the keel which secures the control bar bracket to the keel.
- 4) Detach the control bar bracket from the keel, and lay the control bar against the keel with the top of the control bar pointing towards the nose.
- 5) Fold the partially deployed wing in again, and flip the glider over with the control bar resting underneath the glider.
- 6) Fit the kingpost over the plug on top of the keel, and attach the rear kingpost cable as previously described. Fit the reflex support post over the stud on top of the keel.
- 7) Spread the wings most of the way, and insert the battens, carefully following the procedure described earlier.
- 8) Fit the washout tips over the plugs and slide them against the leading edges.
- 9) Spread the wings as far as possible, and check to see that there are no twisted thimbles or tangs.
- 10) Lift the glider at the nose\*, lifting the control bar at the same time, and swing it back into position beneath the keel. Secure the control bar to the keel with the bolt, nut and safety.
- 11) Check for twisted thimbles in the front to rear wires, and snap the quick release shut. Slide the safety sleeve over the quick release handle.

\* Take care not to overstress the keel in bending when lifting the nose. Lift gently, and make sure the nose is into the wind.



- 12) Check that there are no twisted thimbles or tangs on the side wires. Push back on the crossbar center section until it cams through the center and rests against the kingpost.
  - 13) Secure the crossbar pivot arm to the keel as previously described. Take care not to overtighten the nut.
  - 14) Insert the nose batten as described previously.
  - 15) Attach the reflex support bridle system as previously described and perform a complete preflight inspection of the glider.
- Refer to the steps and pictures in the set up procedure detailed earlier in the manual, and to the description of the preflight check given earlier to be sure that the glider is properly assembled.

#### LAUNCHING YOUR HARRIER

After you have preflighted your glider, carefully check the conditions and make sure they are appropriate. Make sure that you are prepared, mentally and physically for the flight. Put on your harness and helmet, and hook into the primary and safety suspension loops. Do a hang check, making sure that you are hanging high enough from the base tube that your harness and parachute clear the base tube throughout the entire range of pitch control. You should not hang more than six inches from the base tube.

The HARRIER has neutral static balance. When you hold the glider prior to your take off run, you should have the nose slightly elevated, and the wings level. Make sure once again that the conditions are right for launching. If the wind is more than ten mph, or is gusty, you should have a qualified person assist you on your front wires. When using an assistant, make sure you clarify what signals will be used for the release. Make sure all spectators are clear to either side of the direction of your intended launch run. Check once more that you are hooked in. Lift the glider, and hold it wings level and nose into the wind, with the nose slightly elevated. Clear your wire man and/or any spectators, give a good aggressive take off run, and push out. Have a good one!

## FLYING YOUR HARRIER

The HARRIER has fairly straightforward handling characteristics, and you should be able to adapt to them without undue difficulty. You should take your first flight from a familiar site in smooth conditions. One thing to keep in mind during your early flights is to consciously fly a little faster than you are used to, if you have been flying a conventional flex wing such as the Raven. The HARRIER will resist dropping its nose when stalled, and as a result will fly, with some degree of controllability, at speeds well below its minimum sink speed. If you are accustomed to flying as slow as possible to achieve minimum sink, you will tend to fly the HARRIER too slow at first, sacrificing performance and low speed control response. A technique we have found helpful is to maintain a reasonable cruising speed right through the process of turn initiation when entering a thermal, and then after the turn has been established, to slow the glider down slightly to allow for a tighter, flatter banked turn. The HARRIER maintains a good sink rate over a fairly wide range of speeds in the lower speed range, so the primary advantage of slowing down is not to improve sink rate, but to allow for a flatter bank angle in a tight radius turn. Most of the time, except when you are in a well established turn, the extra control afforded by a little more speed will increase your effective performance.

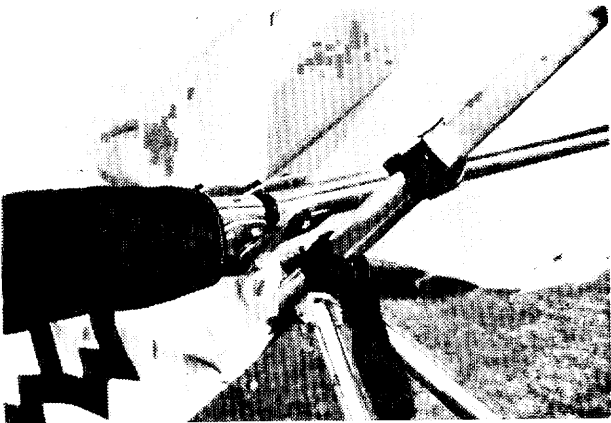
## LANDING YOUR HARRIER

The HARRIER is not a difficult glider to land, but it does require a slightly different technique from what you are probably used to. It is important that you have the wings level and be pointed and flying directly into the wind when you flare. Turns are difficult to execute close to the ground, and you should try to set up a straight final approach. Until you become used to landing your HARRIER, you may find yourself flaring too early. The HARRIER will fly down to a much lower speed in ground effect than it will in normal flight, and as a result it will glide much farther on your final approach than you will expect. If you flare too early, you will climb out before the glider stalls, and then come down harder than you wanted to, probably dropping the nose or a wing or both. On your first landing, bleed your speed off gradually, holding off on your flare until you're SURE the glider won't glide any farther; then flare aggressively and hold the bar out.

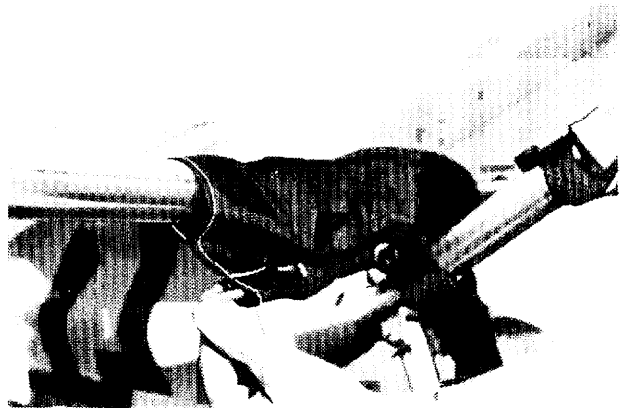
## BREAKING DOWN YOUR HARRIER

- 1) Rest the glider on the tail, nose into the wind, and position the crossbar protector bag adjacent to the crossbar center section. Remove the crossbar anchor bolt, and let the crossbar rest against the kingpost. ( Picture 1.)
- 2) Slide the crossbar cover bag over the center section, and stow the bolt, nut and safety in the pocket in the cover bag. ( Picture 2.)
- 3) Pull the crossbar center section forward until it goes through the center, de-tensioning the sail. Allow the glider to rest on the tail as shown. ( Picture 3.)
- 4) Detach the front flying wires completely. ( Picture 4.)

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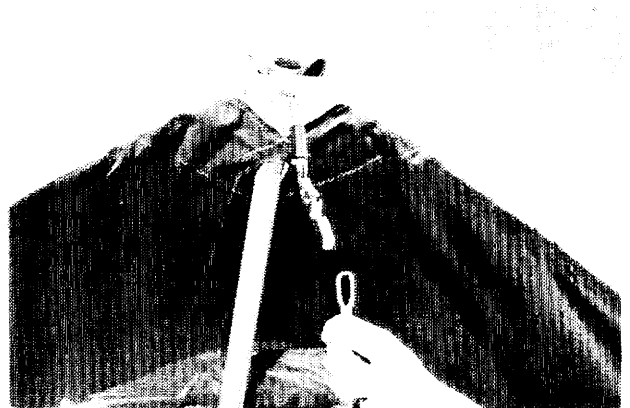
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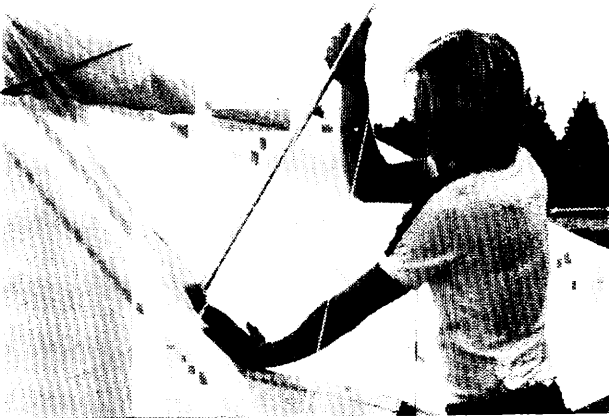
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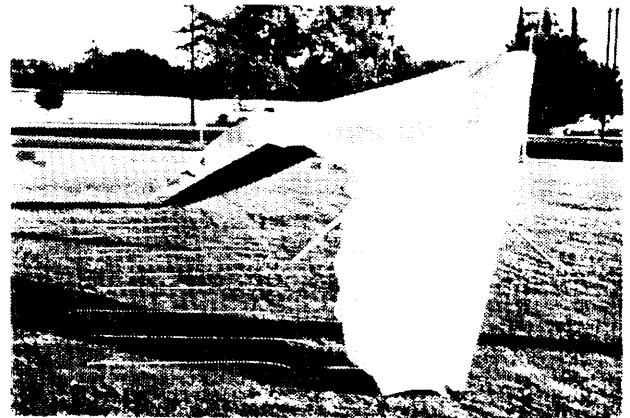


- 5) Detach the reflex support bridle system. Detach the rear kingpost wire. Detach the reflex support post. Lift the kingpost off the plug on top of the keel. ( Picture 5.) Stow the kingpost inside the keel pocket with the bottom end of the kingpost to the rear, and the end of the kingpost slid over the reflex support post. This will keep both the kingpost and the reflex post neatly stowed.
- 6) Pull the wings in slightly and carefully remove all of the battens. ( Picture 6.)
- 7) Fold the leading edges all the way in, pulling the sail over the tops of the leading edges, and taking care that the crossbar center section does not become jammed between the keel and leading edge. Before you can fold the leading edges all the way together, you will have to disengage at least one of the washout tips. ( Picture 7)
- 8) Place the battens together carefully, and put them in the batten bag. Roll one side of the sail, and place a velcro around it to hold it while you roll the other side. ( Picture 8.)

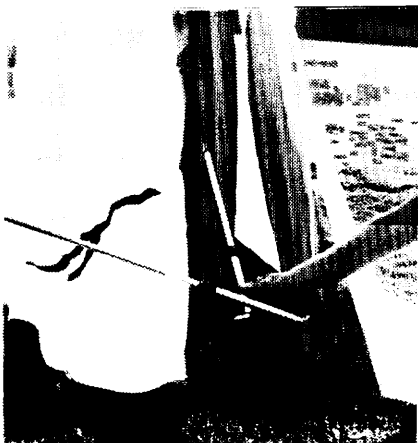
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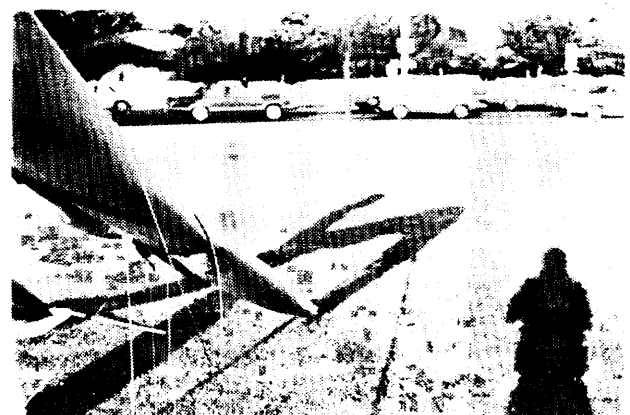
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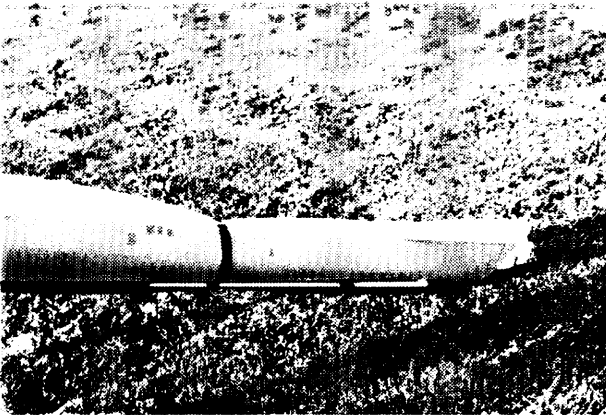
9) Roll the other side of the sail, and place a velcro around both leading edges at the rear of the keel. Try to keep the mylar smooth, and do not cinch the velcros too tight. Attach a velcro at the rear of the leading edges, holding the tips against the leading edges.

