

HARRIER II

OWNER'S MANUAL & SERVICE MANUAL



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TEARSON

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COMPLIANCE VERIFICATION SPEC. SHEETS

INTRODUCTION

Congratulations! You are now the proud owner of one of the finest footlaunched soaring flex-wings manufactured today. Your WILLS WING HARRIER II 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 II. 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, breakdown, preflight, and maintenance procedures as described in this manual. Make sure you follow all appropriate procedures every time you fly. Never take anything for granted in hang gliding; 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.

HARRIER II

The Harrier II is a refined and updated version of the popular Harrier, designed for the recreational soaring pilot from novice through advanced skill levels.

HANDLING

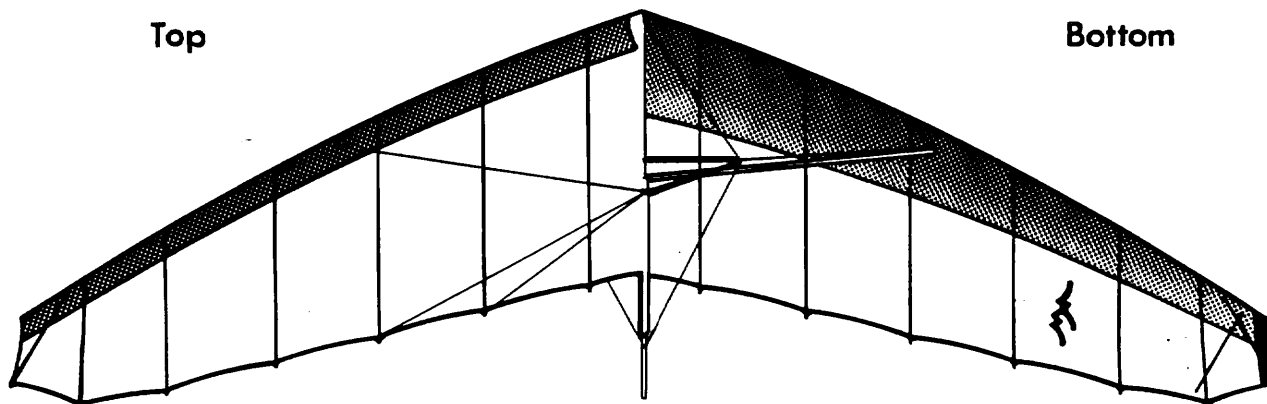
The responsive and coordinated handling of the Harrier is carried on in the Harrier II, providing the instantaneous response and light control pressures so necessary for maximum effective soaring performance. In addition, the Harrier II is lighter in weight, easier to land, and is now slightly roll stable, making it an ideal glider for the new soaring pilot. The Harrier II combines easy, comfortable response with the general handling qualities typical of state of the art defined airfoil high performance flex-wings such as the DUCK, providing an easy transition for advancing pilots who wish to move up to higher performance.

PERFORMANCE

The Harrier II's exceptional sink rate and good penetration capabilities provide a powerful performance combination for gaining experience in the widest variety of soaring conditions.

ENGINEERING

Fully certified to 1981 HGMA Standards, the Harrier II is engineered to maximize your level of safety and confidence as a pilot. The Harrier II incorporates the new special hardware designed for the Duck, and comes with the industry's longest list of standard features. Optional on the Harrier II is leading edge mylar; which offers a slight improvement in sink rate performance.



SPECIFICATIONS

MODEL	147	177	187
SPAN	30'	33'4"	34'4"
NOSE ANGLE	130	130	130
ASPECT RATIO	6.1	6.3	6.4
PILOT WT	110-210 lbs.	150-250 lbs.	165-265 lbs.
PILOT SKILL	II	II	II
GLIDER WT	48/51 lbs.	53/57 lbs.	62/66 lbs.
(NO MYLAR/MYLAR)			
PRICE	\$1675/1795	\$1675/1795	\$1675/1795
(NO MYLAR/MYLAR)			

Specifications are subject to change without notice.

See your authorized Wills Wing Sales and Service Center for a test flight today!

TECHNICAL INFORMATION

The Harrier II has been tested and found to comply with the 1980-81 HGMA Airworthiness Requirements. These standards require for the Harrier II:

An ultimate positive load test at the maximum lift angle of attack at a speed of 64 mph.

An ultimate negative 30 degree angle of attack test at a speed of 45 mph.

An ultimate negative 150 degree angle of attack test at a speed of 32 mph.

Pitching moment tests at speeds of 20 mph, 30 mph, and 40 mph which show the glider to be pitch stable over an extended range of angles of attack.

Flight tests which show the glider to be safely controllable and stable over a wide range of normal and abnormal flight modes and conditions.

NOTE: The Harrier II was designed for footlaunched soaring flight. It was not designed to be towed, tethered, motorized, nor flown at angles of bank beyond 60 degrees or angles of pitch beyond 30 degrees. Operation in any of these modes may severely compromise your safety, and we strongly recommend against it. Should you decide to do so anyway, please avail yourself of the experience and expertise of those people who are qualified in that particular area, and please proceed with extreme caution. Please be advised that Wills Wing can in no way be responsible for the airworthiness or applicability to any specific purpose of any Wills Wing glider, except as described in the HGMA Airworthiness Standards.

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

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

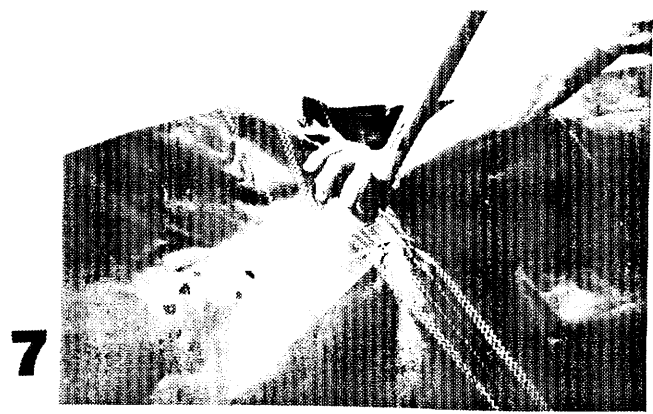
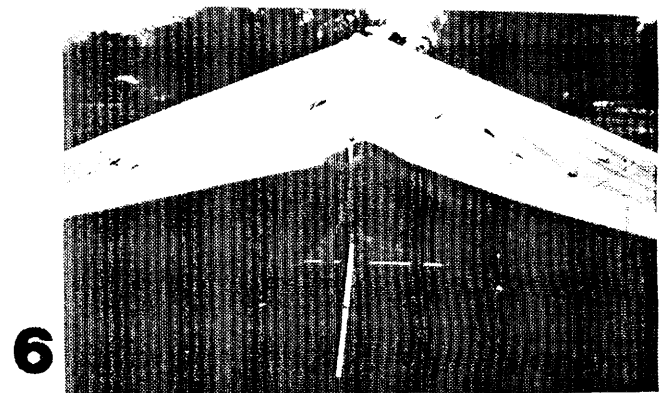
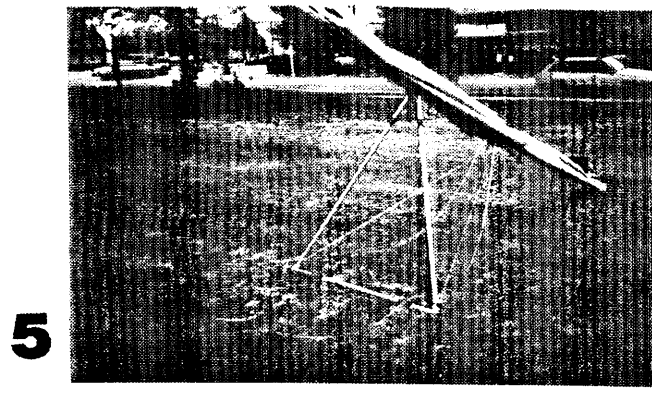
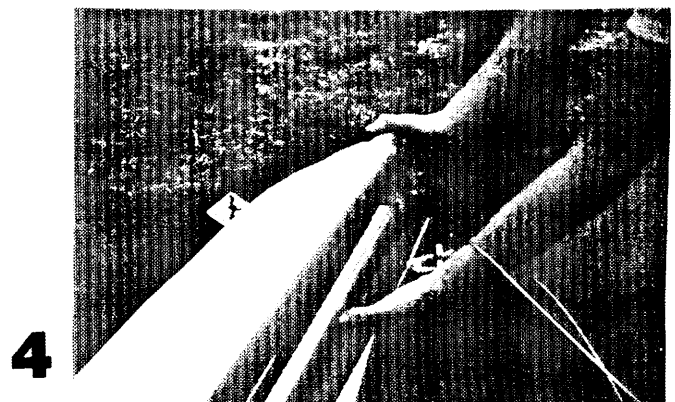
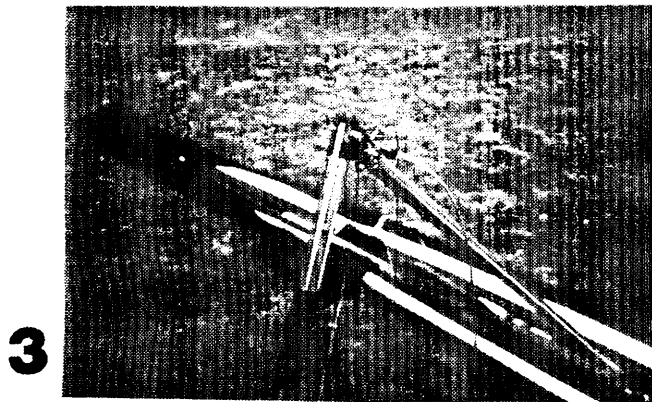
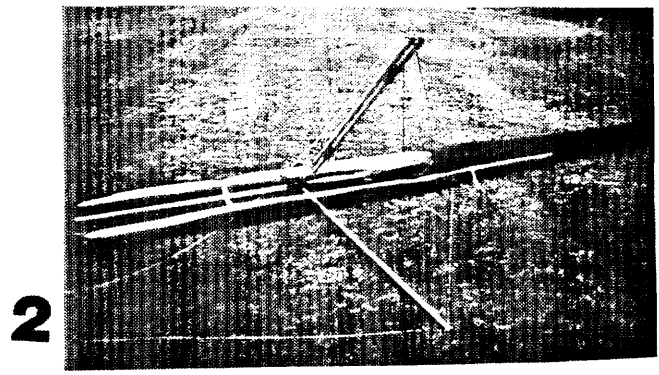
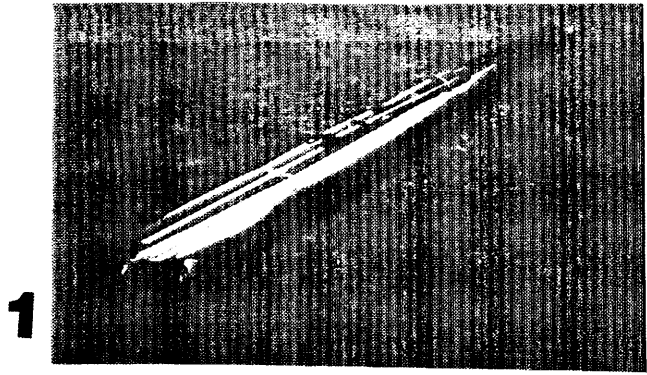
Recommended pilot weight: Harrier II 147: 110 to 210 pounds.

(including all equipment) Harrier II 177: 150 to 250 pounds.

Harrier II 187: 165 to 265 pounds.

Flight operation of the Harrier II should be limited to non acrobatic maneuvers, i.e. those in which the pitch angle will not exceed 30 degrees nose up or nose down from the horizon, and in which the bank angle will not exceed 60 degrees. The Harrier II will strongly resist spinning, and will tend to recover quickly from a spin once control pressures are relaxed without entering extreme attitudes and without extreme loss of altitude. The Harrier II should not be flown at speeds in excess of 45 mph. This speed will generally correspond to a prone pilot position where the pilot has pulled forward such that the basetube lies across the middle of the thigh.

A USHGA pilot proficiency level of II or higher is required to fly the Harrier II safely. Flight operation by unqualified pilots may be dangerous and is prohibited.

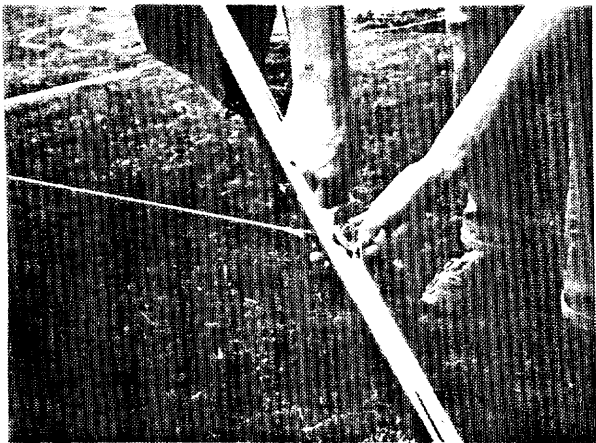


HARRIER II SET UP PROCEDURE

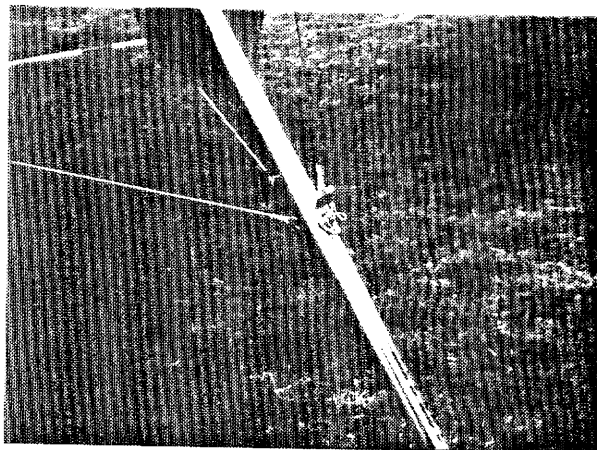
NOTE: THE HARRIER II HAS BEEN DESIGNED TO SET UP QUICKLY AND EASILY AND INCORPORATES A WIDE VARIETY OF NEWLY DESIGNED HARDWARE. USE OF THE SPECIFIC TECHNIQUES DESCRIBED IN THIS MANUAL WILL MAKE THE SET UP AND BREAK DOWN PROCEDURES MUCH EASIER TO PERFORM. PLEASE READ THE MANUAL CAREFULLY AND FOLLOW THE PROCEDURES AS DESCRIBED.