( Picture 9.)

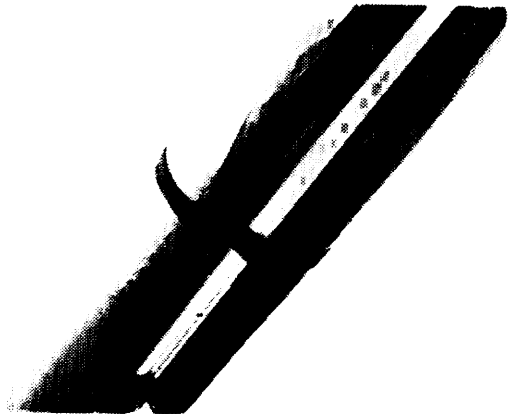
10) Attach a velcro over the top of the keel and around the front leading edges as shown. ( Picture 10.)

11) Remove the nose batten by undoing the velcro, and pulling the batten to one side as shown. The end of the batten will slide out of the pocket and you can pull it out. ( Picture 11.)

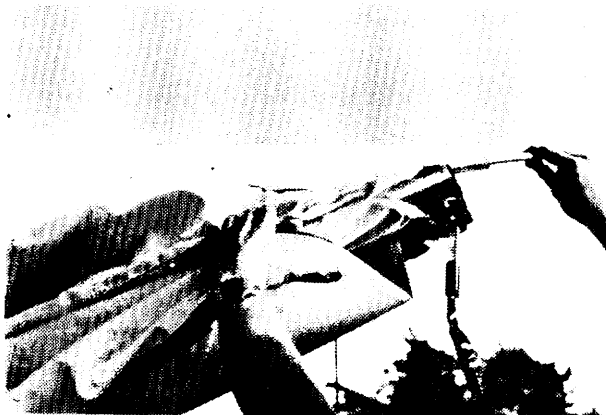
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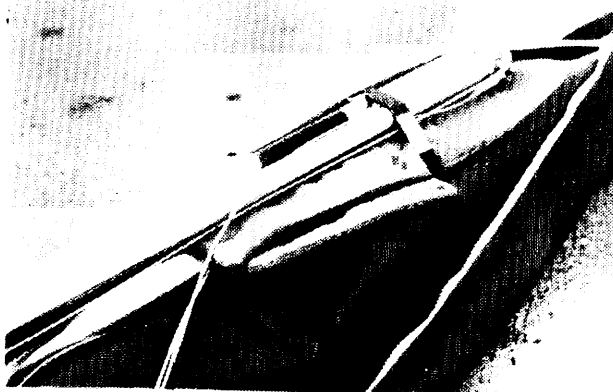


- 12) Put the bag on the glider with the red flag at the tail. Flip the glider over and lay it down. Disconnect the base tube from the upright and fold the base tube to the other upright as shown. ( Picture 12.)
- 13) Fit the short part of the red pad between the keel and leading edges, and the long part of the pad between the keel and control bar. Pass the velcro strap around the glider, and fasten it securely, but not too tightly.(Picture 13.)
- 14) Tuck the cables inside the bag and zip up the bag.

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## TUNING YOUR HARRIER

Your HARRIER was test flown by a factory trained pilot prior to shipment, and should also have been flown by your dealer. It is unlikely that you can improve the performance or handling characteristics of your glider by changing the tuning from the factory settings, and you should not make any adjustments other than those described in this manual unless you are quite sure that your glider is not flying properly. Before making any adjustments not specifically described in this manual, consult your dealer or Wills Wing, Inc.

There are two holes in the keel to which the hangstrap may be mounted. Moving the strap forward will increase the hands off trim speed of the glider; mounting the strap to the rear hole will result in a lower trim speed. If you change the trim speed by moving the strap, be sure to use a new nylock nut to secure the strap in the new position.

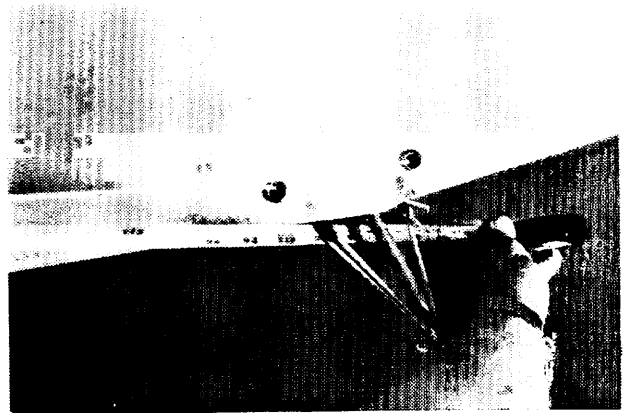
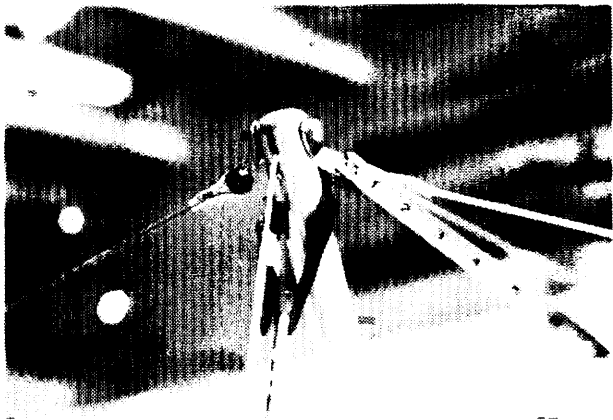
You will need to periodically check your battens for the proper shape. Inserting and removing the battens from the glider will tend, over a period of time, to remove some of the camber from the battens. Enclosed with this manual are diagrams showing the proper shape for each batten. You should inspect your battens every time you put them away, and before you install them prior to each flight. Check that corresponding right and left battens are the same, and that no battens are obviously bent out of shape or broken. Approximately every ten flights or so, you should check each of your battens against the appropriate diagram. The line on the diagram represents the outside edge of the curve of the batten. If you need to correct the shape of a batten, bend it carefully around a smooth radius which is slightly smaller than the radius of the desired curve. Work carefully when bending the battens, try to keep all the bends in the same plane, and avoid sharp bends or kinks. If you have a batten that is badly bent so that you cannot correct the shape, replace it.

You will also need to periodically check the adjustment of your reflex support bridles. Unlike the Raven and earlier Wills Wing gliders, the HARRIER requires precise adjustment of the bridles to maintain the proper aerodynamic characteristics. The bridles are accurately set at the factory, but stretch in

the bridle cables may cause the adjustment to change. You can check the adjustment by hooking a tape measure into the outside hole in the kingpost side wire tang as shown below (Picture 1) and measuring to the point of intersection between the trailing edge and the inside bungee webbing loop at each of the bridle battens (Picture 2). The measurement should not be more than the specified measurements for each bridle on the appropriate spec sheet, (pg.20,21) If the bridles are too loose, you can tighten them by readjusting the webbing loop to which they attach. (Picture 3.)

*The bridle measurement may vary with variations in sail mounting tension and position. The bottom line is this: when properly adjusted, the bridle lines will be just slack in flight. If the bridle lines are pulling reflex into the bridle battens, they are too tight. The surest way to achieve the correct adjustment is to tighten them in small increments until they just become tight, and then loosen them 1/4". Overtightening the bridles will dangerously degrade the handling characteristics.*

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3



## MAINTENANCE OF YOUR HARRIER

Your HARRIER should have a thorough maintenance inspection every six months or 30 hours of airtime, whichever comes first, or whenever you have any reason to suspect that it may have been damaged. Maintenance and service on your HARRIER should be performed by your Wills Wing dealer. Should you need to perform your own service for any reason, you should obtain a copy of the HARRIER Service Manual from Wills Wing.

Your tip bungees and bridle cables should be replaced at six month intervals, or whenever they show any signs of wear. Hang loops, all cables and harness support straps should be replaced at least once a year, or immediately if they show any signs of wear. You should fly only with a harness that has been tested for strength by the manufacturer.

Any parts of your glider which show signs of wear should be replaced immediately. Any tears or defects in the sail should be immediately repaired by a professional sailmaker. If your glider is ever exposed to salt water, you should wash it immediately and thoroughly rinse it with fresh water, then dry it completely. Anytime your glider is exposed to water, you should remove the endcaps from all tubes and swab the insides of the tubes with an oil dampened rag. Your sail should never be washed in anything other than fresh water; any soap or detergent will likely damage the sail cloth and reduce its life, and may adversely affect the flying characteristics of the glider.

With proper care and maintenance, your glider will retain for some years, a high level of airworthiness. The HARRIER has been tested and certified as complying with the 1980 HGMA Airworthiness Standards, which represent the best accumulated knowledge of what constitutes airworthiness in a hang glider. There is much that we still don't know, such as what is the effective lifetime for a hang glider before material fatigue and degradation compromise the glider's airworthiness. We do know that there are forces in nature that can severely compromise your safety regardless of the quality of design or condition of the aircraft you are operating. Your safety is ultimately your responsibility. We strongly recommend that you fly conservatively, both in the choice of the conditions in which you fly, and the safety margins you allow in the maneuvers you attempt. We recommend that you always fly with an emergency parachute system.

## CAR TOP MOUNTING

Your HARRIER should be mounted on your rack with the control bar bracket facing upwards. Your rack should have at least three support points (four is better) spanning at least 13 feet of the glider. No more than three feet of the tail end of the glider should extend beyond the last support. All supports should be heavily padded, and as wide as possible to distribute the load. (4 inches is good.) You should be very carefull when securing your battens for transport that you do not bend them.

## A FEW LAST WORDS

Your Wills Wing HARRIER is a sophisticated high performance glider which will give you years of safe and enjoyable soaring, provided that you treat it properly and always maintain a healthy respect for the demands and potential dangers of flying. Please remember that aviation is always potentially dangerous, and that your safety depends on you. You are reminded that product liability insurance is unavailable for hang glider manufacturers, and that you fly a hang glider at your own risk.

See you in the sky!

Wills Wing, Inc.



COMPLIANCE VERIFICATION  
SPECIFICATION SHEET

**WILLS WING, INC.**

1208-M E. WALNUT - SANTA ANA, CALIFORNIA 92701  
(714) 547-1344

## HARRIER 177

1) Weight of glider in lbs. w/bag	65 pounds	or 67 pounds	with optional mylar	
2) Leading Edge Tube length, O.D.	222 "	2" front	1.875" rear	
Holes at:	1" 112"			
Keel Tube length, O.D.	130" 1.5"			
Holes at:	1" 3" 52.375"	58.75" 60.75"	86.125" 111.75"	
XBar Tube length, O.D.	100.0625" 1.75"			
Holes at:	.5" 1.5" 97.5625"	99.5625"		
Kingpost Tube length, O.D.	41.625" 1.125"			
Holes at:	none			
Control Bar Leg length, O.D.	69.5" 1.125"			
Holes at:	.5" .875" 69"			
Control Bar Base length, O.D.	59.8" 1.125"			
Holes at:	.5" 59.5"			
Washout Tips length, O.D.	32" .75" .625"			
Holes at:	none			
3) Washout Tip Angle	19.5°			
Control Bar Angle	3° forward			
4) Distance Sail to Xbar	5" $\pm$ 1"			
5) Distance Sail to Keel	7" $\pm$ 1"			
6) Distance Bridle to KP	From outside hole; kp tang to trailing edge; inside bungee:			$\leq 65", 95"$
7) Chord @ Root + 3'	83"			
Chord @ Tip - 3'	46"			
8) Span of Sail	33' 4"			
9) Bow in Leading Edge	deflexorless-	sail preloads	to about 4"	
Bow in Keel	none			
Bow in XBar	none			
10) Placard Location	xbar			
Test Fly Sticker	xbar			
11) Pilot Flying Weight	150 to 250 pounds			
Pilot Proficiency	IV			