- 1) Lay the bag on the ground, nose into the wind, zipper up.
- 2) Undo the zipper, the velcro securing the control bar, and fold the bar up and forward. Attach the free end of the base tube to the down tube using the wing nut and safety provided.(fig. 1-3)
- 3) Flip the glider upright, holding the control bar forward, and rest it on the control bar, nose into the wind.(fig 4-5)
- 4) Remove the bag and all of the velcro straps. Spread the wings most of the way, taking care that the bridles and top side wires are not wrapped around the keel or snagged on the keel hardware.(fig 6)
- 5) Make sure that the keel is centered between the leading edges. Lift the kingpost, and fit it over the plug on top of the keel, taking care not to pinch the sail in the process. Check that the bridle cables are not twisted or tangled.(fig 7)

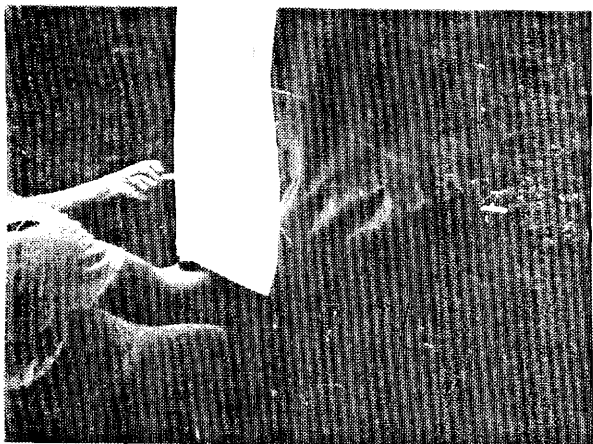
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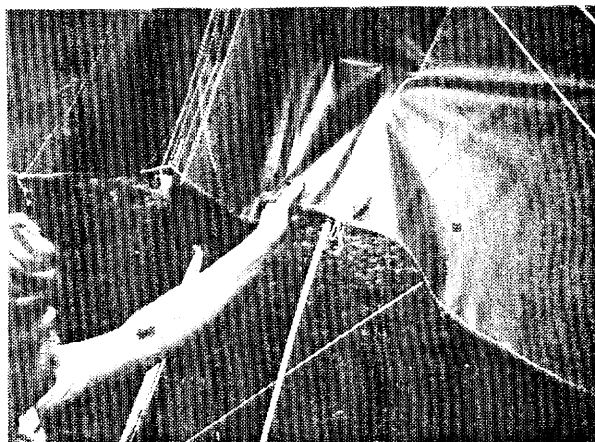
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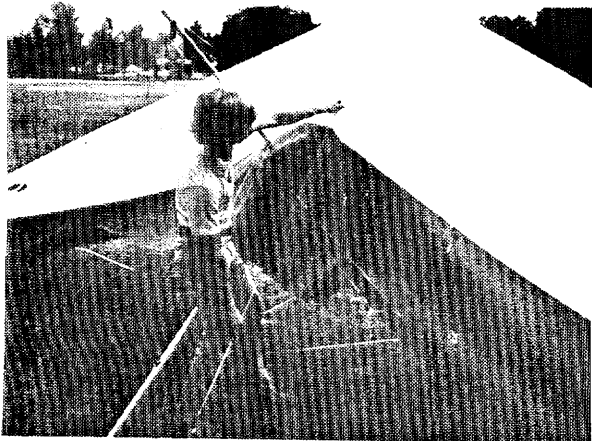
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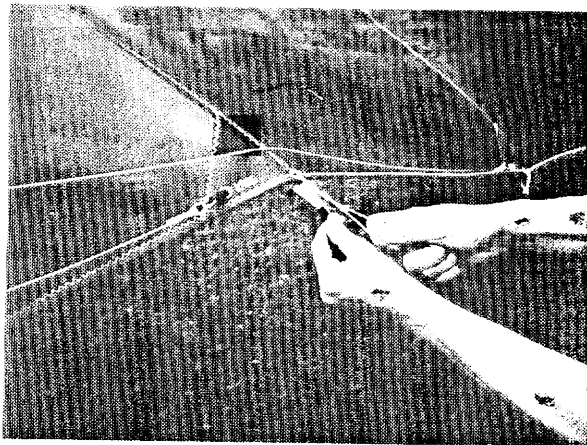
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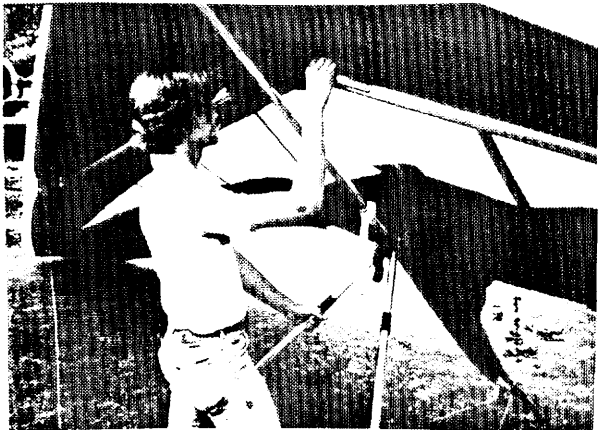
6) Attach the rear kingpost tang to the shouldered bolt on the rear of the keel. BE SURE TO ATTACH THE SAFETY!! (fig 8-9)

7) Install the washout tips, pushing them firmly into the protruding sleeves until they come up against the clevis pin securing the sleeves in the leading edge. Then rotate the washout tips with your finger on the ball on the underside of the sleeve, until you feel the ball drop into the hole in the washout tip. The tip is now secured in place. NOTE: INSTALLATION OF THE WASHOUT TIPS IS MUCH EASIER IF DONE NOW, BEFORE THE BATTENS ARE INSTALLED.(fig 10)

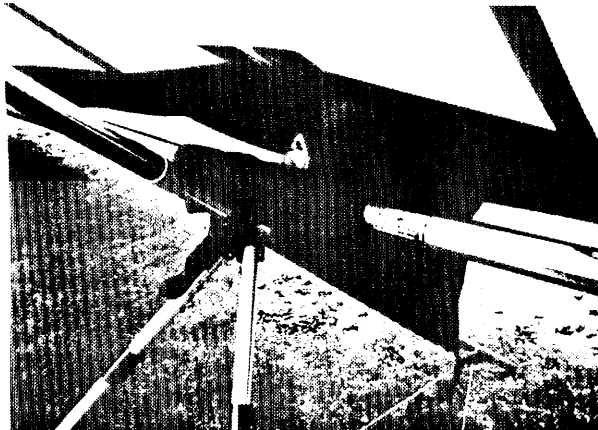
8) Remove the battens from the bag, lay them on the ground, and check them for symmetry, side to side. Correct any that are assymetric.(See the tuning and maintenance sections of this manual for more information on batten shaping.) Insert the battens into the sail carefully, so as not to de-camber the battens or damage the sail. Order of battens is longest to shortest, from the root to the tip. Half of the battens are marked with red tape to make it easier to separate them side to side. By convention, we put the red taped battens in the right side, but since they are symmetrical this is not necessary. When inserting the inboard battens, you may find that they become caught behind the crossbar and/or leading edge. If this happens, reach forward with one hand and lift the batten pocket to allow the batten to slide forward. (fig 11-12) After each batten is inserted loop the string over the batten end twice as shown. (fig 13)

NOTE: THE BATTENS MUST BE INSTALLED BEFORE THE CROSSBAR IS TENSIONED. OTHERWISE YOU WILL DECAMBER THE BATTENS AND MAY RUIN THE SAIL.

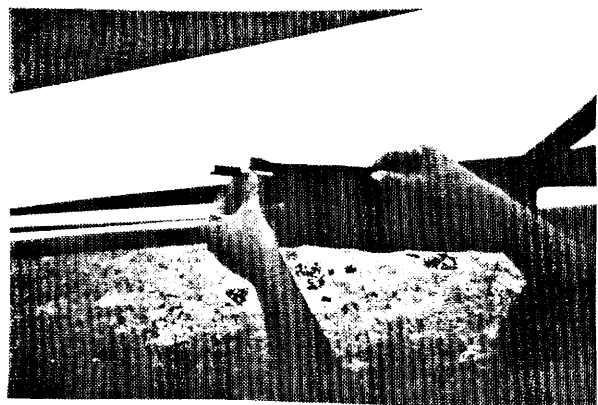
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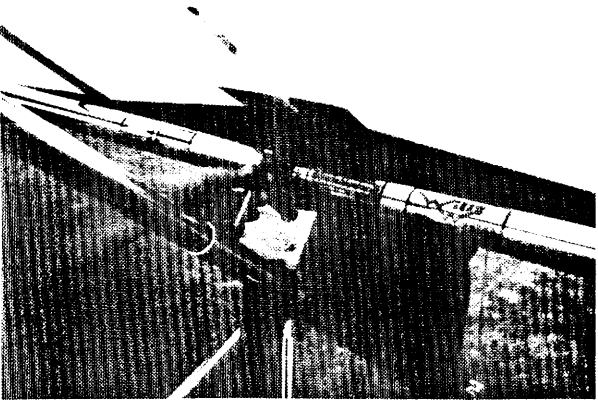
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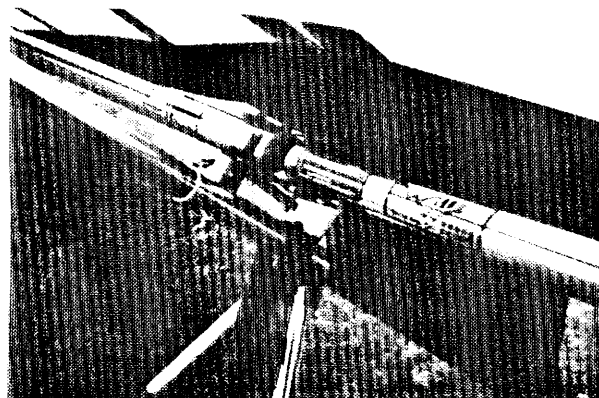
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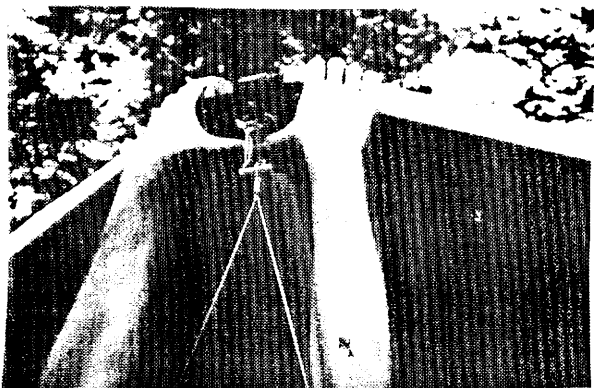
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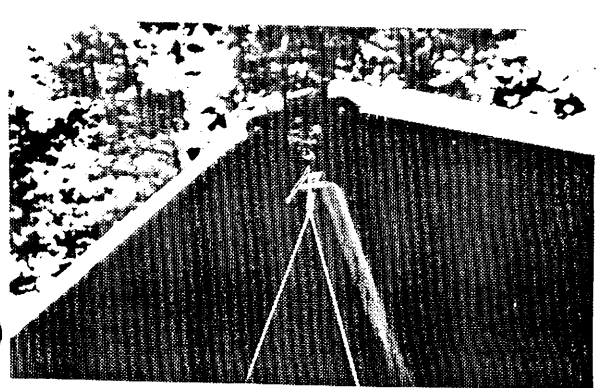
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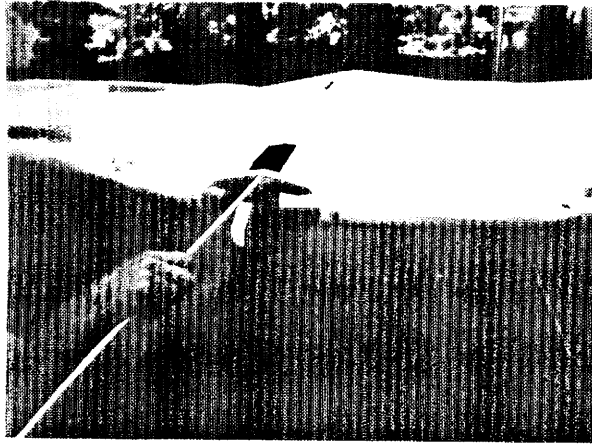


9) Spread the wings all the way and check all wires for twisted thimbles or tangs. NOTE: IF YOU ACCIDENTALLY SET THE GLIDER UP WITH A COCKED THIMBLE AND KINK THE CABLE, YOU MUST REPLACE THAT CABLE IMMEDIATELY OR IT MAY FAIL IN FLIGHT. Grasp the crossbar near the center as shown, and push it back through center, allowing it to rest against the kingpost. (fig 14 and 15). NOTE: BE SURE THE CENTER COVER BAG IS IN PLACE WHEN YOU PUSH THE CROSSBAR BACK, OTHERWISE THE CROSSBAR CENTER HARDWARE MAY DAMAGE THE SAIL AND KEEL.

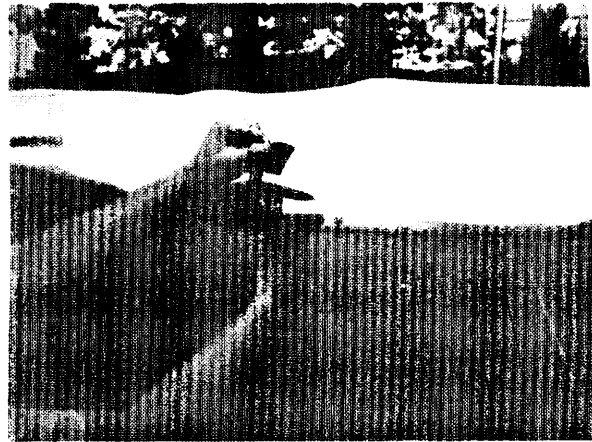
Remove the crossbar pivot bolt from the pocket in the cover bag, remove the safety and wingnut from the bolt, and insert the bolt down through the top of the pivot arm and then through the keel as shown. Install the wingnut and safety. (fig 16, 17 and 18). CAUTION: BE SURE THE CROSSBAR IS BEHIND THE PIVOT ARM AS SHOWN, THAT THE WINGNUT AND SAFETY ARE ON THE BOTTOM OF THE KEEL, AND THAT THE WINGNUT IS NOT OVERTIGHTENED TO THE POINT WHERE THE PIVOT ARM IS RESTRICTED.

10) Attach the bottom nose wire to the nose using the technique shown. BE SURE TO ATTACH THE SAFETY! (fig 19 and 20)

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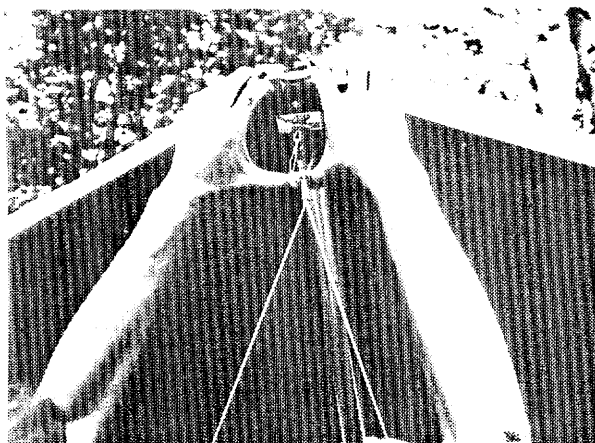
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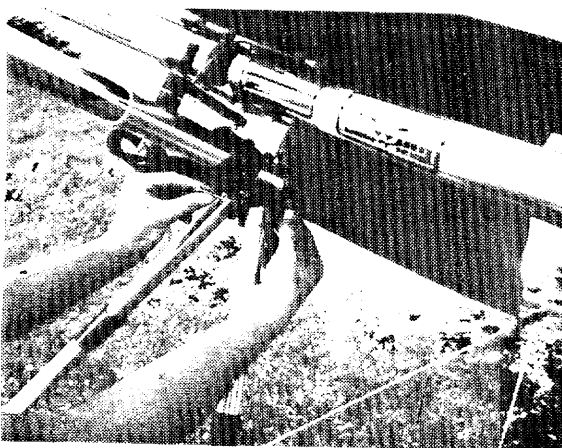
11) Insert the nose batten as shown and secure the velcro. (fig 21 and 22).

12) Do a complete walk around preflight of the glider. Check every assembly. Make sure there are no twisted wires or thimbles. Make sure that the nose and tail keyhole tangs are properly seated and safetied. Make sure the bridle lines are not tangled, nor looped under an inboard batten. (fig 23) Check each seam in the sail for tears or wear points. Inspect your suspension loop and safety. If you have any doubt about any component, do not fly.

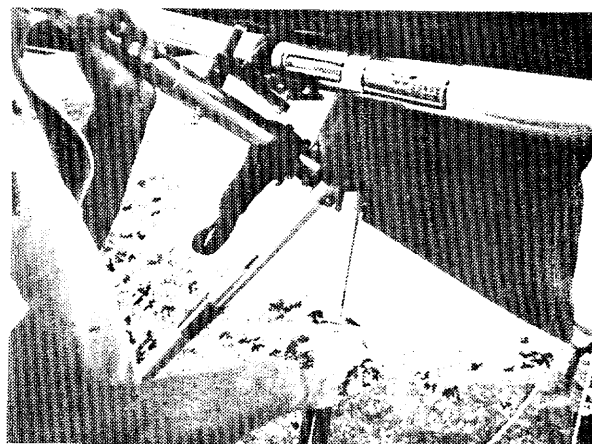
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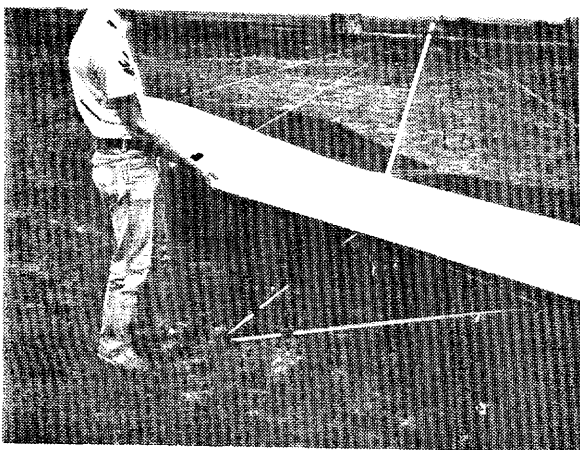
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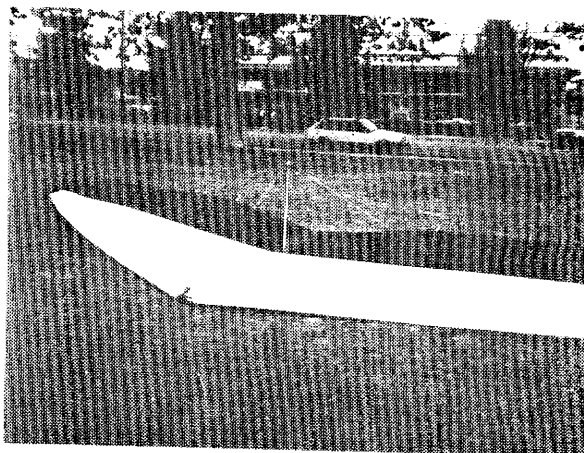
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LAYING THE GLIDER FLAT

Once you have the glider set up, you can easily lay it flat on the ground:

- 1) Remove the safety from the front bottom nosewire bolt. Place your thumbs against the "T" handle on the keyhole tang and push up on this handle while pulling down on top of the nose as shown. (fig 24) This provides the easiest method for removing the keyhole tang from the nose bolt.
- 2) Remove the clevis pin and safety from the control bar "U" channel. (fig 25)
- 3) Lifting the keel, pull the top of the control bar sideways out of the "U" channel, (fig 26), and lay the control bar down.
- 4) Lay the glider flat on the ground (fig 27 and 28). CAUTION: BE SURE TO HAVE THE NOSE POINTED INTO THE WIND WHEN USING THIS PROCEDURE AND BE GENTLE WHEN LAYING THE GLIDER DOWN AND LIFTING IT BACK UP, OTHERWISE YOU MAY BEND OR BREAK THE KEEL. ALSO BE SURE TO DETACH THE CONTROL BAR TOP FROM THE "U" CHANNEL BEFORE LAYING THE GLIDER DOWN!