COMPLIANCE VERIFICATION  
SPECIFICATION SHEET  
HARRIER 147

**WILLS WING, INC.** 

1208-H E. WALNUT - SANTA ANA, CALIFORNIA 92701  
(714) 547-1344

1) Weight of glider in lbs. w/bag	54 lbs				
2) Leading Edge Tube length, O.D.	200" 1-3/4"				
Holes at:	1, 102, 114, 191, 198-1/8, 198-3/8				
Keel Tube length, O.D.	123" 1-1/2"				
Holes at:	1, 3, 48-5/8, 54, 55-3/4, 57, 80-3/8, 108				
XBar Tube length, O.D.	92" 1-3/4.049				
Holes at:	1/2, 2-1/2 each end				
Kingpost Tube length, O.D.	41-5/8" 1-1/8"				
Holes at:	1/4", 1"				
Control Bar Leg length, O.D.	63 " 1-1/8"				
Holes at:	1/2, 7/8, 1/2 Other end				
Control Bar Base length, O.D.	54.5"				
Holes at:	1/2"				
Washout Tips length, O.D.	32"				
Holes at:					
3) Washout Tip Angle	24°				
Control Bar Angle	-6°				
4) Distance Sail to Xbar	6"				
5) Distance Sail to Keel	10"				
6) Distance Bridle to KP	from outside hole; KP tang to trailing edge; inside bungee <sup>≤ 50, 76-3/4"</sup>				
7) Chord @ Root + 3'	78"				
Chord @ Tip - 3'	43"				
8) Span of Sail	30'				
9) Bow in Leading Edge	3"				
Bow in Keel	0				
Bow in XBar	0/swept 2 piece				
10) Placard Location	Xbar				
Test Fly Sticker	Xbar				
11) Pilot Flying Weight	110-210				
Pilot Proficiency	III				

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COMPLIANCE VERIFICATION  
SPECIFICATION SHEET**WILLS WING, INC.**1208-H E. WALNUT - SANTA ANA, CALIFORNIA 92701  
(714) 547-1344

1) Weight of glider in lbs. w/bag	72.5 lbs.				
2) Leading Edge Tube length, O.D.	19' 3" 2" /	1 7/8" /	1 3/4"		
Holes at:	1, 115				
Keel Tube length, O.D.	130" 1 1/2"				
Holes at:	1, 3, 54.125, 58.5, 59.5, 61.25, 62.5				
XBar Tube length, O.D.	103.8125	1 3/4			
Holes at:	.5, 2.5 each end				
Kingpost Tube length, O.D.	42" 1 1/8"				
Holes at:					
Control Bar Leg length, O.D.	69.5 1 1/8				
Holes at:	.5 .875 . 69				
Control Bar Base length, O.D.	59.8" 1 1/8				
Holes at:	.5, 59.3				
Washout Tips length, O.D.	32" .75 /	.625			
Holes at:					
3) Washout Tip Angle	23°				
Control Bar Angle	3°				
4) Distance Sail to Xbar	5"				
5) Distance Sail to Keel	7"				
6) Distance Bridle to KP	outside hole of kp tang to trailing edge at webbing				
7) Chord @ Root + 3'	85"		73.75, 104.875		
Chord @ Tip - 3'	46"				
8) Span of Sail	34' 8"				
9) Bow in Leading Edge	4"				
Bow in Keel	none				
Bow in XBar	none				
10) Placard Location	xbar				
Test Fly Sticker	xbar				
11) Pilot Flying Weight	165 to 265 lbs.				
Pilot Proficiency	III				

# **HARRIER**

## **SERVICE MANUAL**

**WILLS WING INC.**

1208 H East Walnut

Santa Ana Ca. 92701

714 547 1344

*PEARSON*

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## Assembly

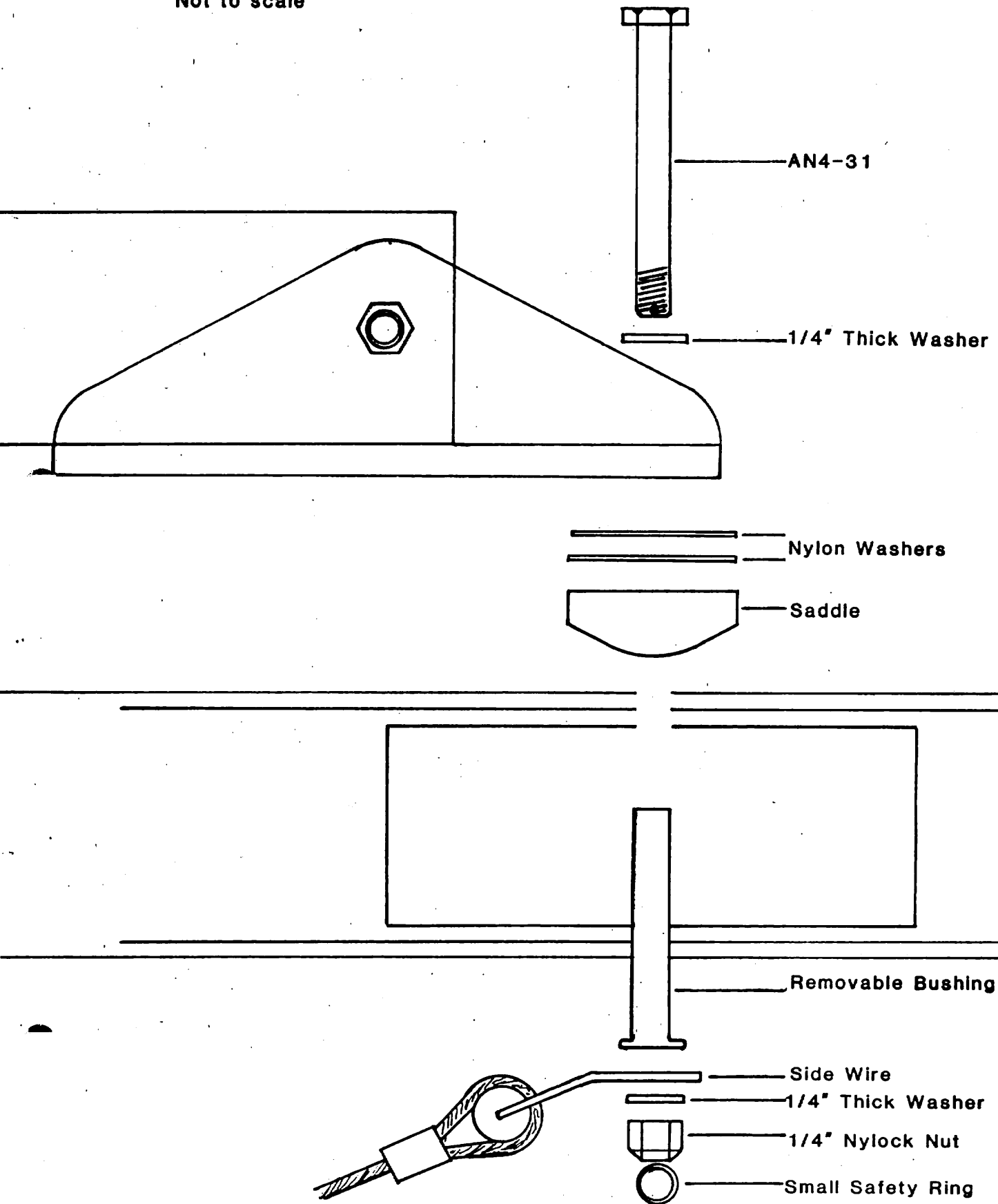
The normal method for shipment of HARRIERs is full length, however, breakdown shipping is available as an option. When re-assembling a HARRIER which has been broken down, special care must be taken to assemble the glider properly. It is possible to assemble the glider incorrectly, in such a way that the mistake will not be readily apparent, yet may dangerously affect the flying characteristics of the glider.

The first step is to make sure that you put the correct rear leading edge into each front leading edge. Start with the glider on the floor, upside down, (control bar bracket up), with the wings slightly spread. As you stand at the rear of the glider and face the nose, this puts the glider's right leading edge on your left. The rear leading edges will be marked "right" and "left"; the "right" rear leading edge gets inserted into the right front leading edge (on your left) and vice versa. Before inserting the rear leading edges, check to see that the short internal sleeve is properly positioned inside the rear leading edge. See the appropriate diagrams if you are unsure of the proper position of the sleeve. As you insert the rear leading edge into the sail, you will need to feed the washout tip through the hole in the sail.

Next, insert the rear leading edge into the front leading edge, until the front end of the rear leading edge butts against the crossbar junction bolt ( be GENTLE).

## XBar/Leading Edge Assembly (Breakdown Leading Edge )

Not to scale



Before you assemble the hardware at the leading edge/crossbar junction, make sure that the rear leading edge is not twisted  $180^{\circ}$  out of phase with the front. If the glider were right side up, the washout tip would point in and up at a  $19.5^{\circ}$  angle.

With the glider upside down, the washout tip should point in and down at an angle of  $19.5^{\circ}$  from the horizontal. Once you're sure that the rear leading edge is properly aligned, assemble the leading edge/crossbar junction. You will need to squeeze your hand inside the hole in the bottom sail surface where the crossbar exits, to reach the head of the AN4-31 bolt.

The nut, washer, safety ring and bushing may now be removed from the bolt, and the bolt removed to the edge of the front leading edge tube. It is best at this point for you to hold the bolt while someone else slides the rear leading edge forward until the holes in the front leading edge, the rear leading edge, (and the rear leading edge inner sleeve) all line up. Re-insert the bolt, and insert the bushing from the bottom. Assemble the rest of the hardware as shown. Before tightening the nut, check again the alignment of the rear leading edge. Also make sure that the bushing is completely through the leading edge, and the saddle, and is seated flush with the bottom of the leading edge and the bottom of the crossbar "L" bracket. Tighten the nut, install the safety ring, and then back the nut off so that you can just turn the bottom side wire tang.

To mount the sail at the rear, it may be necessary to dismount it at the front. Once mounted at the rear, it may be impossible to re-mount it at the front. Not to worry. Once you have the glider set up, it will be easy to remount the front. You are going to set the glider up when you're finished so you can completely check your assembly of the leading edges.

When mounting the sail at the rear, mount it in the rearward most hole, unless this hole is taped over. The tape would indicate that the glider was test flown with the sail mounted in the forward hole. In most cases, the sail should be mounted symmetrically. However, you may get a glider where the sail needs to be mounted in different holes on different sides. Unless the mounting is to be normal (both sides in the rear hole), the presence of tape will indicate which holes not to mount the sail in.

The sail is always mounted to the outside of the leading edge. The mounting bolt passes through a grommet, then through the leading edge, with the wingnut and safety being installed on the bolt on the inside side of the leading edge. Normally the bolt is aligned with the washout tip. However, if the glider was adjusted during factory test flying to remove a tendency to turn to one side, the bolt may not align with the washout tip. However, the bolt should never be more than half the distance to the other sail mounting hole out of alignment with the washout tip. Read the section in this manual on tuning the HARRIER for more information on this subject.

After you have installed the wingnut and safety the assembly procedure should be complete. Set the glider up and check it thoroughly to make sure everything is properly assembled.

Refer to the diagrams throughout this manual if you have any question about any part of the glider.

The initial set up and inspection is a required dealer procedure whether the glider was broken down for shipping or not. This inspection should involve a COMPLETE preflight of the glider. Don't assume anything, check it out.

This is a good time to check the bungee tension for consistency. Bungees are set in the sail loft, and the gliders are not test flown with the battens that they are shipped with. Proper bungee adjustment allows the bungee to be pulled over the batten tip without extreme effort, but the bungee should not extend more than 1/4" past the end of the batten at full stretch. A pair of pliers will allow you to loosen the crimps and adjust any out of tolerance bungees.



## Test Flight

Once the glider has been assembled and inspected, the next step is the test flight. If you are not entirely familiar with the HARRIER's flight characteristics, read the appropriate section in the owner's manual.

During the test flight, you should perform the following maneuvers:

- 1) Multiple 360 turns in both directions with mild bank angles. This is the best way to detect a turn in the glider; it will tend to be mildly roll unstable to one side and mildly roll stable to the other. Properly tuned, the HARRIER is roll neutral to both sides.