ALTERNATE SET UP PROCEDURE

In strong or gusty winds, it is best to set up the glider flat on the ground:

- 1) Begin the set up procedure normally, with the nose into the wind, zipper on the bag facing up. Undo the zipper and undo all the velcros.
- 2) Assemble the control bar as previously described, and then detach it from the keel as shown in fig 25 & 26.
- 3) Flip the glider over so that it lays nose into the wind, flat on the ground, on top of the assembled control bar.
- 4) Spread the wings, and follow the rest of the normal set up procedure as previously described, except with the glider laying flat on the ground.
- 5) When you are ready to fly, lift the nose and attach the control bar and front wires. YOU SHOULD HAVE HELP AT THIS POINT TO STABILIZE THE GLIDER.
- 6) Proceed with the preflight inspection as previously described. If you don't have someone to hold the nose while you do the preflight, turn the glider carefully so that it is tail down and slightly tail into the wind (mostly crosswind). You should not put the glider nose down or tail down directly into a strong wind.

LAUNCHING THE HARRIER II

The Harrier II 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. If the wind is more than ten mph or is gusty, you should have at least one wire assistant, on the nose wires. Make sure all signals are clearly understood beforehand. Make sure all spectators are clear. Make sure you are hooked in and check your position hanging in the control bar. Make sure you have pre-flighted your harness. Give a good aggressive run and ease the bar out for lift-off.

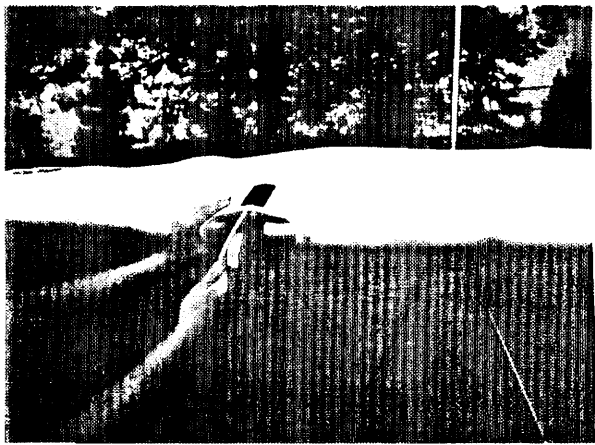
Have a good one!

FLYING THE HARRIER II

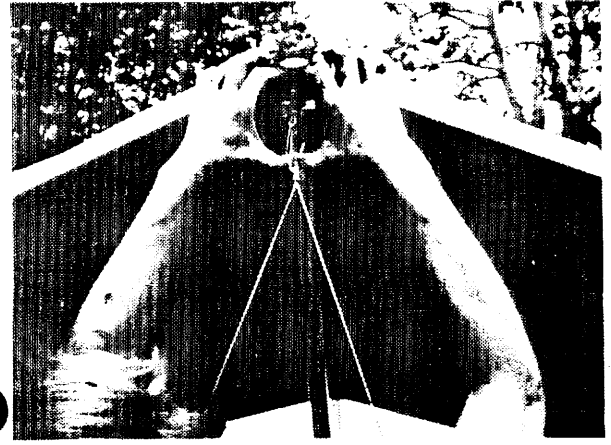
The Harrier II has straightforward flight characteristics typical of a defined airfoil flex-wing. Make your first flights from a familiar site in mellow conditions. Give yourself an extra margin of safety in all maneuvers until you are thoroughly familiar with the glider's response characteristics. Note that minimum sink is achieved at 3-4 mph faster than minimum controllable airspeed.

LANDING THE HARRIER II

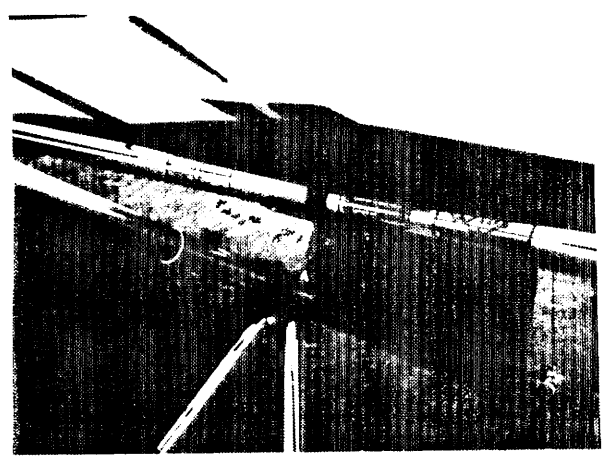
As with all defined airfoil flex-wings, landings should involve a long straight final approach at faster than best L/D airspeed, straight into the wind. Allow the speed to bleed off slowly, keeping the glider flying wings level, and close to the ground. When it is time to flare, flare aggressively and abruptly, and hold the bar out. Flaring too early will cause the glider to climb out, fall, and nose in. Flaring too late, or too gently will cause the glider to retain its forward momentum and nose in. Hanging too low in your harness or holding your hands low on the uprights will make your landings more difficult.



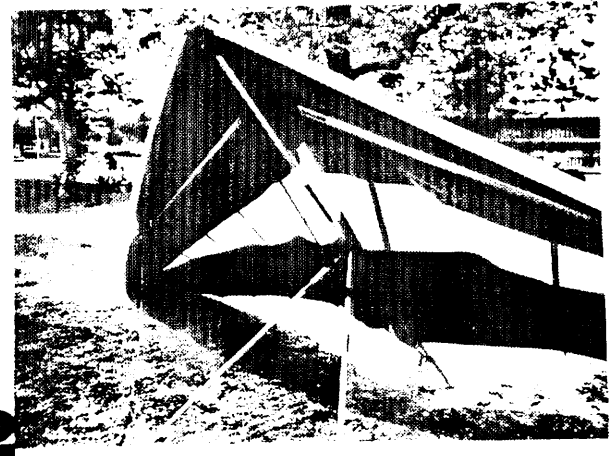
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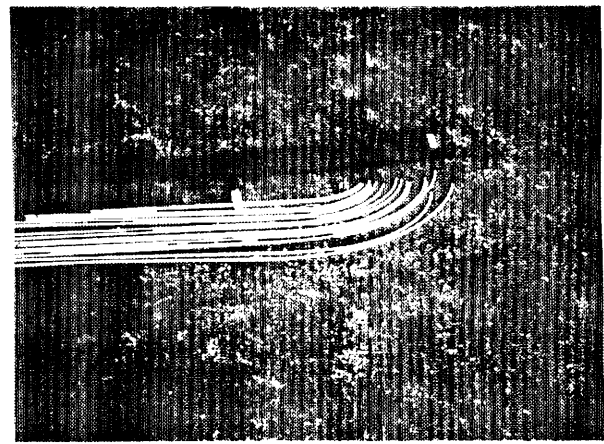
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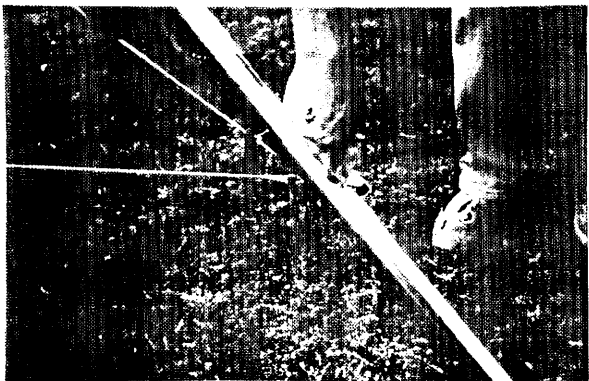
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HARRIER II BREAKDOWN

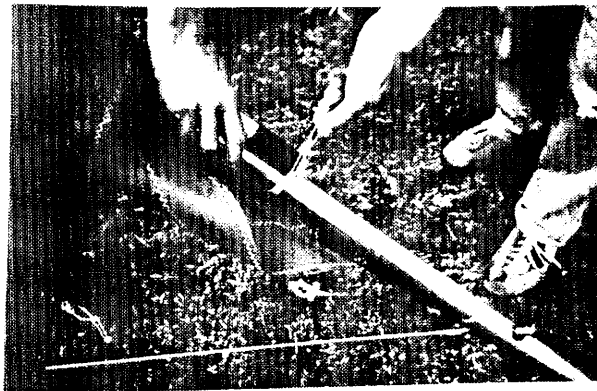
Breakdown of the Harrier II is simply the reverse of the set up procedure.

- 1) Remove the nose batten first. (fig 29)
- 2) Detach the bottom front wires at the noseplate. (fig 30)
- 3) Remove the crossbar pivot bolt and let the crossbar rest against the kingpost. (fig 31)
- 4) Slide the crossbar cover bag over the crossbar center section, and pull the crossbar forward through center. (fig 32)
- 5) Pull the wings in slightly and remove all the battens. Place them carefully together (fig 33) and stow them in the batten bag.

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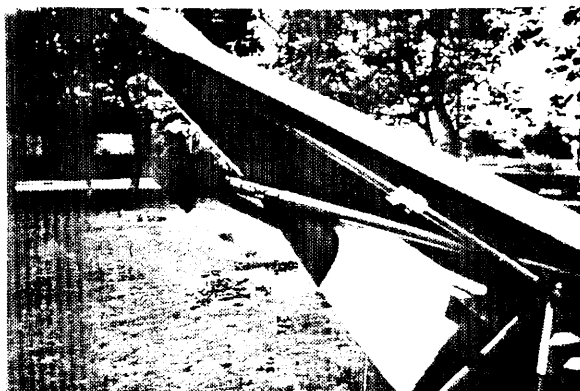
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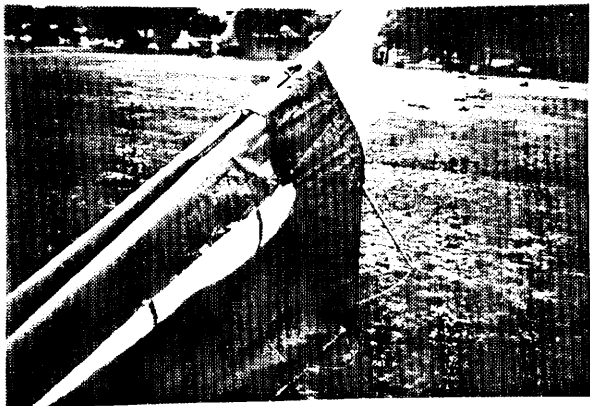
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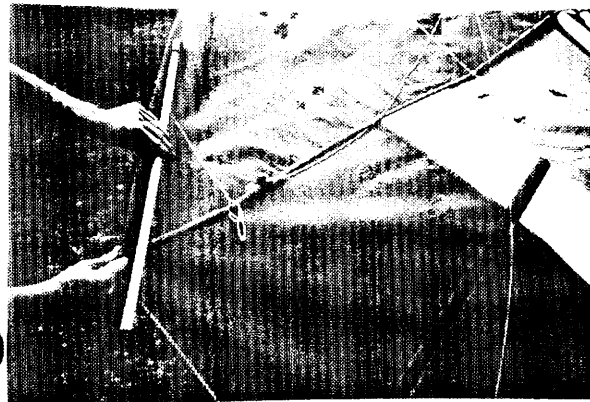
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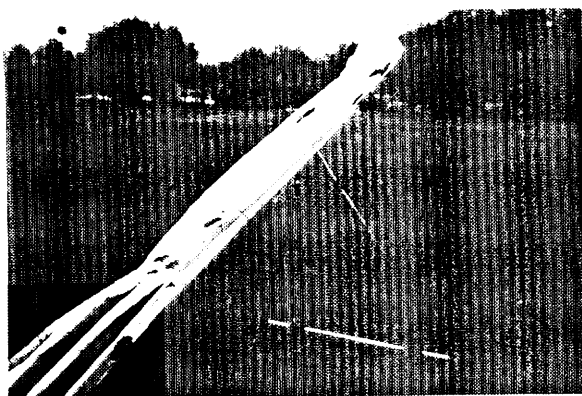
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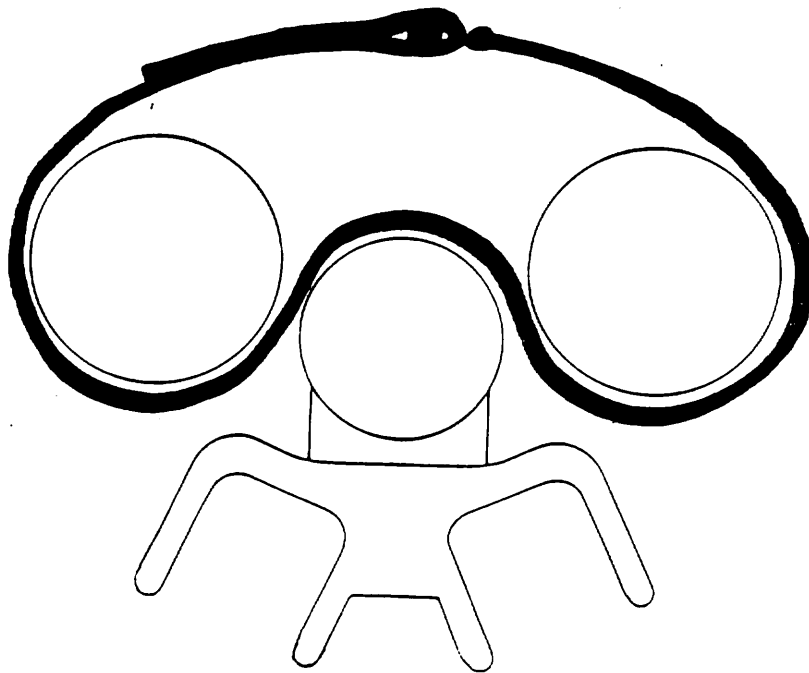
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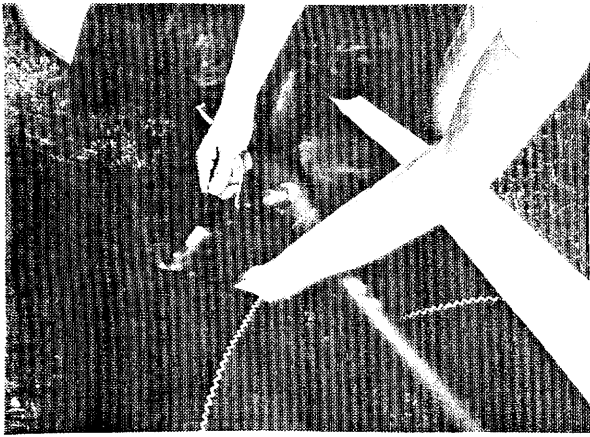