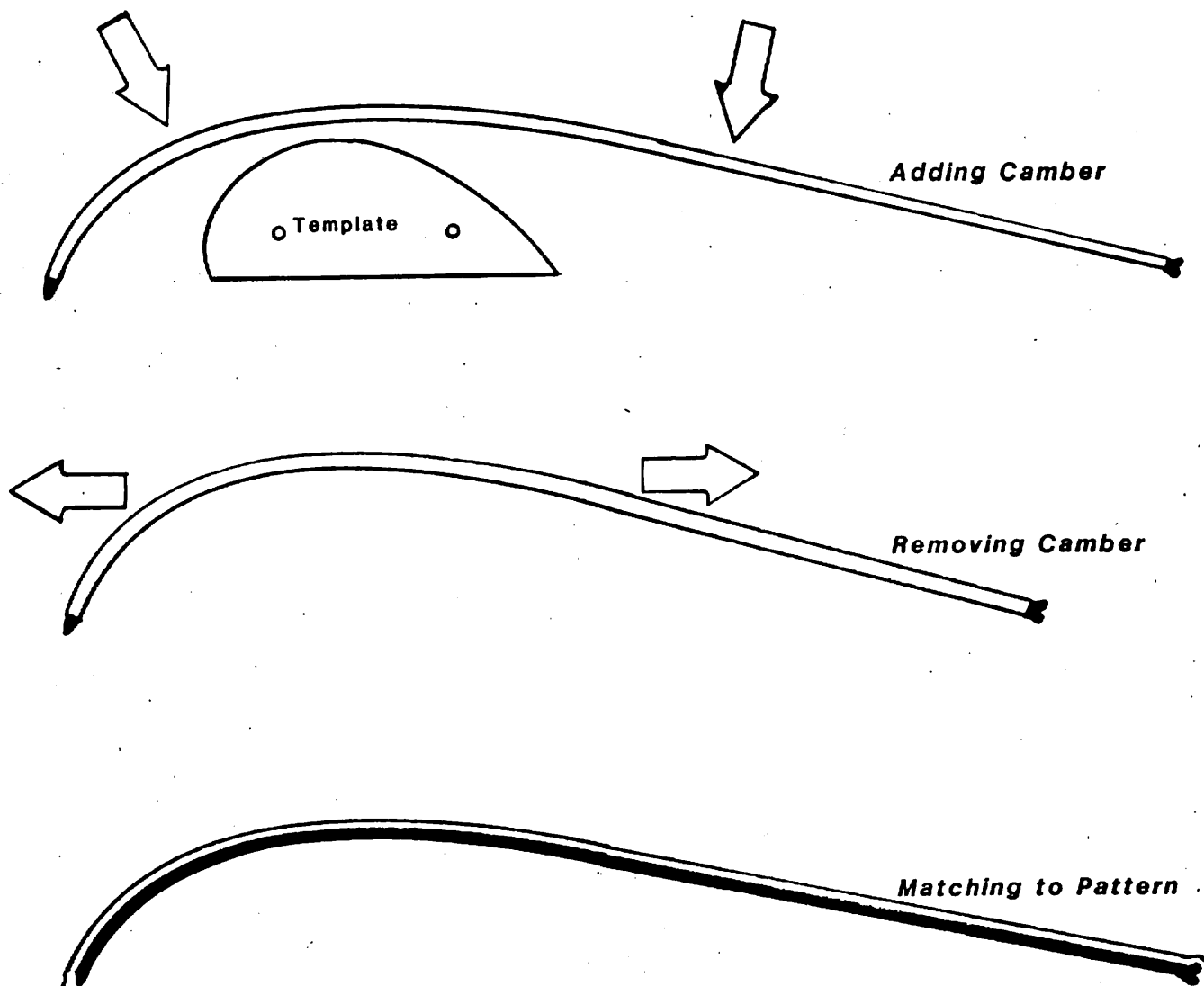
- 2) Low speed roll initiation from wings level. This is to test for lag or adverse yaw. Keep in mind that the HARRIER is not supposed to roll in crisply at exceptionally low speeds, but it should be quite responsive at any speed from trim on up.

- 3) Sustained, pilot full forward dives. The bar pressure in a dive is mild, but should be smooth, progressive and consistent. If it is not, carefully check the bridle settings (see the owner's manual), and the batten camber. Bridles set too high will produce excessive pitch bar pressure, and improperly cambered battens may produce insufficient bar pressure.

## HARRIER 177

Wills Wing, Inc.

## TRUEING BATTENS



## Tuning and Maintenance

Trueing the battens is an important maintenance procedure. Each pilot is supplied with a batten diagram and a brief explanation of how to true the battens in the owner's manual. You should check the battens on any glider that comes in for service, and especially on a glider that exhibits any unusual flight characteristics, (excessive or insufficient pitch bar pressure, inherent turn tendencies).

Battens with sharp bends, snakes, kinks, or bends in more than one plane are best discarded and replaced. With care, the battens should maintain their shape fairly well. They will tend to decamber over a period of time as a result of being installed and removed. The best way to recamber them is to set up a table in your shop where you can lay the batten diagram out flat, and also mount a plywood template like the one shown in the diagram. The template should have a smooth curve of increasing radius, with the smallest radius significantly tighter than the tightest radius of any batten. The batten will tend to spring back when bent, so some practice is required to achieve the proper degree of bend when adjusting camber. Using a template on a flat table will simplify the process, and make it much easier to keep all the bends in one plane.

To add camber, bend the batten around the template as shown. To remove camber, stretch the batten as shown. Vary the points at which you apply the forces to vary the distribution of camber. When matching the batten to the diagram, match the outside edge of the batten to the curve as shown.

We recommend that trueing battens to the diagram be done only in the shop except in emergencies. Prior to each flight, the corresponding right and left battens should be checked against each other for symmetry as described in the owner's manual. This will help famaliarize the pilot with the shape of his battens and help him to recognize a badly out of shape batten. Small variations in the batten shape are not critical in determining the glider's flight characteristics.

#### BATTEN TIP REPLACEMENT:

Broken batten tips can be replaced by drilling out the old tip with a .300 drill bit. The new tip is then crimped in place using a nicopress tool.

Adjusting the keel pocket restraining strap adjusts the amount of camber in the inboard section of the wing in flight. The normal adjustment will leave a finger or two of slack in the strap. If the strap is too tight, the glider will be stiff and slow in roll initiation, especially at low speeds. If the strap is too loose, the sail will ride forward until restrained by the kingpost at the kingpost cutout. This may damage the sail, and excessive looseness in the strap may also reduce the tendency of the glider to pitch up at low angles of attack.

Normally the leading edge tension need not and should not be adjusted. Loosening the leading edge sail tension, (mounting the rear of the sail farther forward) will improve the low speed roll response. Excessive looseness will degrade performance, and may create wrinkles or flutter in the sail. If the sail is loosened from the factory setting, the holes in the leading edge will have to be burned farther back to prevent tearing of the sail. This applies to the kingpost area as well.

You will notice when you look at the rear sail mounting that the two holes into which the sail can be mounted are not lined up. The alignment of the sail mounting bolt relative to the frame sets the washout of the tip, and is critical in determining the turn trim of the glider. When you loosen the sail, you must



rotate the sail mount plug to maintain the same relative twist in the tip. Read carefully the section in this manual on turn trim (coming up next!).

Turn trim is accomplished on the Harrier by twisting the tips. The sail is mounted to a plug inserted in the end of the leading edge. The plug is secured with a set screw installed into the leading edge from the back side (see diagram). The plug has extra set screw holes to allow for the rotation of the sail mount plug. Early HARRIERS have sail mount plugs with three  $\frac{1}{4}$ " sail mount holes, and one set screw hole for each. This allows for maintaining proper twist alignment when loosening the sail, but does not allow for adjusting turn trim. When twisting early 3 hole sail mount plugs for turn trim, a new set screw hole will have to be drilled in the plug so that the plug can be resecured in its new position. The procedure is described below.

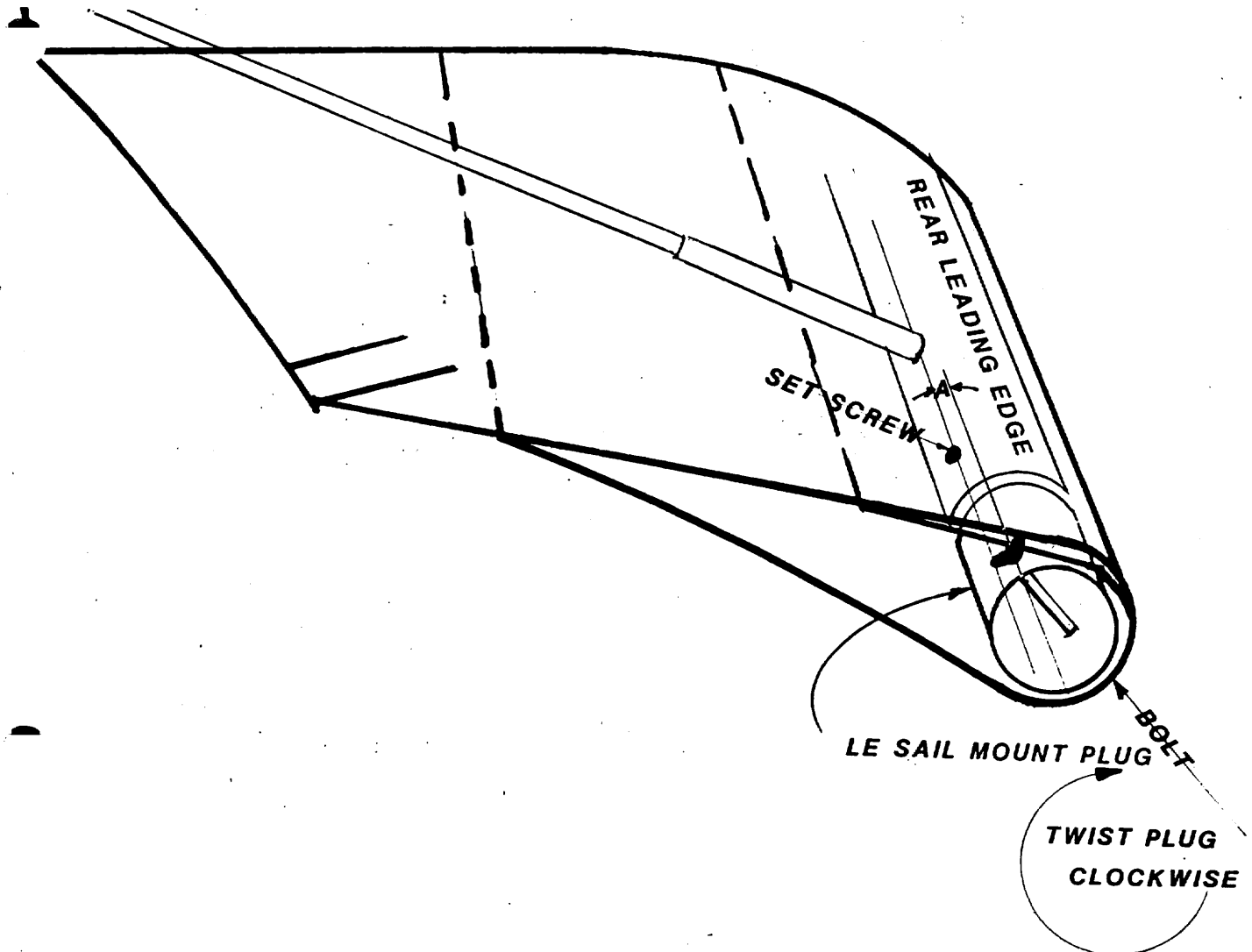
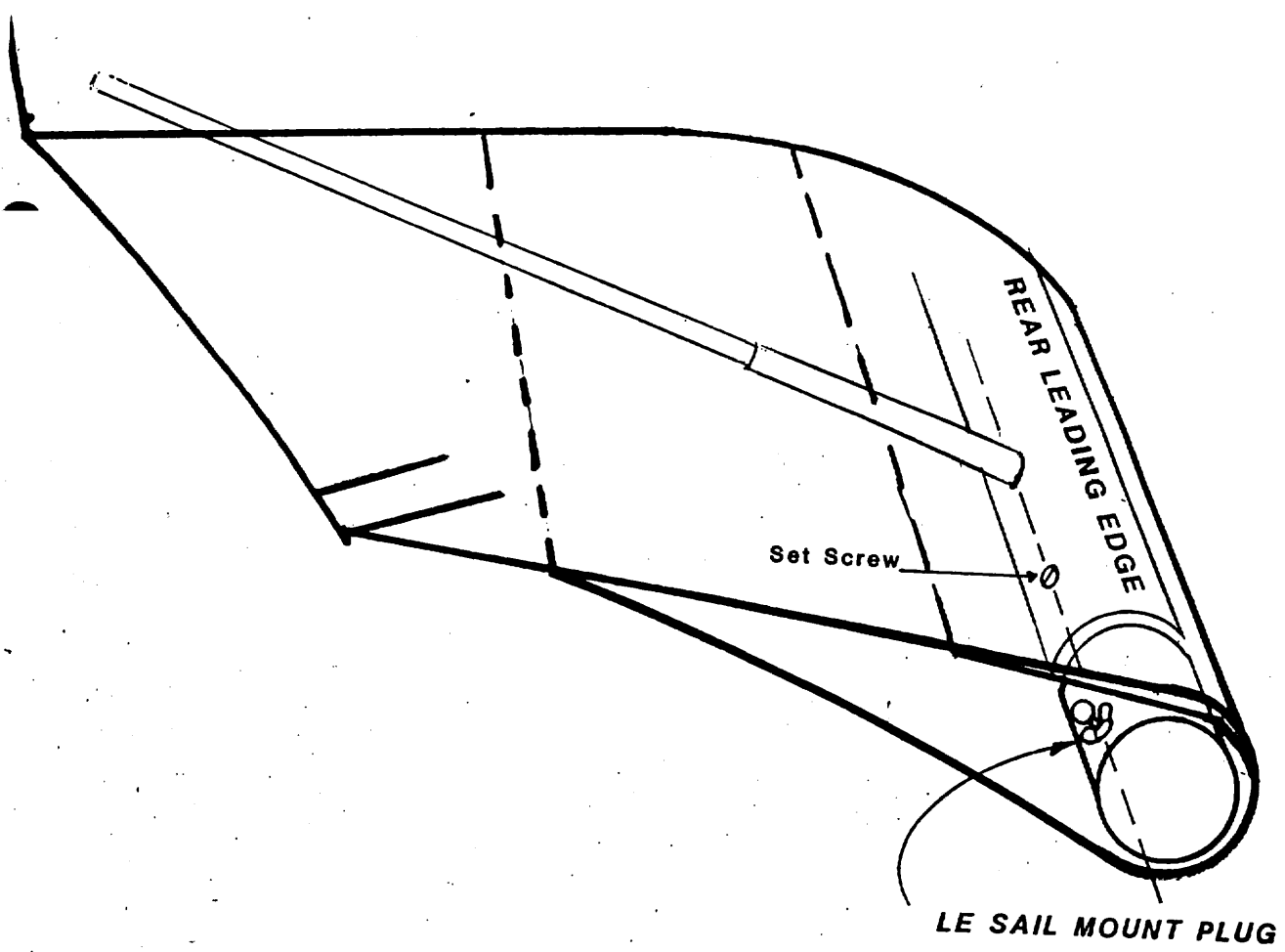
Late model HARRIERS have two holes for sail mounting in the plug, and five set screw holes; one for each sail mount hole, and one in between each sail mount hole, and one outside of each sail mount hole. (see frame diagram.) This allows the plug to be rotated such that the sail mount bolt aligns with the washout tip with the sail mount bolt in either hole. This is the normal alignment. It also allows the plug to be rotated about  $\frac{1}{4}$ " up or down from the point where the sail mount bolt