- 6) Detach the top rear wire keyhole tang from the rear of the keel. (fig 34)
- 7) Remove the kingpost from the base, and slide it back into the keel pocket securing it under the bungee retainer. (fig 35)
- 8) Remove the washout tips. Place one hand under the crossbar, and lift it as you fold in the wing. (fig 36) PROPER EXECUTION OF THIS TECHNIQUE IS VERY IMPORTANT; OTHERWISE THE CROSSBAR WILL TEND TO DROP BELOW THE KEEL AND LEADING EDGES (FIG 37). IF THIS HAPPENS, THE LEADING EDGE/CROSSBAR JUNCTION PLATE MAY BEND OR BREAK, AND THE CROSSBAR MAY BE PARTIALLY CRUSHED AND WEAKENED. Take care not to pinch your hand between the leading edge and crossbar when folding in the wing. After carefully folding in both wings and checking to see that the crossbar is properly located above the keel and leading edges, pull the sail out over the top of the leading edges on each side. (fig 38).
- 9) Roll the washout tips up in the sail as shown. (fig 39)
- 10) Place one velcro strap around the glider just aft of the leading edge/crossbar junction. Secure the velcro strap that is attached to the front keel. (fig 40) Make sure this strap passes over the top of the keel and supports the leading edges above the control bar top "E" bracket. (See diagram)

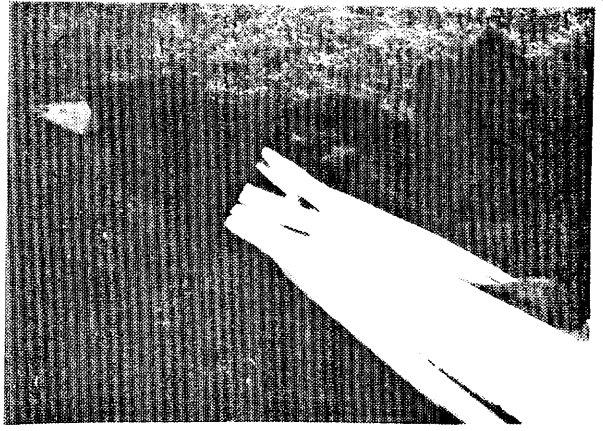


Front Velcro Strap

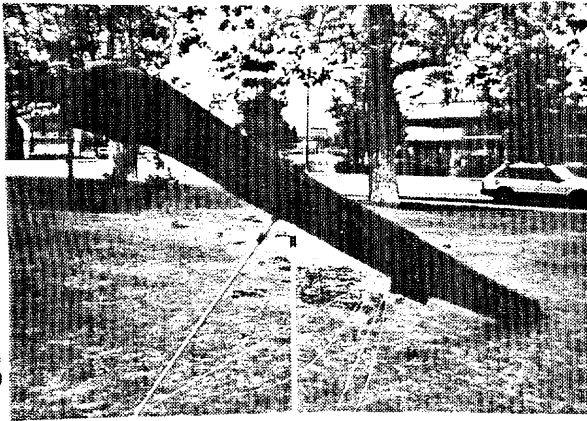
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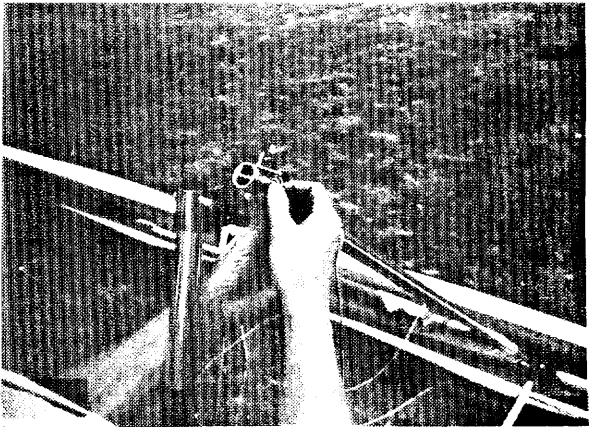
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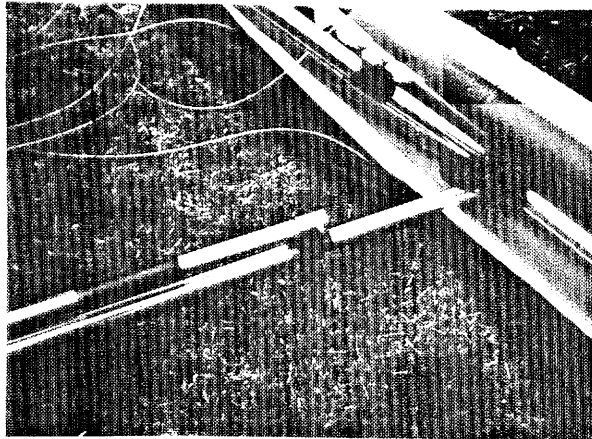
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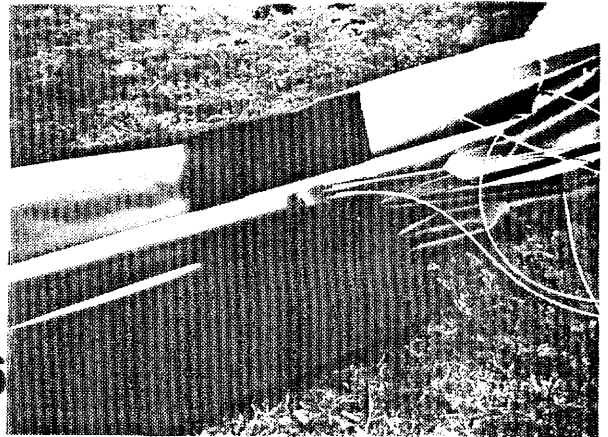
44



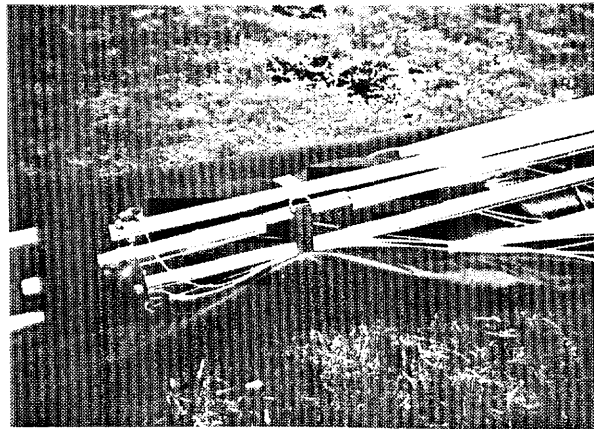
45



46



47



11) Install the protective rubber caps over the washout studs as shown. (fig 41) Install the third velcro around the leading edges as this point, taking care that the sail is not pinched between the leading edges. Slide the glider bag on the end of the glider as shown. (fig 42).

12) Place the rest of the glider bag over the glider. (fig 43) Lay the glider on its side and disconnect the leg from the "U" bracket as shown. (fig 44)

13) Fold the base tube against the other leg as shown, securing the "U" bracket over the rubber protector. (fig 45)

14) Slide the short part of the pad under the keel as shown. (fig 46) Fold the long part of the pad over the keel, fold the control bar down against the pad, and secure the velcro as shown. (fig 47) Zip up the bag.

HARRIER II TUNING

There are a number of adjustments which can be made on your glider for tuning purposes. You should be very careful when changing the tuning of your glider. Make sure you know what to expect before you make any tuning changes. Read the section in the service section of this manual on tuning and make sure you understand and follow the instructions carefully. Make all tuning changes in small increments, and test fly the glider from a familiar site in mellow conditions following each change.

HARRIER II MAINTENANCE

You should inspect your battens for left/right symmetry before each flight, and correct any assymetry. You should true them to the pattern periodically. See the section on batten maintenance in the service section of this manual for further information.

You should periodically inspect your bridles in flight for proper adjustment. See the service section of this manual for further information.

Your Harrier II should have a complete maintenance inspection every six months or 30 hours of airtime, whichever comes sooner, or at any time that you have reason to believe that any component may have been damaged.

Maintenance and service should be performed by your Wills Wing dealer.

MINIMUM SERVICE SCHEDULE

EVERY SIX MONTHS

Complete maintenance inspection of sail and airframe (requires removal of sail from frame.) Replace any parts that show signs of wear. Have any tears or wear points in sail repaired by a professional sail maker.

EVERY YEAR

Replace hang loops, harness suspension lines, bridle cables, all airframe support cables.

SPECIAL CIRCUMSTANCES

Any time you suffer a crash or hard landing you should thoroughly inspect your glider and replace any parts that are bent or broken. Inspect the sail carefully for tears, especially along the trailing edge, at the rear leading edge attachment points, and at the kingpost cut-out. Have any sail damage repaired by a professional sail maker.

Even a simple ground handling mishap may cause concealed damage, such as bent battens, which could severely affect your glider's flight characteristics. If your glider flips over in the wind, or something similar happens, you should breakdown far enough to remove and inspect your battens, and perform a careful preflight after re-assembly.

It is possible to bend a leading edge on a hard landing and not be able to discover the damage without removing the sail from the frame. The flight characteristics of a glider with a bent leading edge may not be noticeably different, while the safety of the glider may be significantly compromised.

If your glider is ever exposed to salt water you must rinse it thoroughly with fresh water, including the insides of all tubes. This will require the removal of all end caps. After rinsing, or any time your glider gets wet, you should dry it thoroughly, 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, as any soap or detergent will likely degrade the cloth and may adversely affect the flying characteristics.

With proper care and maintenance, your glider will retain for some years a high level of airworthiness. The Harrier II was tested and found to comply with the 1980-81 HGMA Airworthiness Standards, which represent the best accumulated knowledge of what constitutes airworthiness in a hang glider. There is much that we still do not 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 which 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 your choice of the the conditions in which you fly and the safety margins you allow in the manuevers you attempt. We recommend that you fly only with a harness that has been tested for strength by the manufacturer, and that you always fly with an emergency parachute system. Our experience has shown us that pilots who fail to follow these recommendations are often killed or severely injured in accidents that could easily have been prevented.

CAR TOP MOUNTING

Your Harrier II should be mounted on your rack with the control bar bracket (zipper on the bag) facing upwards, and the flag at the rear. Your rack should have at least three support points, spanning at least 13' of the glider. These should be padded and at least 4" wide to distribute the load. You should be careful when securing your battens that you do not bend them.

A FEW LAST WORDS

Your Wills Wing Harrier II is a sophisticated high performance glider that 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 this glider is not covered by product liability insurance, and that you fly a hang glider at your own risk.

See you in the sky!

Wills Wing, Inc.

SERVICE SECTION

INTRODUCTION

This section of the manual is intended for the use of Wills Wing dealers performing service on the glider. THIS MANUAL ASSUMES A HIGH DEGREE OF FAMILIARITY WITH HANG GLIDER SERVICE PROCEDURES, THE USE OF APPROPRIATE TOOLS, ETC. WE STRONGLY RECOMMEND THAT ALL SERVICE PROCEDURES BE PERFORMED BY A QUALIFIED WILLS WING DEALER. We know of several incidents of serious accidents which were caused by improper assembly of glider components during service procedures done by pilots unfamiliar with general practices of glider design and assembly. When doing service work on a hang glider, please be absolutely sure you know what you are doing; someone's life will depend on it. There are numerous photographs and diagrams in this manual to help you understand the proper assembly of the glider. If you have any questions after studying the manual, please contact Wills Wing.

POST SHIPMENT ASSEMBLY

Part of your required service as a Wills Wing dealer is to unpack, assemble, inspect and test fly each glider before you deliver it to the customer. The following instructions cover this pre-delivery procedure.

If the glider has been shipped full length, it requires no assembly other than the normal set up procedure described earlier in the owner section of this manual. Please refer to that section.

If the glider has been broken down for shipment, the rear leading edges will have been removed, and will need to be re-installed.

- 1) Remove the glider and parts from the shipping tube, unzip the bag, and spread the leading edges slightly. The rear leading edges should be marked to indicate right and left. Remember that with the glider lying on its back, the right leading edge will be on your left, as you look from the tail of the glider. On the 147 Harrier II, the assembly of the rear leading edge to the front is secured by a clevis pin. On the 177 and 187, the assembly is secured by the bushing into which the bolt which secures the crossbar to the leading edge fits. When the leading edge is properly installed, the plug in tip sleeve will point up and in, at an angle of about 24 degrees from the horizontal. (With the glider upside down on the floor or table, the sleeves will point in and down at 24 degrees.) If improperly installed, the sleeve will point either outwards, which would make it impossible to assemble the glider, or in and down at 24 degrees from the horizontal, which would put 24 degrees of negative twist in the tip and make the glider extremely unsafe to fly. Once again, please note that when the glider is lying on its back (when the zipper on the bag is up)

the washout tip sleeves will point "down" and in when properly installed, since the glider is upside down. (SEE DIAGRAM) THERE IS AN UNSECURED SHORT SLEEVE INSIDE THE REAR LEADING EDGE ON THE 177 AND 187 THAT MUST BE PROPERLY IN PLACE BEFORE THE BUSHING IS INSERTED. CHECK FOR THE PROPER LOCATION OF THIS SLEEVE BEFORE AND AFTER YOU INSTALL THE REAR LEADING EDGE, AND BEFORE YOU INSERT THE BUSHING. After the rear leading edges are installed and secured, install the leading edge/crossbar plate bolt, tangs, nut and safety (177 & 187) as shown in the appropriate diagram.

2) Once the leading edges are properly installed and secured with the clevis pin and safety (147) or bushing (177 & 187), the sail may be mounted to the rear leading edge. Refer to the diagram for the proper intallation of the clevis pin, washers and safety. NOTE THAT THE SAIL IS MOUNTED TO THE OUTSIDE OF THE LEADING EDGE. The proper orientation of the sail mount plug will have the sail mount clevis pin aligned as shown to the washout sleeve, unless the sail mount plug has been rotated to correct for a turn. In this case there should be only a slight variation from the normal orientation.

ANYTIME YOU ARE MOUNTING OR DISMOUNTING THE SAIL AT THE REAR LEADING EDGE, CHECK THE CONDITION OF THE WEBBING AND GROMMET WHICH SECURE THE SAIL TO THE CLEVIS PIN. IF THE WEBBING IS TORN OR THE GROMMET IS LOOSE, HAVE A SAILMAKER REPLACE THEM, MAKING SURE THAT THE REPLACEMENT GROMMET ENDS UP IN EXACTLY THE SAME POSITION. ALSO CHECK TO SEE THAT THE SAIL MOUNT PLUG IS PROPERLY ALIGNED AND SECURED WITH A SET SCREW.

3) When mounting the sail at the rear of the leading edge, you may find it difficult to stretch the sail back far enough to intall the clevis pin. If so, you can dismount the sail at the nose. If you do dismount the sail at the nose, you should remount it immediatley after mounting the rear. Otherwise the sail will slide rearward on the frame at the nose, and when you spread the leading edges during set-up, you will tear the sail.

SET UP, INPSECTION AND TEST FLIGHT

Following removal of the glider from the tube and installation of the leading edges (if necessary) set up the glider according to the instructions in the owner section of this manual. Before inserting the battens, check them against the pattern and recamber any that may have been altered in shipping.

When installing the battens, check that the batten strings are properly adjusted, and re-adjust any that require it. Proper adjustment of the strings will allow you to pull the string just past, but not more than 1/4" to 3/8" past the end of the batten before the pain in your finger becomes severe. If the strings are too loose, particularly on the outboard battens, the sail may flutter at the trailing edge. If the strings are too tight, the battens may wear through the front of the batten pocket, requiring an expensive sail repair.

Following set-up, perform a complete pre-flight inspection of the glider as described in the owner section of this manual. Your attitude during this inspection should be to assume that the glider was improperly made and assembled, and not test flown. IN OTHER WORDS, DON'T TAKE ANYTHING FOR GRANTED. DON'T ASSUME THAT THE GLIDER IS PROPERLY PUT TOGETHER JUST BECAUSE IT CAME FROM THE FACTORY. At this point in time it becomes your responsibility to make sure that the glider you deliver to your customer is right, in every respect.

After you have inspected the glider, the next step is the test flight. You should fly the glider from a familiar site in mellow conditions. During the test flight, perform the following maneuvers:

1) Multiple 360 degree turns at shallow bank angles in both directions. This is the best way to detect a turn in the glider; it will feel mildly roll stable to one side and mildly roll unstable to the other. Properly tuned, the glider will be essentially roll neutral to slightly roll stable, and will be equally so to both sides. At this time, also check for proper speed trim.

2) Low speed roll initiation from wings level. This is a test for adverse yaw; the tendency of a glider to resist rolling and yaw in the wrong direction at low speeds. Some degree of adverse yaw may be present at very low speeds, but from trim speed on up, the glider should roll smoothly with good coordination, and should not require you to pull in on the bar prior to roll initiation.

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, the alignment of the sail mount plugs, and the batten camber.

If the glider exhibits any improper flight characteristics, refer to the tuning section of this manual and try to correct the problem. Fly the glider between each adjustment to check on your progress. Do not deliver a glider until it has exhibited in flight the proper flying characteristics. Refer to your Wills Wing Dealer Test Pilot's Manual for further information on test flying. If you have a problem you cannot solve, please contact Wills Wing. After you are satisfied that the glider flies properly, initial and date the red "Dealer Test Fly Sticker" on the crossbar.