aligns with the washout tip, and this rotation is how turn trim is accomplished.

All HARRIERs are test flown from the factory, and should fly properly without turns in either direction when they leave here. If you have a HARRIER with a turn there are several possible explanations:

- 1) The glider has been damaged; either in shipping or during flying, or ground handling, or transportation. A bent leading edge is impossible to detect on a HARRIER without dismounting the sail from the frame. Since a bent leading edge can severely compromise the safety of the glider, you should check for that first by pulling the sail off the frame. Look especially for stress marks at the rear end of the 2" front leading edge tubing, and on the 2" at a point 37" forward of the crossbar junction. (This is the forward end of the 1 7/8" rear leading edge tube.) We are assuming that by now you have checked the battens for any possible asymmetry. If not, you may have done a lot of work for nothing. Check them now, and see the section in this manual on batten trueing, which you should have read already.

If you find a bent or stressed leading edge, replace it. Do not try to straighten it, sleeve it, repair it, glue it, or anything else. Replace it.



2) If the frame passes inspection, and the battens are true, then you can proceed to remove the tendency of the glider to turn by twisting the tip. The glider should have been trimmed from the factory, but test pilots are human, and it's possible that a turn might get by. It's also possible that something has been altered in the glider to produce the turn. In any event, proceed as follows:

Work with the leading edge that the glider is turning away from. In other words, if the glider has a left turn, work with the right leading edge. Remove the set screw which secures the sail mount plug and twist the plug up at the rear (clockwise for the right leading edge as shown) about  $1/4"$ . If you have a late model two hole sail mount plug, this should bring the next set screw hole in the plug in alignment with the set screw hole in the rear leading edge. In this case, re-insert the set screw and test fly the glider in that configuration. (Refer to the diagram; the distance labeled "A" is about  $1/4"$ )

If you have an early model 3 hole plug,  $1/4"$  rotation will bring you only halfway to the next set screw hole in the plug. Do not rotate the plug farther than this. Instead, carefully align the tip just prior to launch, and fly the glider without the set screw. The plug will not tend to rotate in flight. If the adjustment turns out to be correct, mark the position of the plug by scribing a line across the leading edge and plug, and drill a new set screw hole at that alignment.

The 1/4" rotation will adjust for a significant turn. If you are playing with a micro turn, you may have to go less than that. In that case, you will have to drill a new set screw hole no matter which model sail plug you have. In this case, drill the new hole in a different spot, to insure that you do not overlap a previous hole in the plug.

To Summarize:

- 1) First check the battens.
- 2) Next check the frame.
- 3) If both are ok, twist the sail mount plug on the side the glider is turning away from. Twist the plug up at the rear (i.e. put more twist in that tip.)
- 4) Resecure the plug after proper turn trim has been achieved.

NOTE: FAILURE TO RESECURE THE PLUG WILL LEAD TO RANDOM TENDENCIES OF THE GLIDER TO TURN DEPENDING ON WHERE THE PLUG IS ALIGNED PRIOR TO EACH LAUNCH. THIS IS NO FUN.  
MORAL: SECURE THE PLUG.

Before starting the plug twisting procedure, inspect each plug and note the alignment. The normal alignment will have the sail mount bolt aligned with the washout tip. If one side is not aligned this way, the tip was probably adjusted at the factory. It is best to have either both tips aligned normally, or to have one normal and one with extra twist. For example, do not correct for a right turn by twisting the left tip up, if the left tip is normal and the right tip is twisted up. Instead, return the right tip to normal.

The HARRIER should have a periodic maintenance inspection every six months or 30 hours of airtime, whichever comes first. This inspection should involve a complete disassembly of the glider. During reassembly, refer to the appropriate diagrams in this manual for the correct usage of parts and assembly sequence.

#### CABLES:

All cables should be replaced once a year, except for the bridle cables, which should be replaced every six months. Any cable which shows any sign of wear, fatigue, broken strands, etc should be replaced immediately.

#### SAIL:

The sail should be thoroughly inspected for rips, wear points, etc. and repaired as necessary. Pay particular attention to the area of the kingpost cut-out. Improper assembly of the glider (installing the kingpost before spreading both wings), hard landings, or any severe, assymetric loading of the sail can cause the sail to tear at the edge of the kingpost cut-out. If the tear is very small, it can be repaired by using a hot knife to enlarge the cut-out slightly. The corners of the cut-out should be radiussed, with as large a radius as possible. Later model HARRIERS will have extra reinforcing at this point. The application of light webbing or 9 oz. tape folded around the edge of the cut-out will serve as a good reinforcement, and is recommended for those gliders on which this problem is evident.

**FRAME:**

All frame tubes should be carefully inspected for straightness. Any bent frame members should be replaced. Also inspect for dings, gouges, etc. Any damage to the tubing in the center 3/4 of any compression member (xbar, control bar uprights, kingpost) will weaken the member. The leading edge is under a combination of bending and compression, and any damage not within about two feet of the front or rear ends of the leading edge will weaken it. Severe gouges or dings should not be tolerated in any part of any member.

Inspect also for crystalization or other indications of stress or fatigue in the tubing, as well as for corrosion.

**SUSPENSION COMPONENTS:**

All main suspension components such as the hangstrap and main harness support straps should be replaced at least once a year.

**NUTS AND BOLTS:**

Replace any bent bolts, and all nylock nuts removed during disassembly. Check those nuts not removed for proper tightness, especially the crossbar hinge bolt nut.

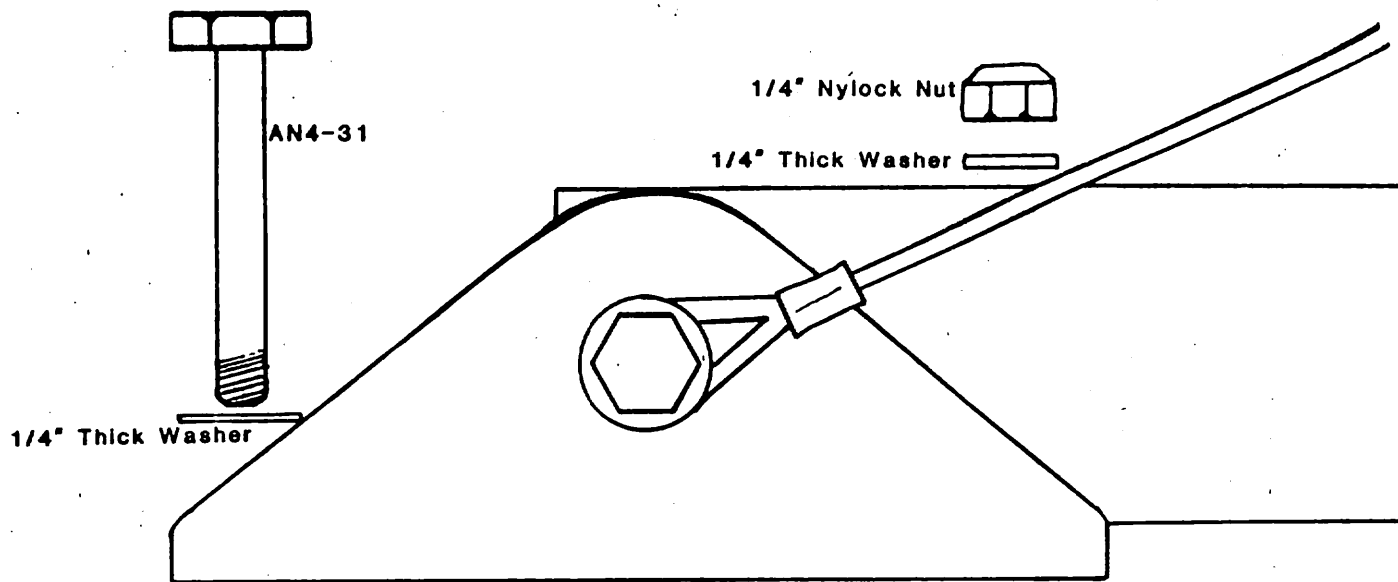
**TIP BUNGEEES:**

Replace the tip bungees at least every six months. This is extremely important, because this bungee is the only thing holding the tip on.



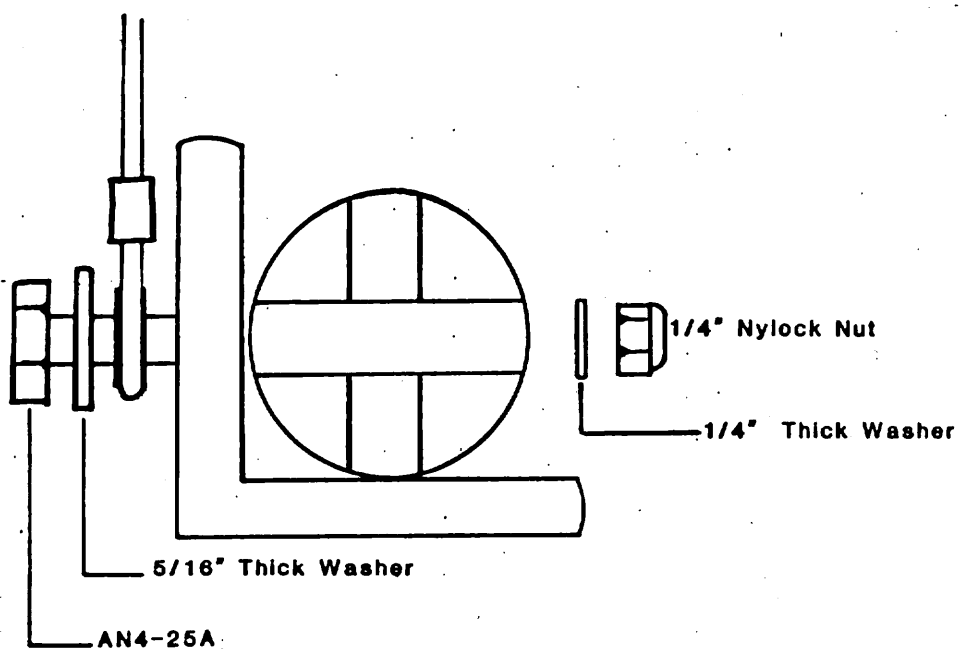
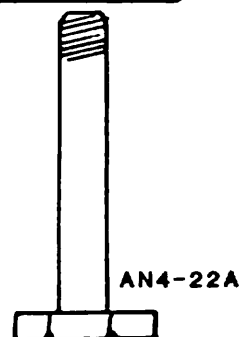
## HARRIER 177

Wills Wing, Inc.