The final steps in your glider delivery procedure are to review the set-up, breakdown, and transport procedures, as well as the owner's manual with your customer. Fill out the glider delivery checklist, have your customer initial it, and send it in. Deliver the team cap, spare parts kit, and batten diagram. Also, please encourage your customer to send in his customer response form.

TUNING

In this section we will cover the effects of all the tuning adjustments which can be made on the glider.

BATTENS

The battens will need to be trued to the pattern from time to time. Repeated installation and removal will tend to de-camber the battens. Hard landing and nose-ins may bend the tip battens or induce reflex into the #3 and #4 battens. (Note: Battens are numbered from the tip inboard. The reason for this is that on scaled sizes the outboard (#1, #2 etc.) battens will be the same batten, while a smaller glider may not have a #7 batten.) Small variations in batten camber will not have a significant effect on flight characteristics. Excessive camber in the battens will usually make the glider trim faster, have less bar pressure in a dive and be less pitch stable, and be stiffer and slower to roll. Too little camber will reduce the performance of the glider. Battens which are assymetric from left to right will tend to induce a turn in the glider.

The best way to true battens is in the shop on a flat table, using a radiused template as shown. Try to avoid putting sharp kinks in the batten. Unlike structural frame members, battens may be bent and re-bent repeatedly without causing any safety hazard. However, you may find it easier to replace a badly bent batten than to re-true it. When re-shaping a batten the material will tend to spring back after it is bent, so some practice is required to arrive at the proper final bend. We recommend against truing battens to the pattern outside the shop. In the field a bent batten can be trued to it's corresponding batten from the other side. As long as the battens are symmetrical and close to the proper shape, the glider will fly normally. When truing the battens to the pattern, line up each end of the batten underneath the line on the pattern, and check for the deviation along the batten as described on the pattern.

KEEL POCKET RESTRAINING STRAP

This strap, which mounts the keel pocket to the rear of the keel, determines the ability of the inboard section of the wing to take camber. If it is too tight, the camber will be restricted, and handling and performance will suffer. To check the adjustment, rest the glider on its tail, stand on the base tube, and push up hard on the sail at the center, just behind the double surface. If there are diagonal wrinkles in the keel pocket, the strap is too tight and is restraining the sail improperly. If there is excessive slack in the keel pocket behind the trailing edge, or in the strap, the strap is too loose.

REFLEX SUPPORT BRIDLES

The proper adjustment for the reflex bridles is just slack in normal flight. The dimensions listed on the compliance verification specification sheet in the rear of this manual give you the normal measurements. However, the "just slack" criterion is the determining factor. This is best determined by flying the glider and sighting the shadow of the bridles on the sail. They should be perceptibly slack, but not more than just slack. Be sure to distinguish between the curved shadow of a straight bridle on the curved surface of the sail, and the shadow of a bridle line which is curved because it is hanging slightly slack. Slack bridles will wiggle when you shake the control bar. If the bridles are too tight, the handling of the glider will be seriously degraded. If they are too loose, the glider will not have the level of pitch stability for which it was designed and certified, and may not be safe. LOOSENING THE BRIDLES BEYOND THE PROPER ADJUSTMENT WILL NOT IMPROVE EITHER HANDLING OR PERFORMANCE.

FRONT TO REAR WIRE LOOP LENGTH ADJUSTMENT

There are washers stacked underneath the tang which connects the bottom rear wires to the rear of the keel. Removal of one or more of these washers will allow for the tightening of the front to rear wire loop. This loop should be snug, but not so tight that you have difficulty attaching or removing the keyhole tang from the bottom nose wire bolt. Following the removal or addition of washers you should install a new nylock nut, and check to see that at least one or more threads protrude from the nylon in the nut after installation.

LEADING EDGE SAIL TENSION

The leading edge sail mount plug has two holes for the adjustment of leading edge sail tension. The provision for tensioning the sail tighter than normal is primarily intended to retension older sails which may have stretched along the leading edge. Tightening the sail will tend to slightly improve performance, but tends to make the glider much stiffer and slower to turn, and to increase the tendency for adverse yaw. Loosening the leading edge sail tension is usually the single most effective way to improve the handling of a stiff, slow rolling glider. (Check first to see that all other adjustments are properly set.) When remounting the sail to a different hole in the plug, make sure to rotate the plug appropriately so as to maintain the proper amount of twist in the tip. Also make sure to secure the plug with the set screw following any such adjustments. (See the appropriate diagrams in the back of this section.)

LEADING EDGE SAIL MOUNT PLUG

This plug can be rotated to change the effective twist in the wing tip. Adjusting this twist is the most effective way to correct for a tendency of the glider to turn to one side. The normal adjustment results in the sail mount clevis pin being almost parallel (see diagram) to the washout tip sleeve. Rotating the plug so as to twist the trailing edge up (Clockwise for the right tip) will make the glider turn towards that wing, while rotating the plug so as to reduce twist in that wing will make the glider turn away from that wing. When adjusting for a turn, you may find that decreasing the twist in one wing is more effective than increasing the twist in the other wing. Whenever changing this adjustment, do so in small increments, and make sure to re-secure the plug with the set screw. Rotating both tips up will tend to reduce the trim speed, increase the pitch bar pressure, and make the glider more roll stable. You should not rotate BOTH tips down below the point where the clevis pins are parallel to the washout tip sleeves, nor should you rotate either tip down to the point where there is less than 1" clearance between the sail and the end of the washout tip in flight at trim speed.

MAINTENANCE

Schedule:

Every Six Months: Complete maintenance inspection of sail and airframe. Remove sail from frame, inspect sail for tears and wear points and repair as necessary. Inspect frame for bent, dinged, or gouged members. Replace any compression members (crossbar, control bar leg, kingpost) that show damage anywhere in the middle 3/4ths of the length. Replace any member that is severely damaged at any point. Replace any leading edge that shows damage not confined to within two feet of the nose or tail. Replace any cable that shows any wear or damage. Replace any bent bolts, and all nylock nuts removed during disassembly. Replace hang loop if it shows any wear. Carefully inspect sail mounting webbing and grommet at the rear of the leading edge; have these replaced by a sail maker if they show any signs of wear. THE POSITION OF THIS GROMMET IS CRITICAL; IF YOU HAVE IT REPLACED MAKE SURE THE REPLACEMENT IS IN THE SAME POSITION. Replace any safety rings that are bent or deformed. Replace the safeties on the keyhole tangs, and the rubber sleeves on the washout tip sleeves. Inspect the batten retaining strings and replace or adjust if necessary. Inspect all tubes, bolts, and cables for corrosion.

Every Year: Perform the six months service and, in addition, replace all airframe support cables. Also replace the bridle cables. Replace the hang loop. Advise the customer to replace all main suspension lines on the harness.

Fill out the service schedule when work is done on the glider.

DISMOUNTING THE FRAME FROM THE SAIL

To remove the sail from the frame:

- 1) Detach the keel pocket restraining strap.
- 2) Remove the clevis pin from the control bar "U" channel and detach the control bar from the keel.
- 3) Detatch the bottom side and lower front to rear wires from the control bar.
- 4) Remove the kingpost cap from the kingpost and remove each of the top wires from the cap. You will need to remove the black plastic cap and the white plastic retaining rivet by pushing them out from the bottom of the cap with a 1/4" diameter punch.
- 5) Dismount the sail at the nose, and at the rear leading edges.
- 6) Carefully slide the frame out through the nose of the sail. (It is best to have a helper at this point.)

SERVICE RECORD

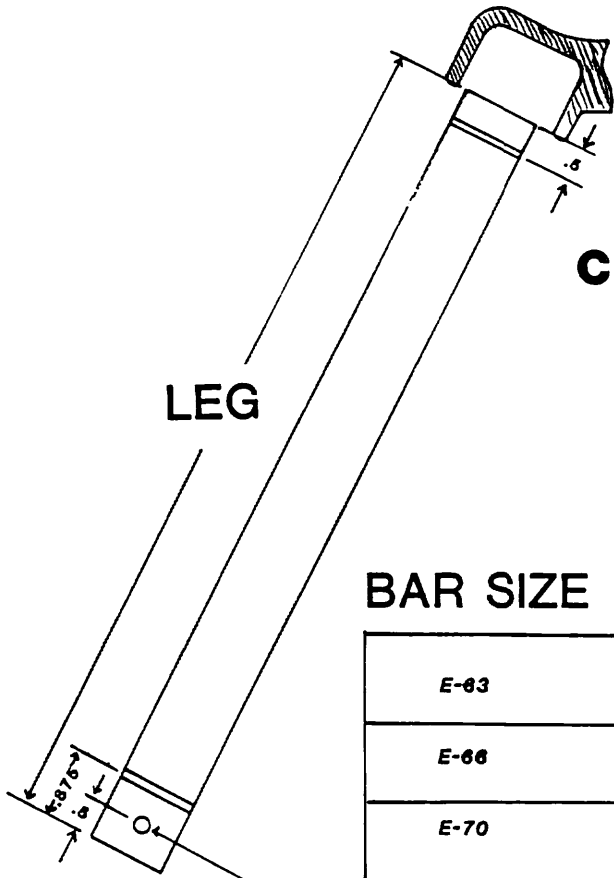
EVERY SIX MONTHS

ITEM	DATE	DEALER & SERVICEMAN	DATE	DEALER & SERVICEMAN	DATE	DEALER & SERVICEMAN
Sail Inspection						
Airframe Inspection						
Cable Inspection						
Necessary Repairs Completed						
Sail Inspection						
Airframe Inspection						
Cable Inspection						
Necessary Repairs Completed						
EVERY TWELVE MONTHS						
Airframe Cables Replaced						
Bridle Cables Replaced						
Hang Loop Replaced						

Additional Service Work

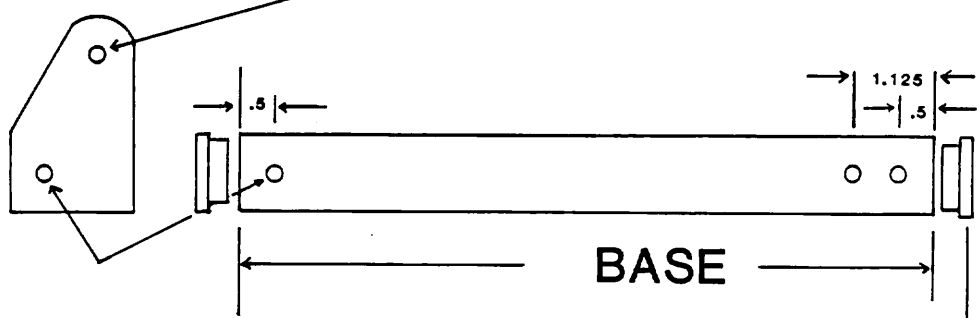
DESCRIPTION OF WORK DONE AND PARTS REPLACED

DESCRIPTION OF WORK DONE AND PARTS REPLACED	DATE	DEALER & SERVICEMAN



CONTROL BARS

BAR SIZE	LEG	BASE
E-63	63 1.125 x .058	54.5 1.125 x .058
E-66	66.25 1.125 x .095	57.125 1.125 x .058
E-70	69.5 1.125 x .095	59.78 1.125 x .058

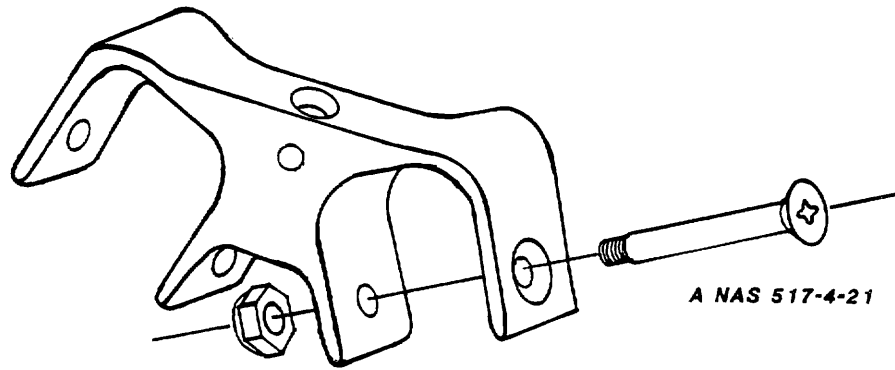


NOTE: All holes 1/4"
 Not to scale
 Supine Harriers used an
 E-63 bar with .095 legs