## CROSSBAR / "L" BRACKET ASSEMBLY

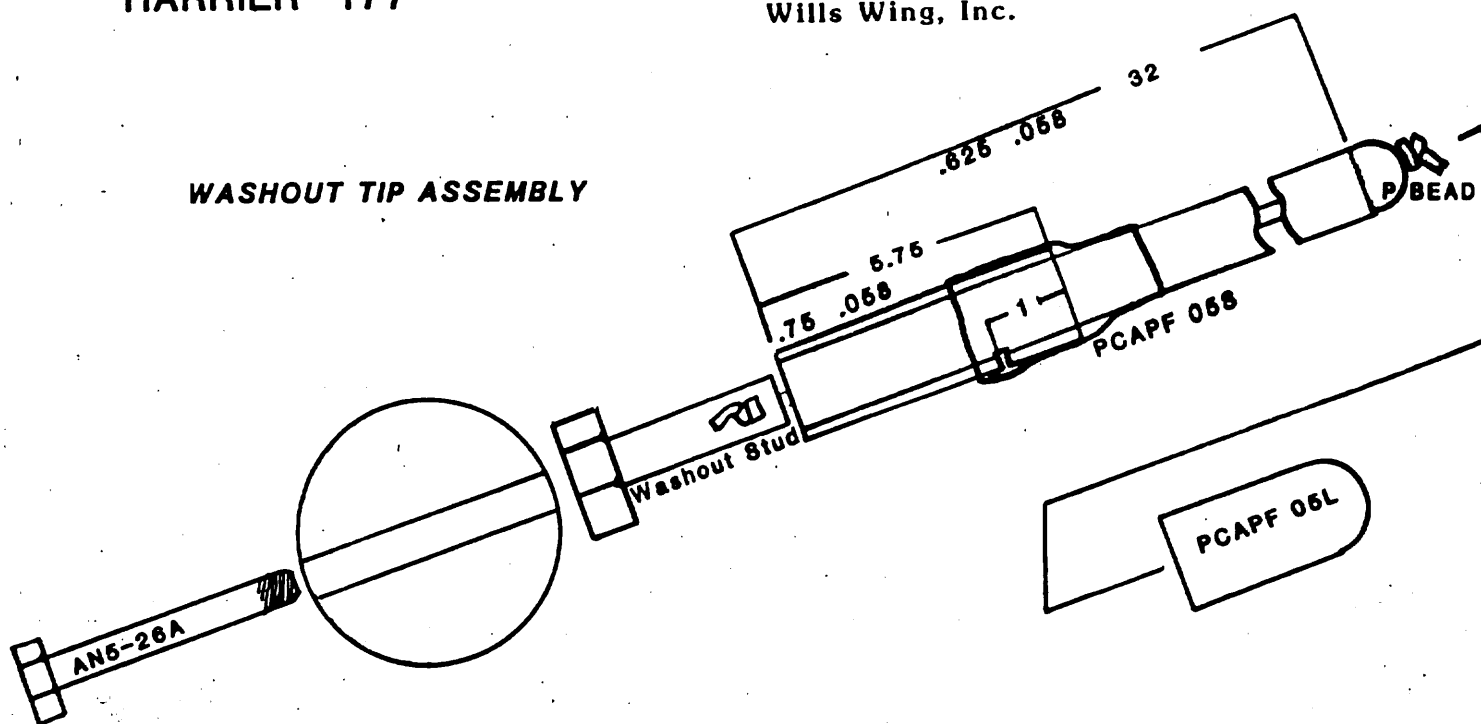
NOT TO SCALE



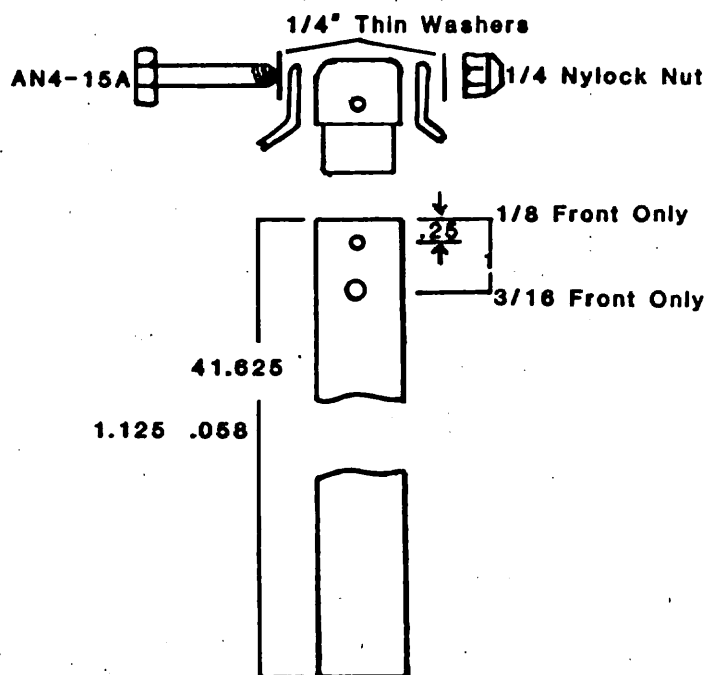
## HARRIER 177

Wills Wing, Inc.

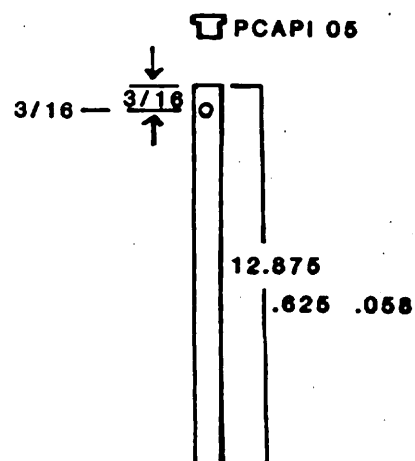
## WASHOUT TIP ASSEMBLY



## KINGPOST ASSEMBLY

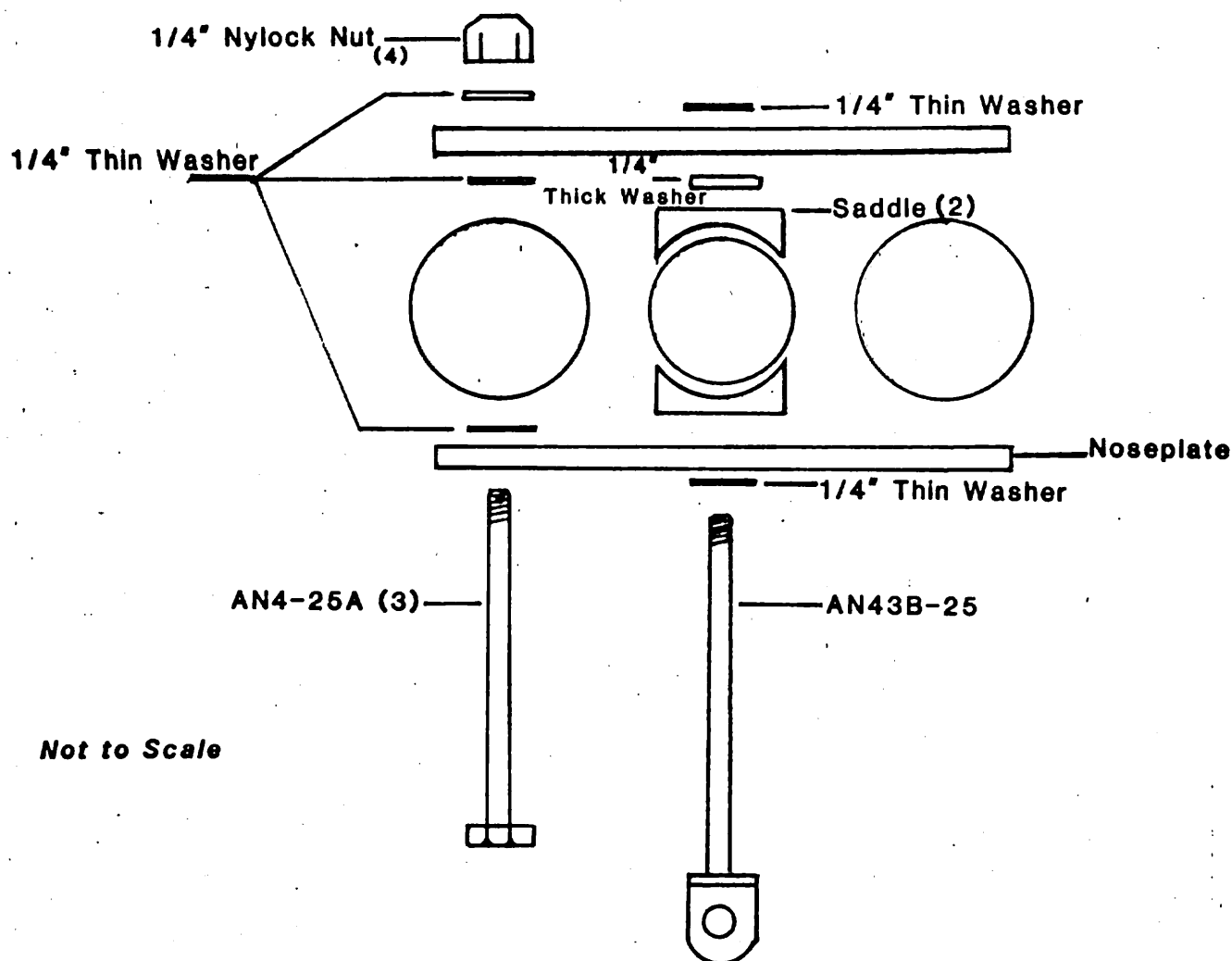


## REFLEX POST

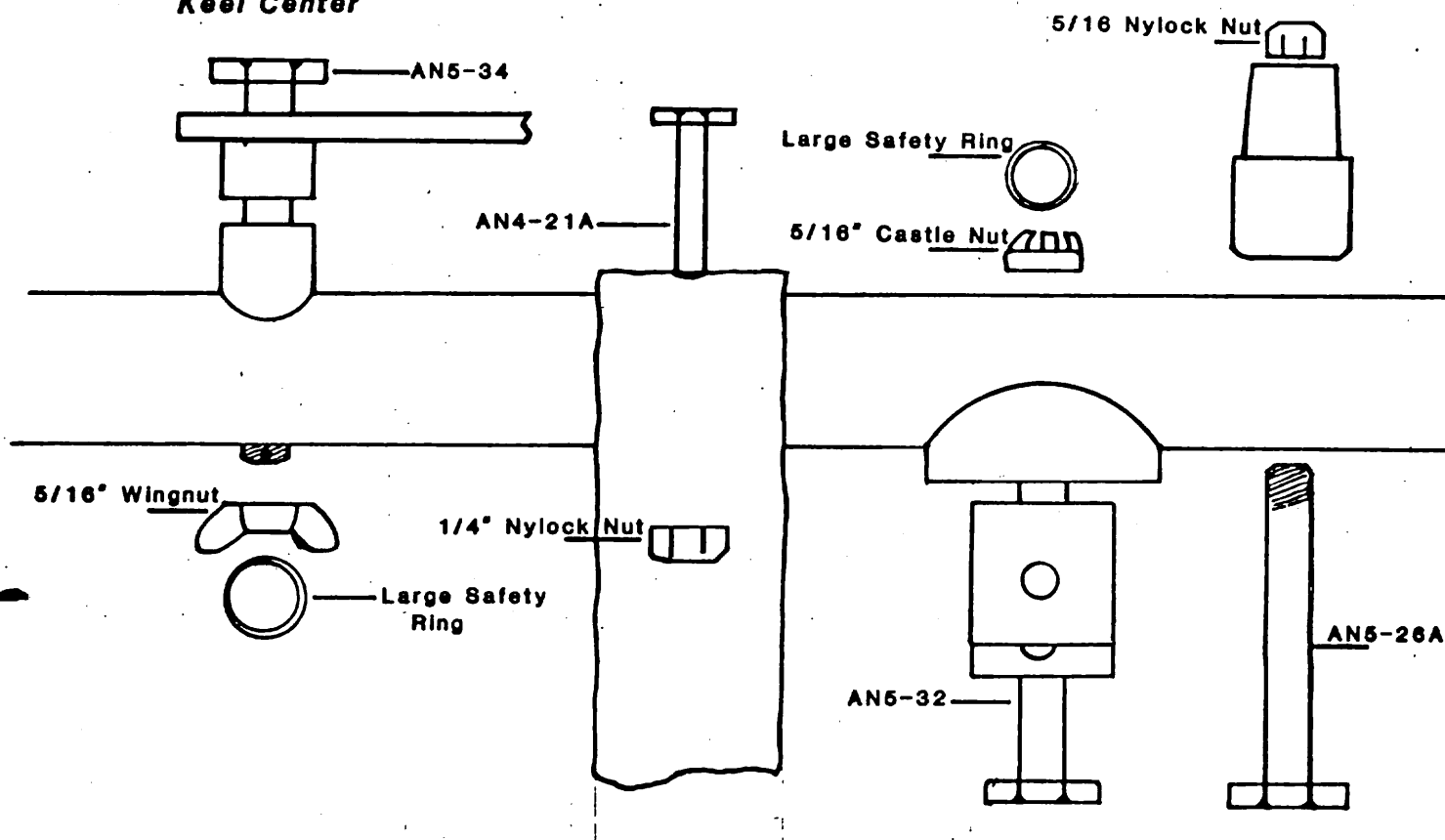


NOT TO SCALE  
ALL DIMENSIONS IN INCHES

## Noseplate Assembly



## Keel Center

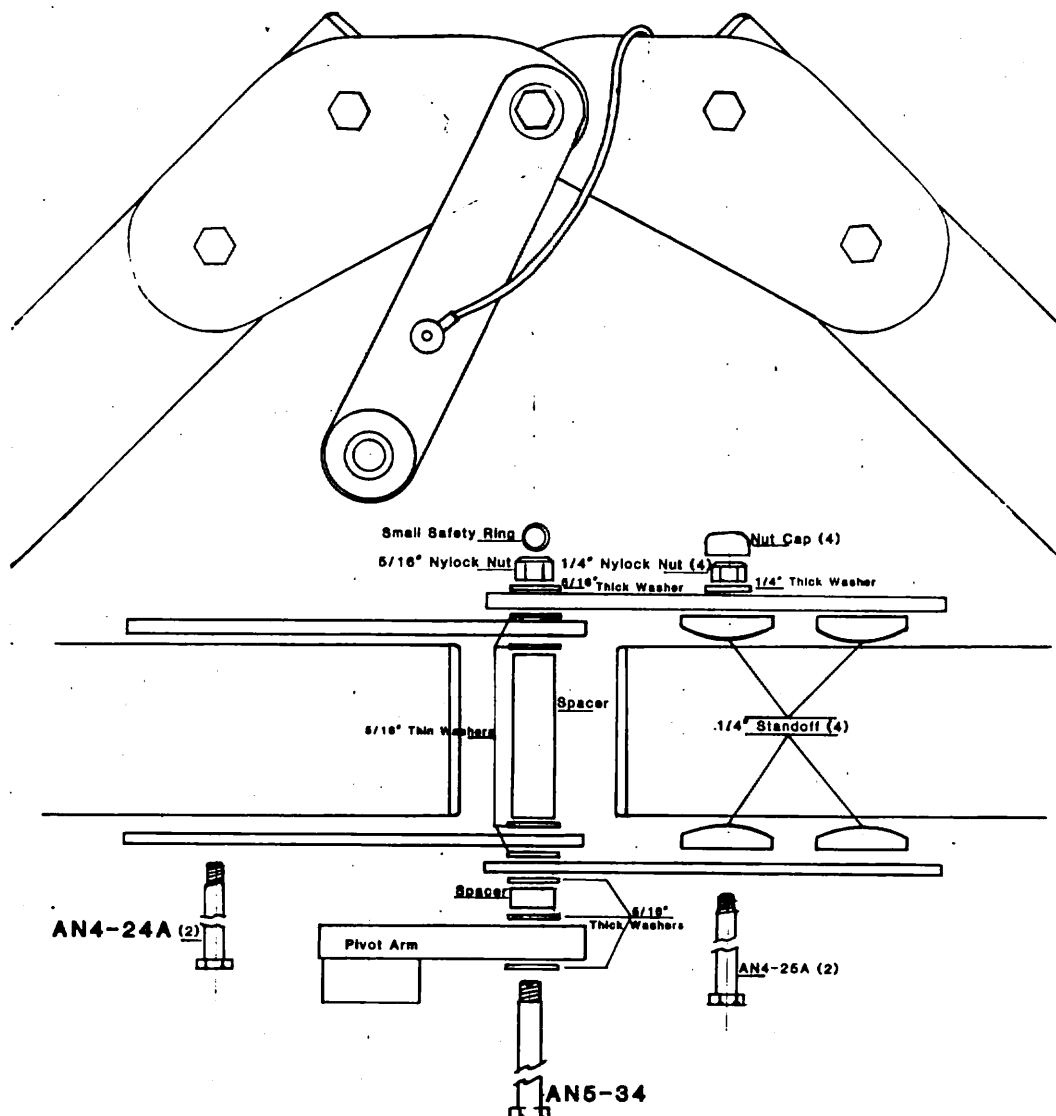


## HARRIER 177

Wills Wing, Inc.

## Crossbar Center Section Assembly

Not To Scale

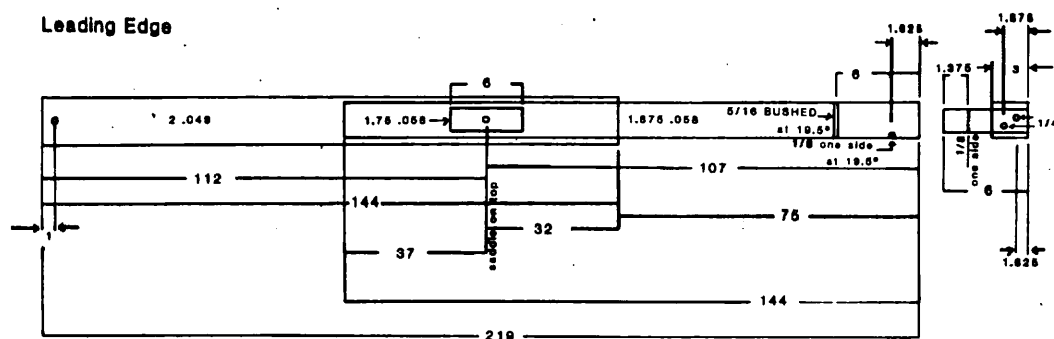


## HARRIER 177

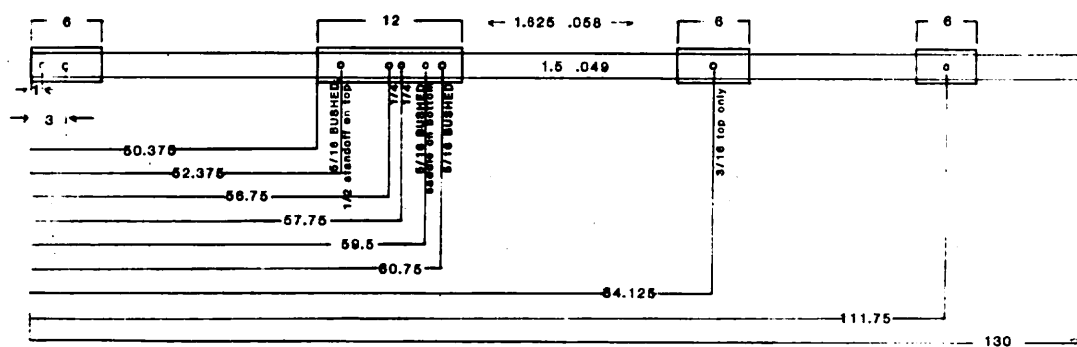
Not to Scale  
All holes 3/8, bushed to 1/4,  
unless otherwise specified  
All dimensions in inches

Wills Wing, Inc.

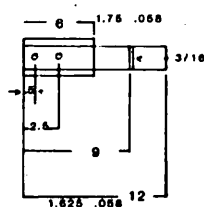
Leading Edge



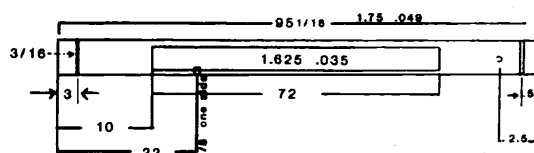
Keel



XBar Center

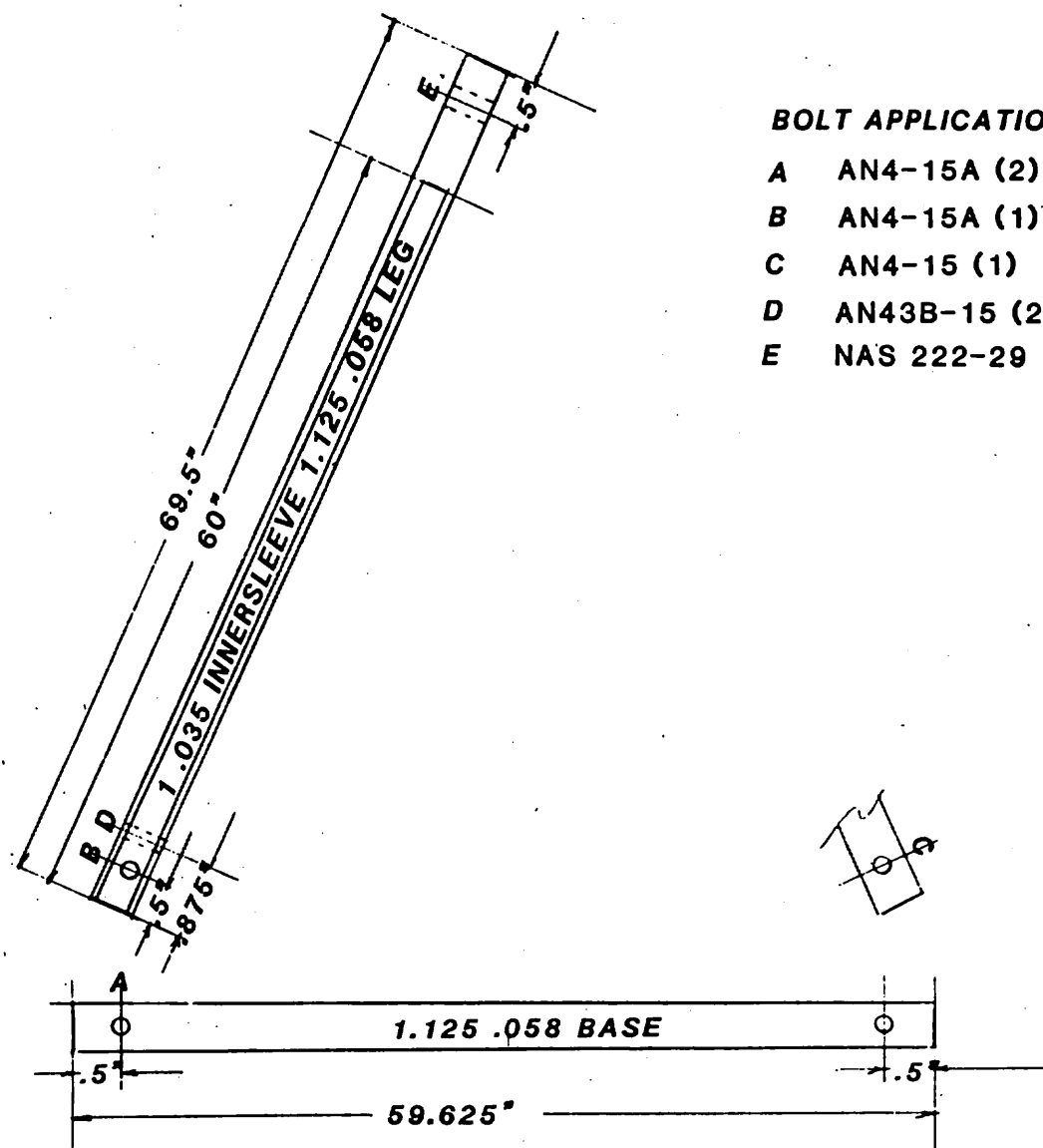


XBar



## HARRIER 177

Wills Wing, Inc.