APPLICATION	
E-63	H-I, II 147
E-66	H-II 177 Duck-160
E-70	H-I 177, H-I, II 187 Duck-180

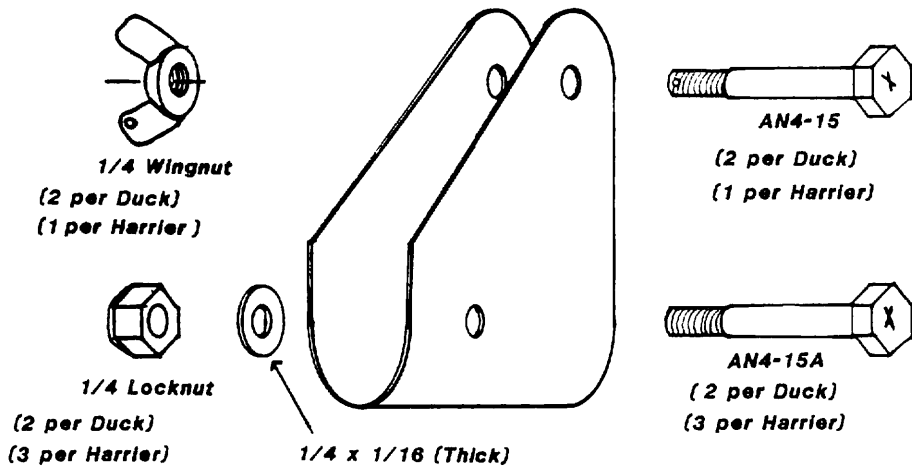
CONTROL BAR

3-2

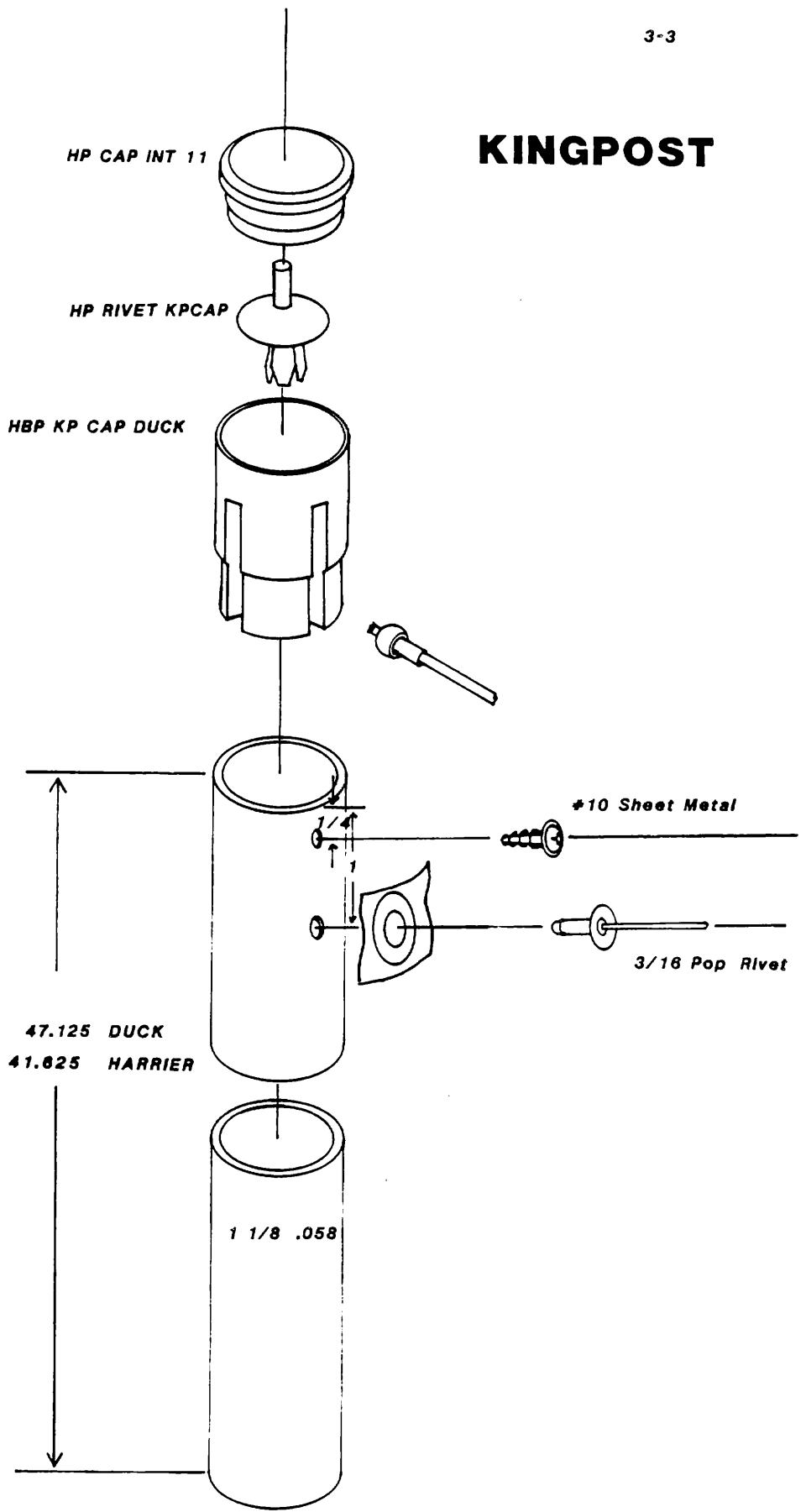


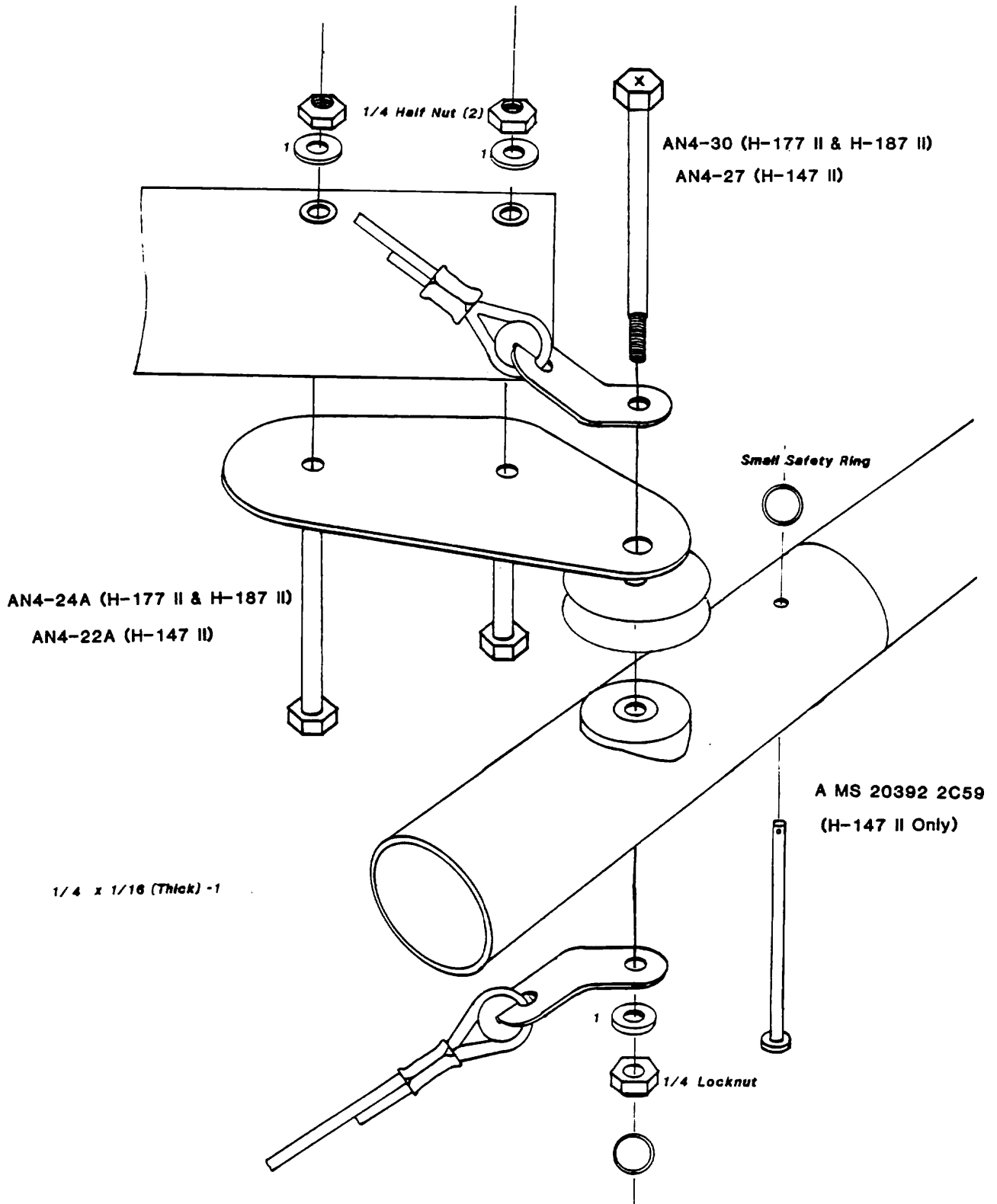
1/4 Half Nut

A NAS 517-4-21



KINGPOST





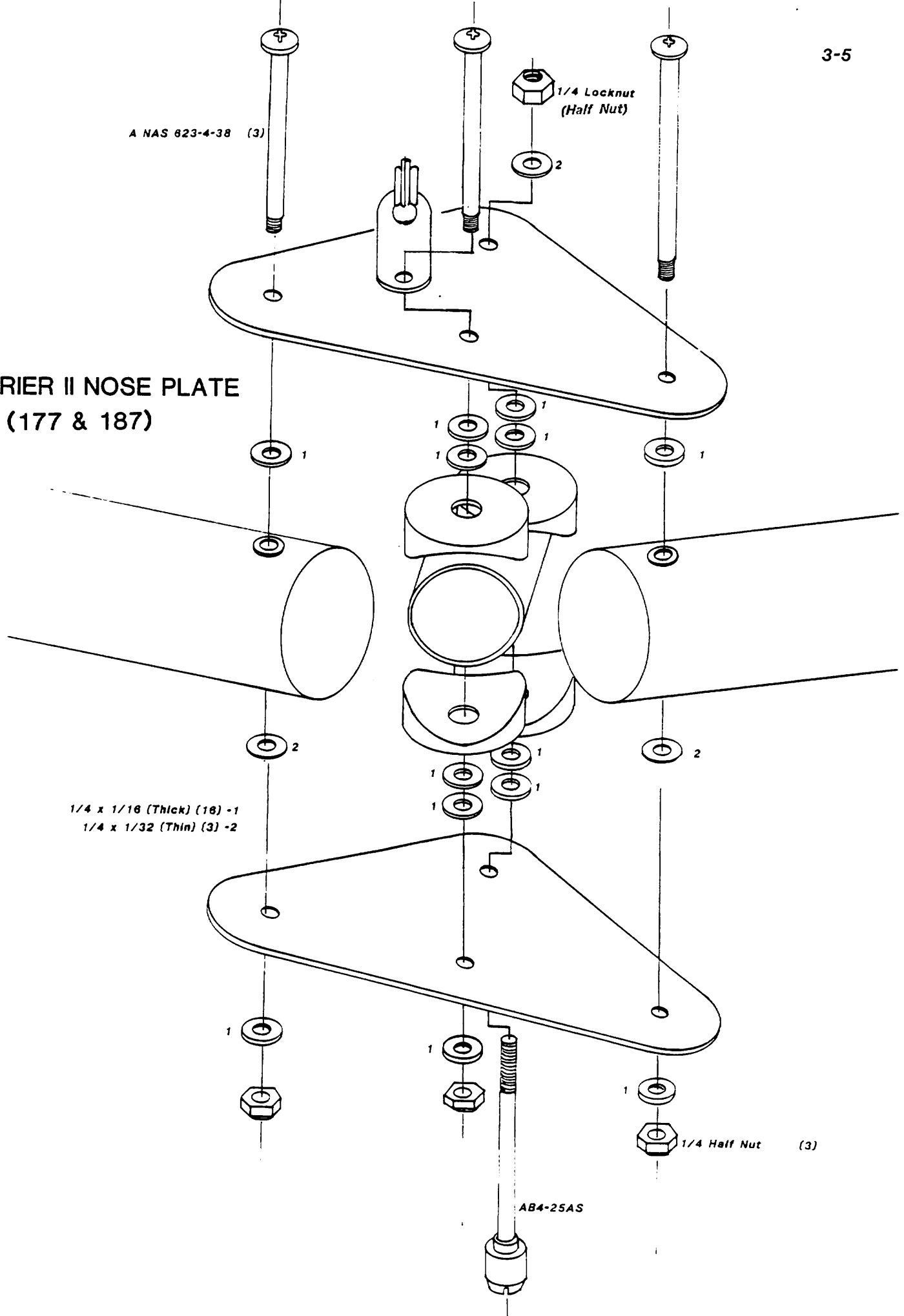
HARRIER II XBAR / LEADING EDGE

A NAS 823-4-38 (3)

1/4 Locknut
(Half Nut)

2

HARRIER II NOSE PLATE (177 & 187)



1/4 x 1/16 (Thick) (18) - 1
1/4 x 1/32 (Thin) (3) - 2

AB4-25AS

1/4 Half Nut (3)

AN4-23A

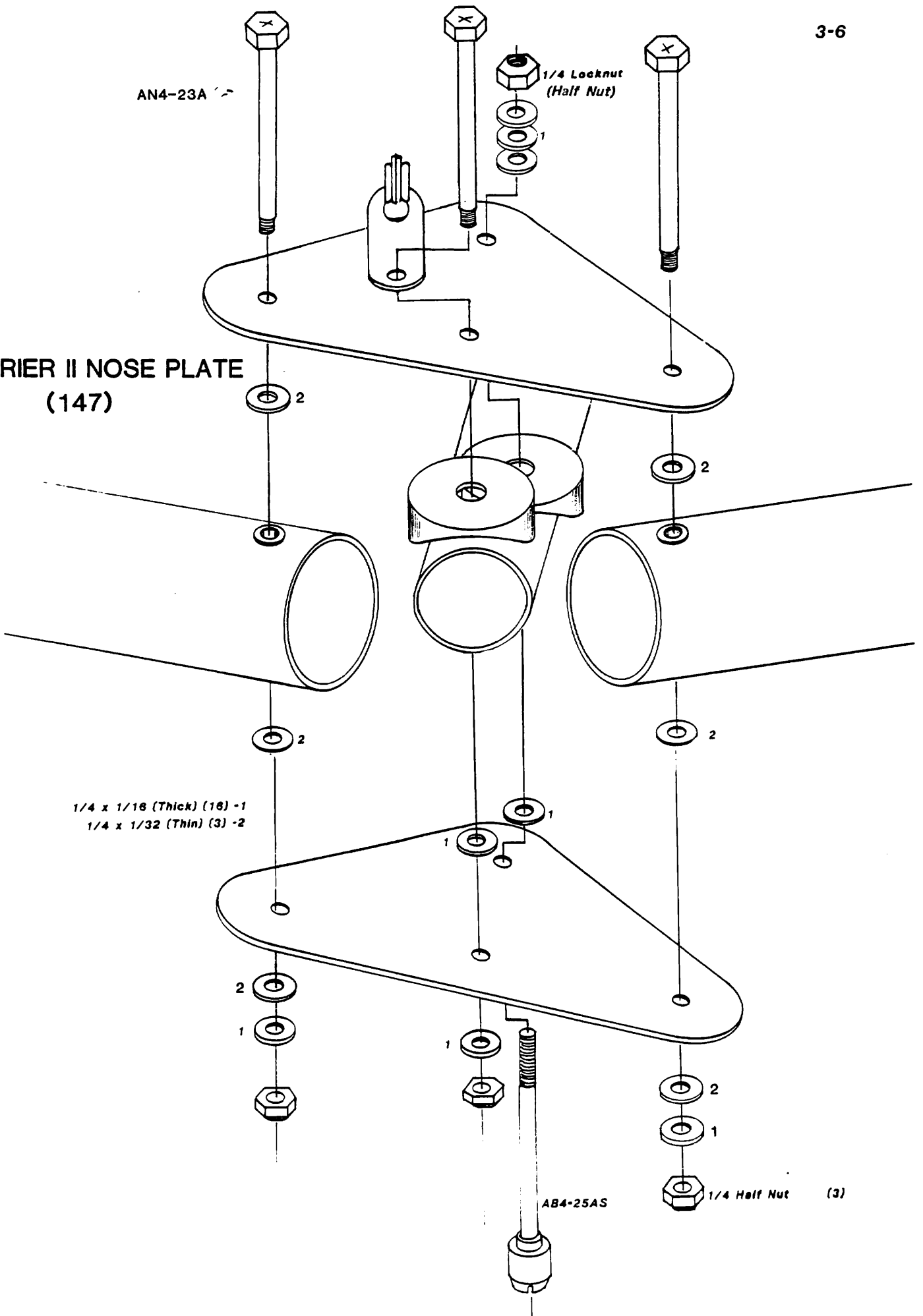
1/4 Locknut
(Half Nut)

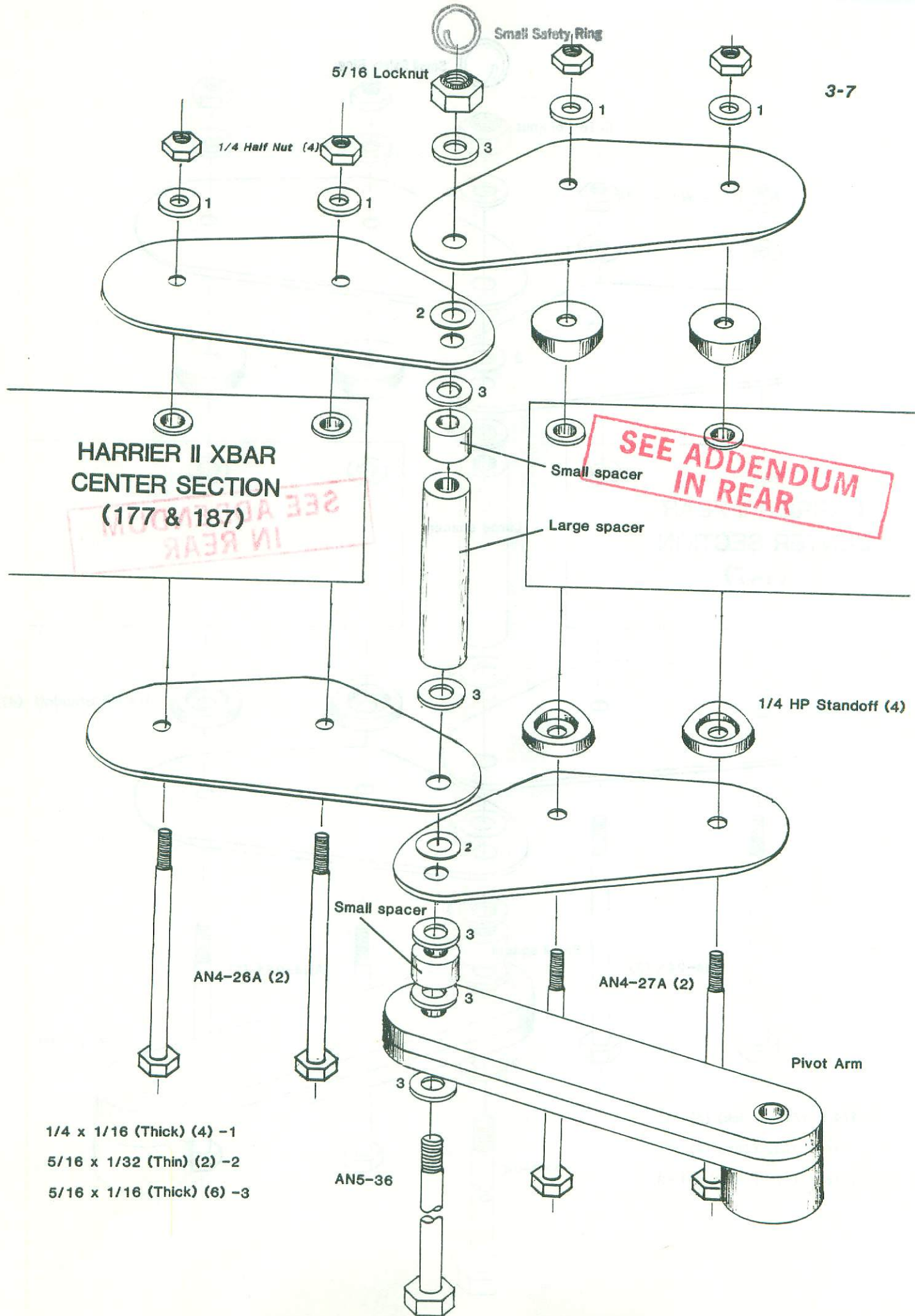
HARRIER II NOSE PLATE
(147)