HARRIER 177 control bar

## Supine Bar

Base 54.5"

Leg 63"

Sleeve 56"

PART NO.	DESCRIPTION	QUANTITY	DEALER	RETAIL
<b>"AN" HARDWARE</b>				
			SEE CURRENT PRICE LIST	
A27039109	'MS' 3/16" PHILLIPS/QR	2		
A203922C 61	'MS' XBAR CLEVIS	2		
AN310-5	5/16 CASTLE NUT	1		
AN350-4	1/4 WINGNUT	3		
AN350-5	5/16 WINGNUT	1		
AN364-4	1/4 LOW PROFILE NUT	2		
AN365-3	3/16 LOCK NUT	2		
AN365-4	1/4 LOCK NUT	22		
AN365-5	5/16 LOCK NUT	2		
AN4-15	CNTROL BAR/BASE BRKT	1		
AN4-15A	CNTRLBAR/BASE BRKT/KP TOP	4		
AN4-21A	HANGSTAP/KEEL	1		
AN4-22A	XBAR/'L' BRKT	2		
AN4-24A	XBAR/PLATES	2		
AN4-24A	REAR WIRES/KEEL	1		
AN4-25	LEADING EDGE/SAIL REAR	2		
AN4-25A	XBAR/'L' BRKT/SIDE WIRE	2		
AN4-25A	XBAR/PLATES	2		
AN4-25A	REAR NOSE PLATE	1		
AN4-31	XBAR/'L' BRKT/LEADING EDGE	2		
AN43B-15	CNTRLBAR LEG/SIDE WIRE	2		
AN43B-25	FRONT NOSE PLATE	1		
AN5-26A	WASHOUT STUD BOLT	2		
AN5-26A	KING POST PLUG/KEEL	1		
AN5-32	CONTOL BAR/KEEL	1		
AN5-34	XBAR PIVOT/KEEL	1		
AN5-34	XBAR HINGE	1		
AN960-416L	1/4 WASHER THIN			
AN960-516L	5/16 WASHER THIN			
ANAS222-29	CNTROLBAR LEG/'E' BRKT	2		
ANSFTYRNGL	LARGE SAFETY RING	3		
ANSFTYRNGS	SMALL SAFETY RING	7		



PART NO.	DESCRIPTION	QUANTITY	DEALER	RETAIL
		(PER GLIDER)	(EACH)	(EACH)

**BATTENS**

B177 NO1	HARRIER NUMBER 1 BATTEN	2	3.50	5.00
B177 NO2	" " 2 "	2	6.25	8.93
B177 NO3	" " 3 "	2	6.25	8.93
B177 NO4	" " 4 "	2	6.25	8.93
B177 NO5	" " 5 "	2	9.00	12.86
B177 NO6	" " 6 "	2	9.00	12.86
B177 NO7	" " 7 "	2	9.00	12.86
B177 NOSE	HARRIER NOSE BATTEN	1	6.25	8.93
B177 SET	HARRIER COMPLETE BATTEN SET	1	90.25	128.93
B BTNSHFT	HARRIER FIBERGLASS ARROWSHAFT		1.40	2.00
B177DIAGRM	HARRIER BATTEN MAINTENANCE DIAGRAM		2.80	4.00

**CABLE SETS**

C177 BRIDL	HARRIER REFLEX BRIDLE	1	12.60	18.00
C177 BSIDE	HARRIER BOTTOM SIDE WIRE	2	12.60	18.00
C177 BTM	HARRIER BOTTOM FRONT/REAR	1	28.00	40.00
C177 TOP	HAR TOP FRONT/REAR W/CAP	1	15.00	21.43
C177 TSIDE	HARRIER TOP SIDE	2	9.00	12.86

**SOFTWARE**

F177 BRDLP	HAR BRIDLE ADJUST LOOP	1	1.50	2.15
F177 HSTRP	HARRIER HANG LOOP	1	5.00	7.15
F177 ADJKP	KEELPOCKET SAIL ADJUSTER	1	1.50	2.15
F177 BTBAG	HARRIER BATTEN BAG		7.00	10.00
F177 GLBAG	HARRIER GLIDER BAG		52.50	75.00

**HARDWARE**

H ALSP4-02	1/2DIA*1/4 AL SPACER	1	.56	.80
H ALSP4-15	1/2DIA*1 5/8 AL SPACER	1	.56	.80
H BALL PIN	BALL LOCK PIN	1	2.10	3.00
H BRDLCBNR	BRIDLE CARABINER	1	1.40	2.00
H CB'E'BRK	CONTROL BAR 'E' BRACKET	1	4.90	7.00

PART NO.	DESCRIPTION	QUANTITY (PER GLIDER)	DEALER (EACH)	RETAIL (EACH)
H CBBSBRKT	CONTROL BAR BASE/LEG BRKT	2	4.20	6.00
H CLEVIS/C	CLEVIS CABLE SWEDGE W/O CABLE	1	4.90	7.00
H H NSPLT	HARRIER NOSEPLATE	2	4.20	6.00
H KP CAP	KING POST CAP	1	2.80	4.00
H KP PLUG	KING POST BASE PLUG	1	2.80	4.00
H LNYRD	BALL PIN LANYARD	1	2.10	3.00
H QR ADPTR	QUICK RELEASE ADAPTER	2	1.05	1.50
H QR BAR	QUICK RELEASE BAR	2	1.05	1.50
H QR LEVER	QUICK RELEASE LEVER	1	2.80	4.00
H QRELEASE	QUICK RELEASE COMPLETE, ASSEMBLED	1	7.00	10.00
H RNGKEY05	BRIDLE RING 5/8	2	.35	.50
H WSHSTUD	WASHOUT STUD	2	2.80	4.00
H XB PIVOT	XBAR PIVOT	1	3.50	5.00
H XB 'L' BRK	XBAR 'L' BRACKET	2	5.60	8.00
H XBPLT177	XBAR PLATE 177	4	3.50	5.00

## SPARS AND TUBING COMPONENTS

M177 CBBTB	HAR CONTROL BAR BASE TUBE W/GRIPS	1	11.20	16.00
M177 CBLEG	HAR CONTROL BAR LEG	2	15.40	22.00
M177 KEEL	HARRIER KEEL	1	32.50	46.43
M177 KPOST	HARRIER KINGPOST	1	11.20	16.00
M177 LEL	HAR LEFT LEADING EDGE	1	75.00	107.14
M177 LEPLG	HAR LE SAIL ADJ PLUG	2	4.90	7.00
M177 LER	HAR RIGHT LEADING EDGE	1	75.00	107.14
M177 RPOST	HARRIER REFLEX POST	1	2.80	4.00
M177 WSHTB	HAR WASHOUT DEFINED TIP(TUBE ONLY)	2	7.00	10.00
M177 XBAR	HAR CROSSBAR HALF	2	43.30	61.86
M177 XBSLV	HAR XBAR CENTER SLEEVE	2	4.20	6.00
M177 CBAR	HAR CONTROL BAR COMPLETE	1	59.50	85.00

NOTE: DAMAGED LEADING EDGES MUST BE REPLACED AS A UNIT. FRONT AND REAR LEADING EDGES ARE NOT AVAILABLE SEPARATELY.

## PLASTIC PARTS

P BIN TIFP	BATTEN TIP FRONT 3/8	16	.50	.72
P BIN TIFR	BATTEN TIP REAR 3/8	14	.50	.72
P NUT CAPD	DEEP NUT CAPS	6	.28	.40

PART NO.	DESCRIPTION	QUANTITY	DEALER	RETAIL
		(PER GLIDER)	(EACH)	(EACH)
P NUT CAPS	SHALLOW NUT CAPS	3	.28	.40
PCAPF 05S	TIP CAPS/QR LOCK	5	.35	.50
PCAPF 11	CONTROL BAR GRIPS	2	.56	.80
PCAPF 14	KEEL PROTECTOR	1	.56	.80
PCAPI 11	ENDCAP CONTROL BAR BASE	2	.56	.80
PCAPI 14	ENDCAP KEEL	2	.56	.80
PCAPI 16	ENDCAP XBARS	4	.56	.80
PCAPI 16	ENDCAP REAR LE	2	.56	.80
PCAPI 20	ENCAP FRONT LE	2	.56	.80
PSO 2	STANDOFF REFLEX POST	1	.28	.40
PSO 4	STAND OFF XBAR PIVOT	2	.28	.40
PSA 14	SADDLE KEEL NON BUSHED	4	.56	.80
PSA 14B	SADDLE KEEL BUSHED	2	.56	.80
PSA 20B	SADDLE LEADING EDGE	2	.56	.80
PSO 2	STANDOFF XBAR PLATE	4	.28	.40

## SAIL HARDWARE

S BNG CRMP	BUNGEE CRIMPS	28	.07	.10
S177 MYLAR 14	14 MIL MYLAR/PER SIDE	2	15.40	22.00
S177 BNGE	HARRIER BUNGIE PRECUT		.28	.40

## TUBING SIZE AND APPLICATION

TA 03-035T	2024 BUSHINGS
TA 10-035	CONTROL BAR LEG SLEEVE
TA 15-035	XBAR INNER SLEEVE
TAA 03-035	BATTEN TUBING
TAA 05-058	TIPS TUBING
TAA 05-058	REFLEX POST
TAA 06-058	TIPS SLEEVING
TAA 11-058	KINGPOST
TAA 11-058	CONTROL BAR LEG
TAA 11-058	CONTROL BAR BASE
TAA 14-049	KEEL TUBING
TAA 15-058	KEEL SLEEVE

PART NO.	DESCRIPTION	QUANTITY	DEALER	RETAIL
TAA 16-049	XBAR TUBING			
TAA 16-058	LEADING EDGE SLEEVE			
TAA 17-058	LEADING EDGE REAR			
TAA 20-049	LEADING EDGE FRONT			
TS 316-035	STEEL TUBE/QUICK RELEASE			

PART NO.	DESCRIPTION	QUANTITY	DEALER	RETAIL
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**TUBING**

PRICE PER FOOT

TAA 03-035	3/8 x .035 6061T6 ANODIZED			.50
TA 03-035	3/8 x .035 2024 T3 UNANODIZED			1.00
TAA 04-028	1/2 x .028 6061T6 ANODIZED			.57
TAA 04-035	1/2 x .035 6061T6 ANODIZED			.61
TA 04-065	1/2 x .065 6061T6 UNANODIZED			.97
TAA 05-058	5/8 x .058 6061T6 ANODIZED			.92
TAA 06-049	3/4 x .049 6061T6 ANODIZED			.92
TA 10-035	1.0 x .035 6061T6 UNANODIZED			.95
TAA 10-065	1.0 x .065 6061T6 ANODIZED			1.33
TAA 11-058	1 1/8 x .058 6061T6 ANODIZED			1.17
TAA 14-049	1 1/2 x .049 6061T6 ANODIZED			1.52
TA 15-035	1 5/8 x .035 6061T6 UNANODIZED			1.17
TAA 15-058	1 5/8 x .058 6061T6 ANODIZED			1.85
TA 16-035	1 3/4 x .035 6061T6 UNANODIZED			1.30
TAA 16-049	1 3/4 x .049 6061T6 ANODIZED			1.58
TAA 16-058	1 3/4 x .058 6061T6 ANODIZED			1.96
TAA 17-058	1 7/8 x .058 6061T6 ANODIZED			2.00
TAA 20-049	2.0 x .049 6061T6 ANODIZED			1.88
TS 188-020	3/16 x .020 STANLESS			1.75

TUBING MAY BE PURCHASED IN 12 FOOT LENGTHS ONLY. CUTTING AND DEBURING AVAILABLE FOR 1.50 PER CUT.

SCRAP TUBING SUITABLE FOR RACKS, SLEEVING, ETC. .50/ft.