1/4 x 1/16 (Thick) (16) -1
1/4 x 1/32 (Thin) (3) -2

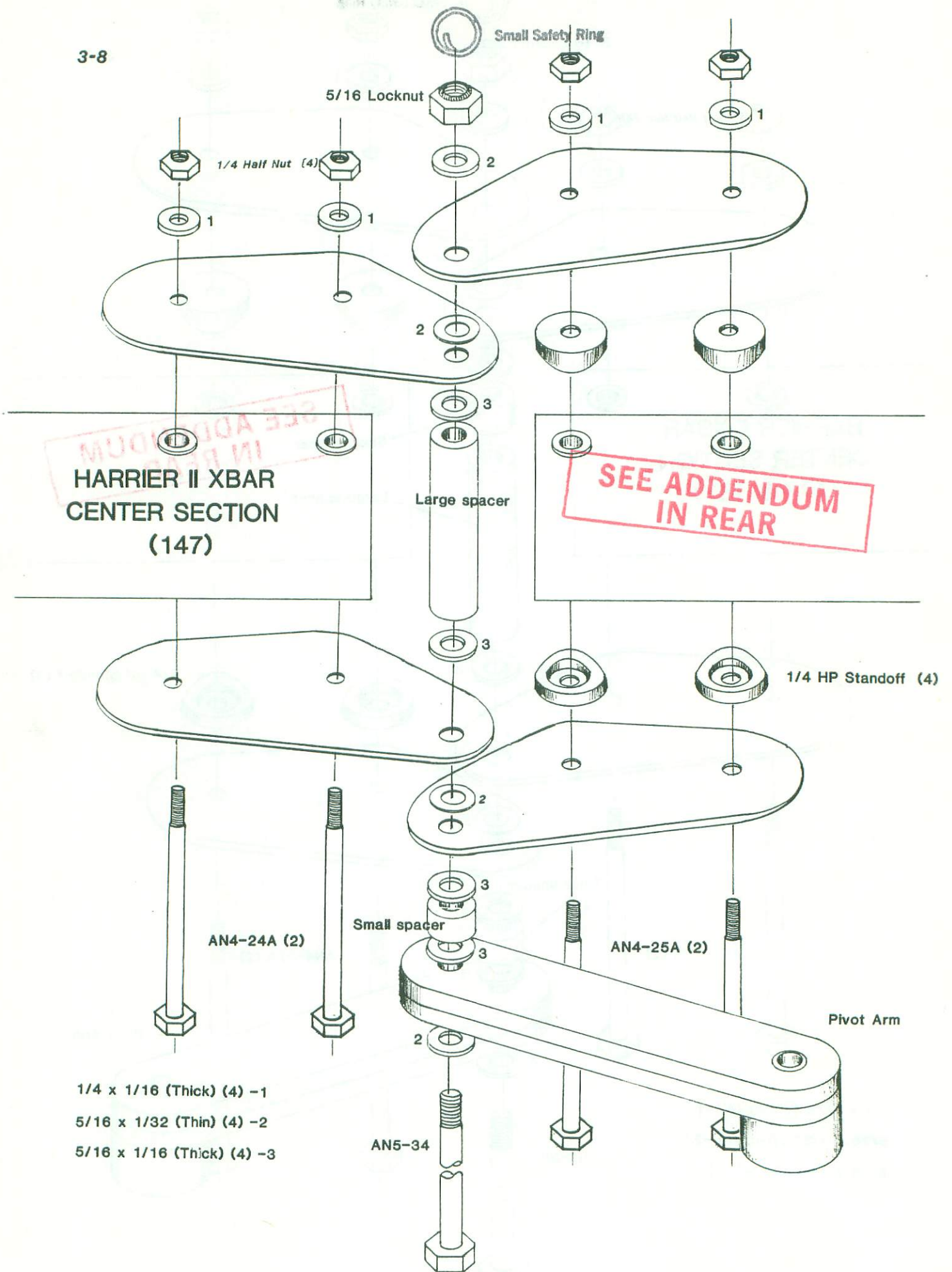
AB4-25AS

1/4 Half Nut (3)





- 1/4 x 1/16 (Thick) (4) -1
- 5/16 x 1/32 (Thin) (2) -2
- 5/16 x 1/16 (Thick) (6) -3

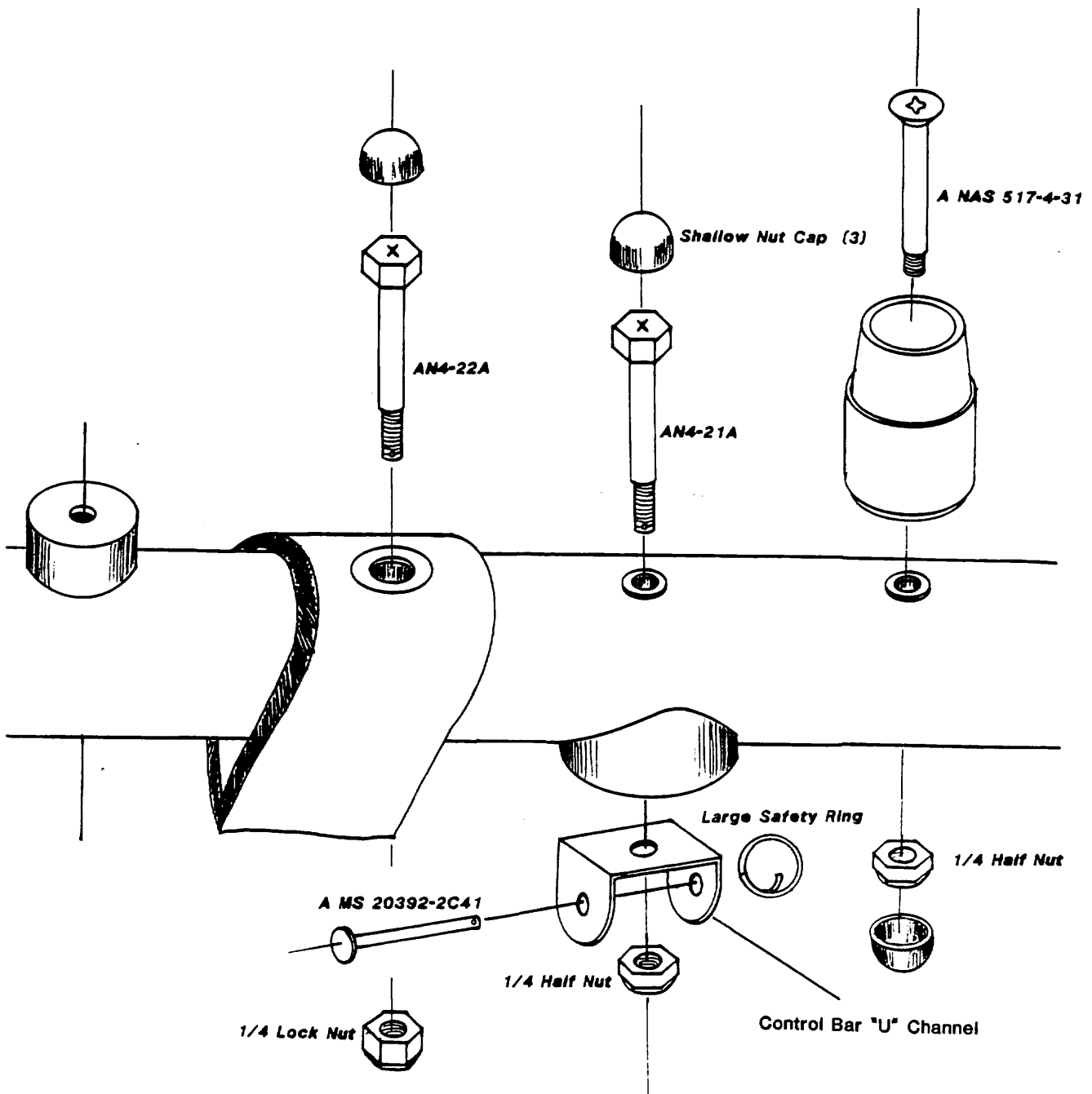


1/4 x 1/16 (Thick) (4) -1

5/16 x 1/32 (Thin) (4) -2

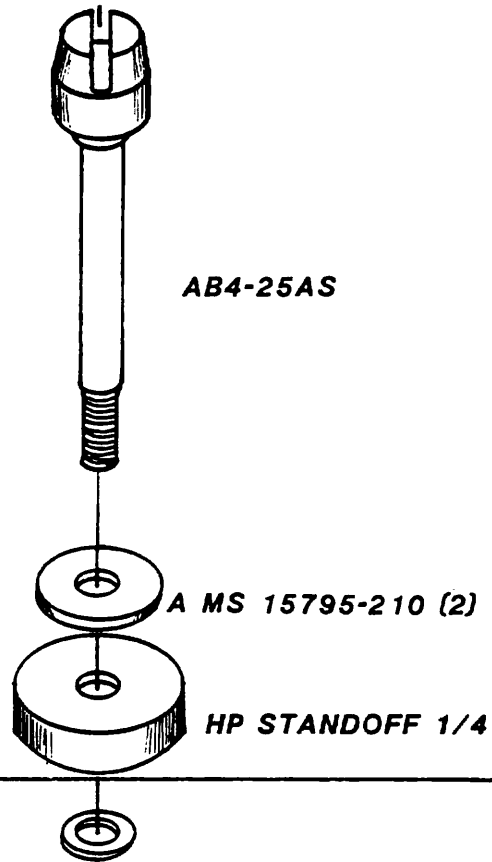
5/16 x 1/16 (Thick) (4) -3

HARRIER II KEEL CENTER

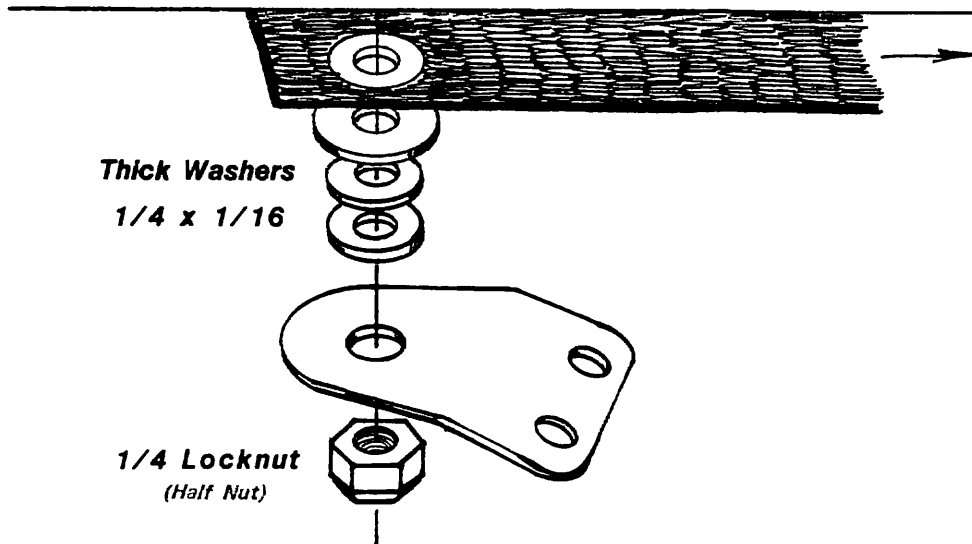


NOTE: This configuration applies to the H-177 II & H-187 II. On the H-147 II the hang strap and control bar mounting locations are reversed.

3-10

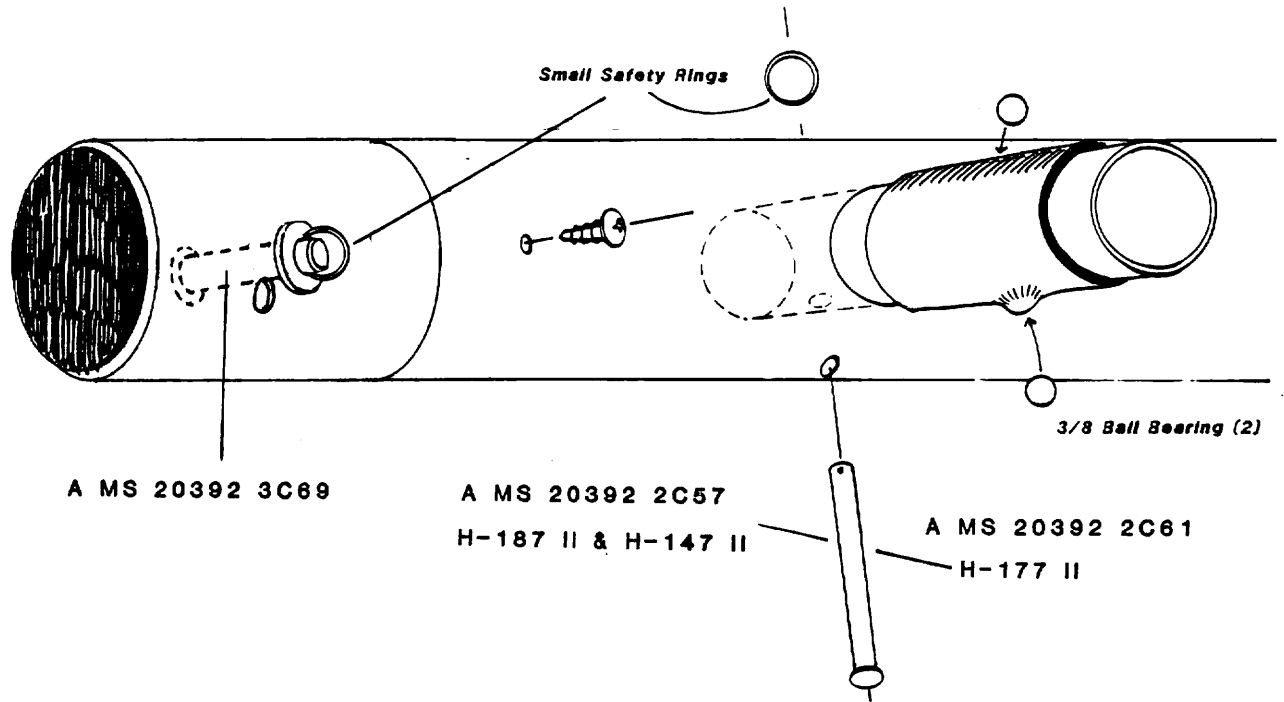


HARRIER II REAR KEEL

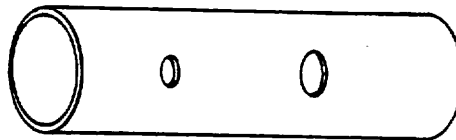


HARRIER II REAR LEADING EDGE

3-11

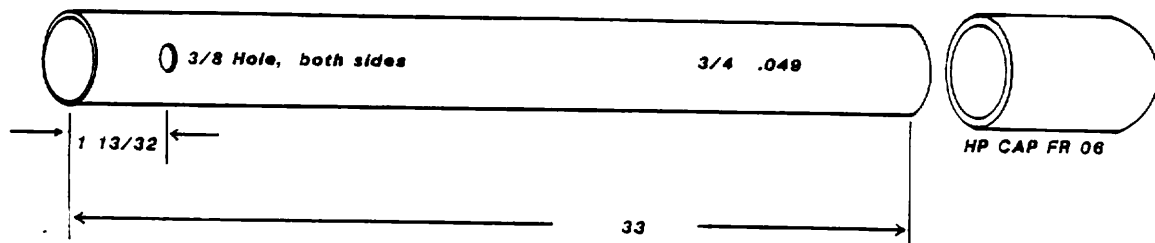


WASHOUT SLEEVE

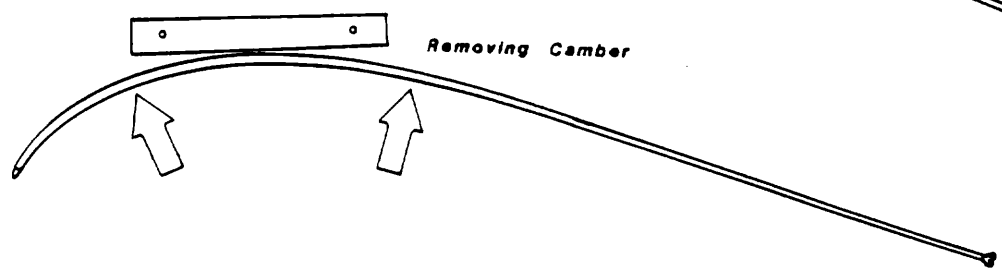
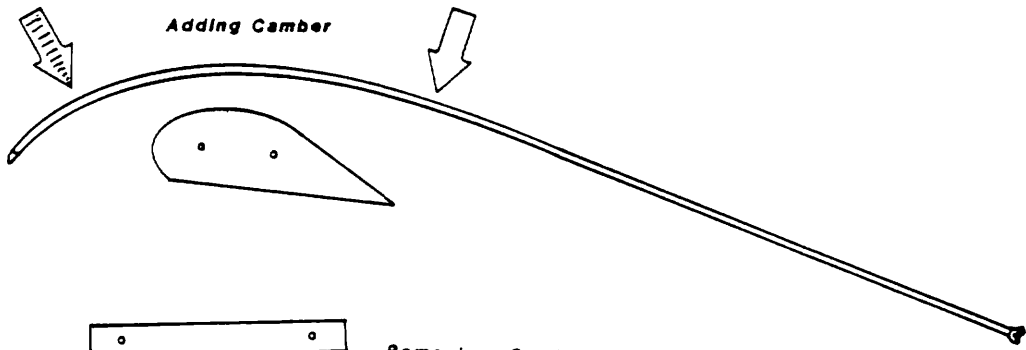
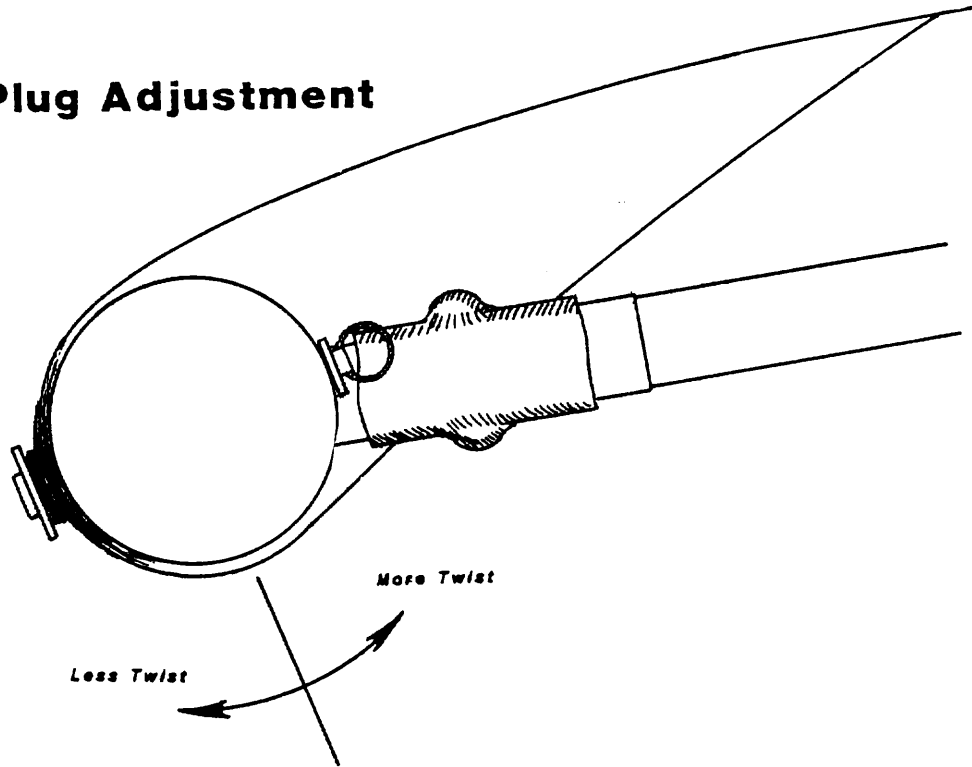


7/8 .058

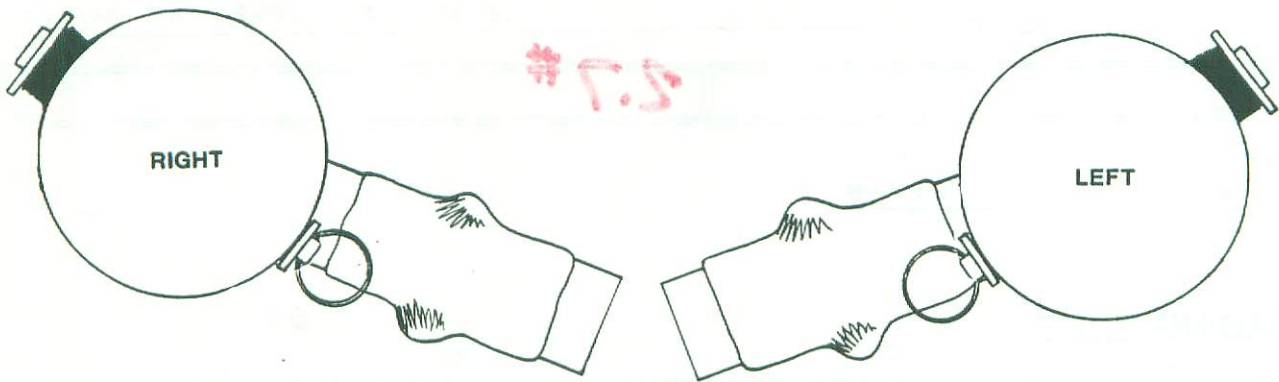
WASHOUT TIP



Sail Plug Adjustment

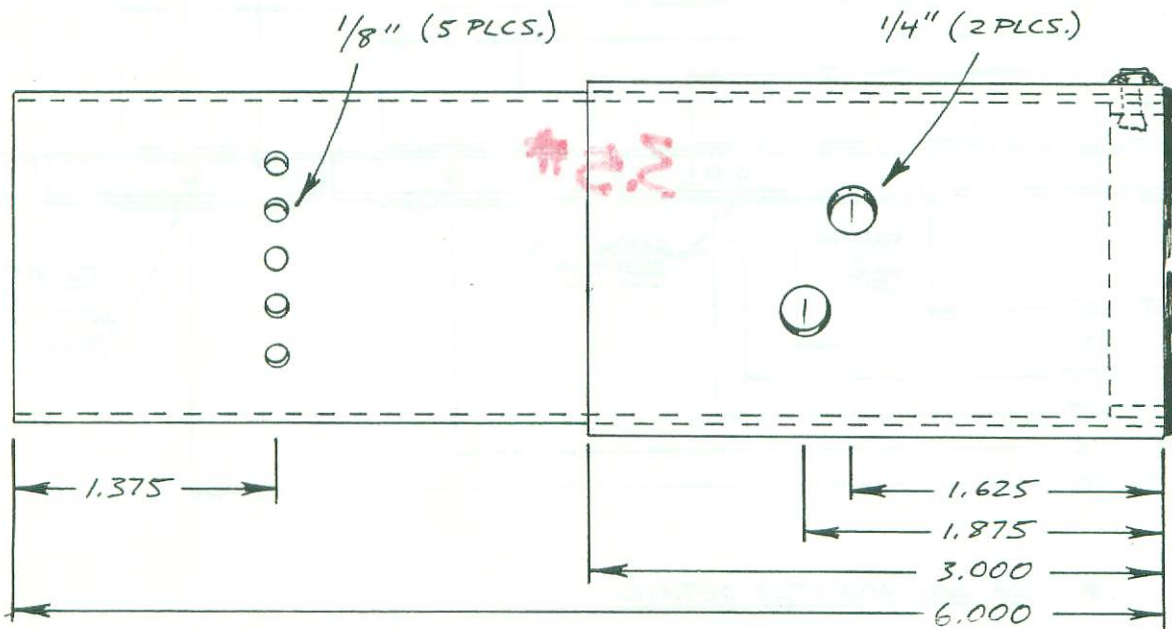


Batten Maintenance



Installation of Rear Leading Edges

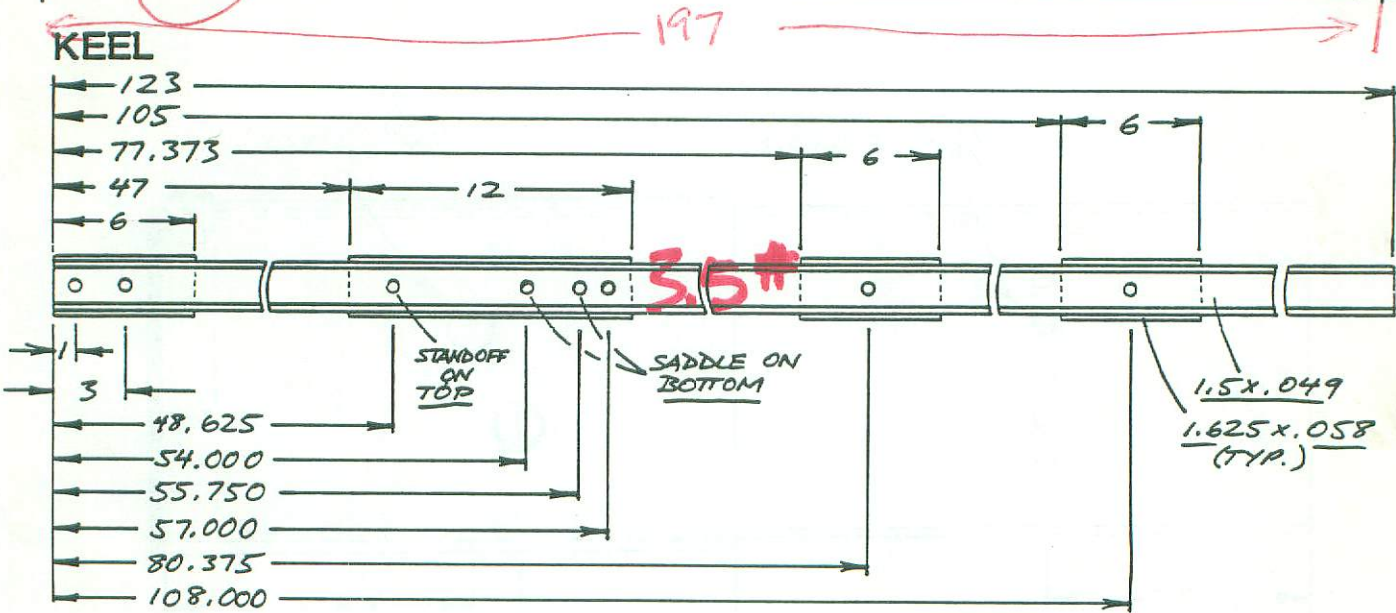
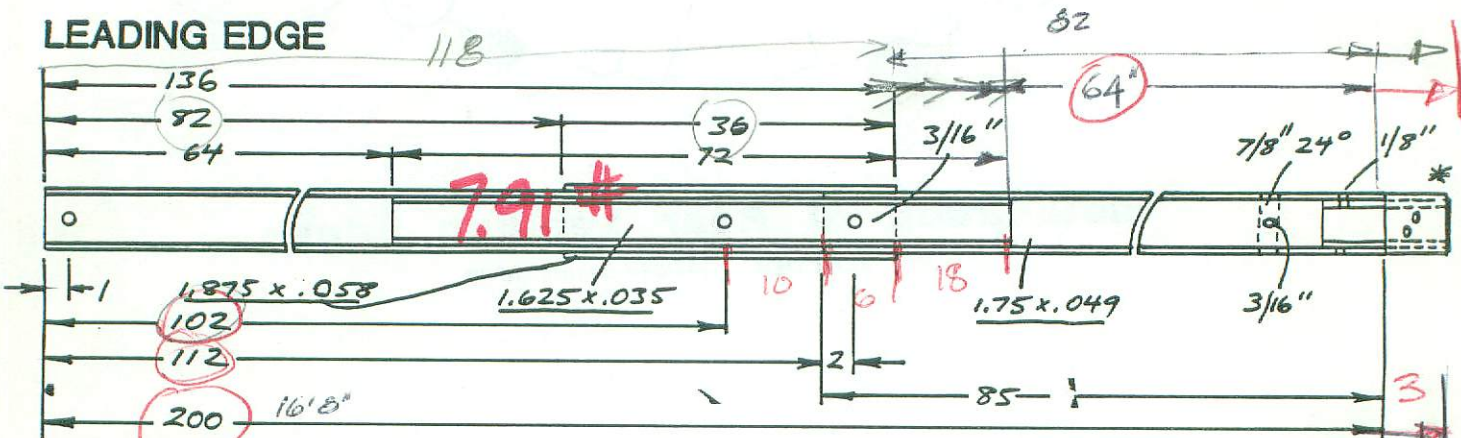
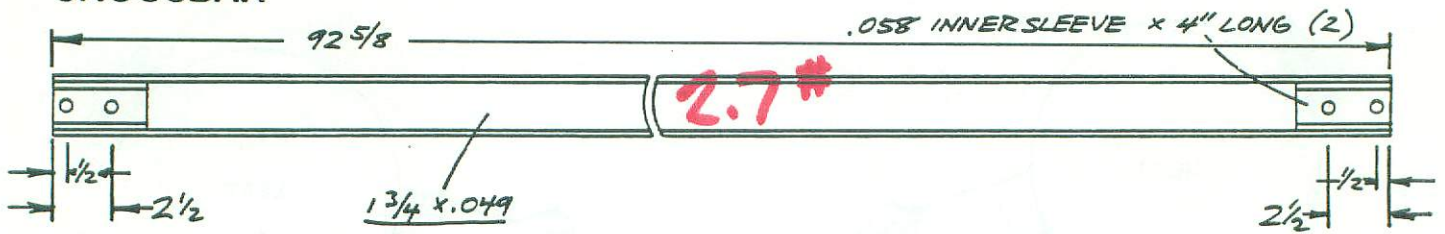
REAR VIEW GLIDER UPSIDE DOWN



Sail Adjuster Detail

147 HARRIER II

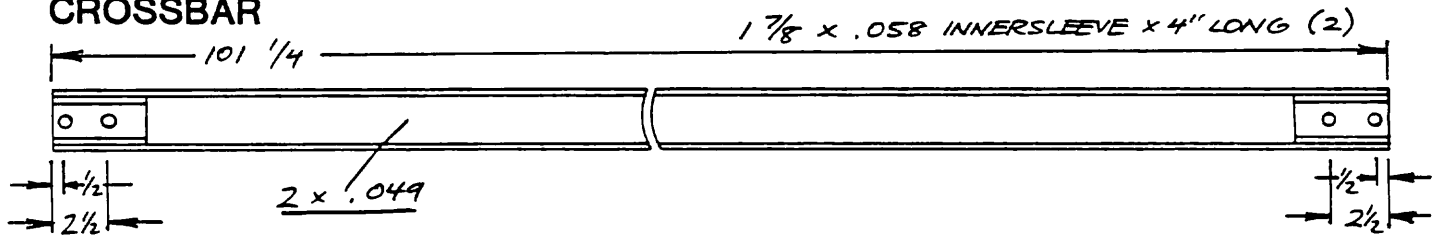
CROSSBAR



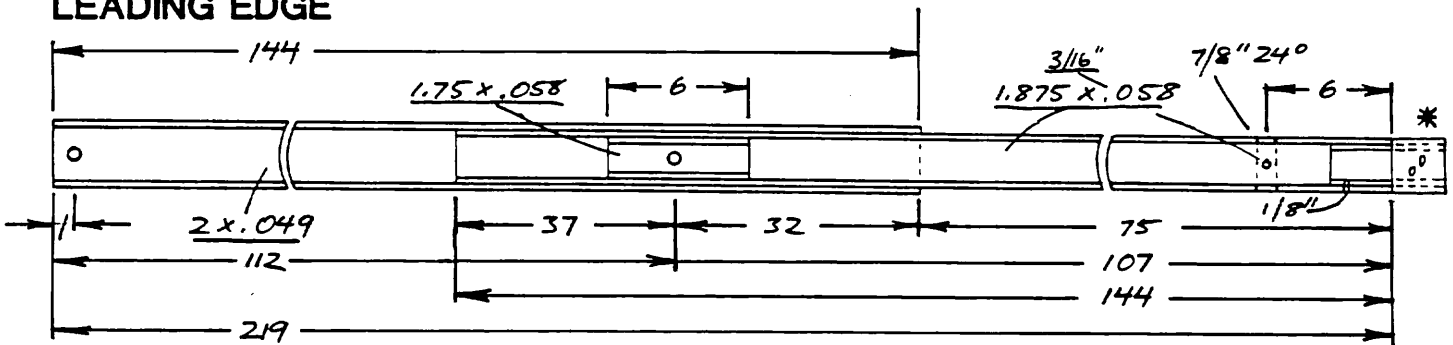
* SEE SAIL ADJUSTER DETAIL ...

177 HARRIER II

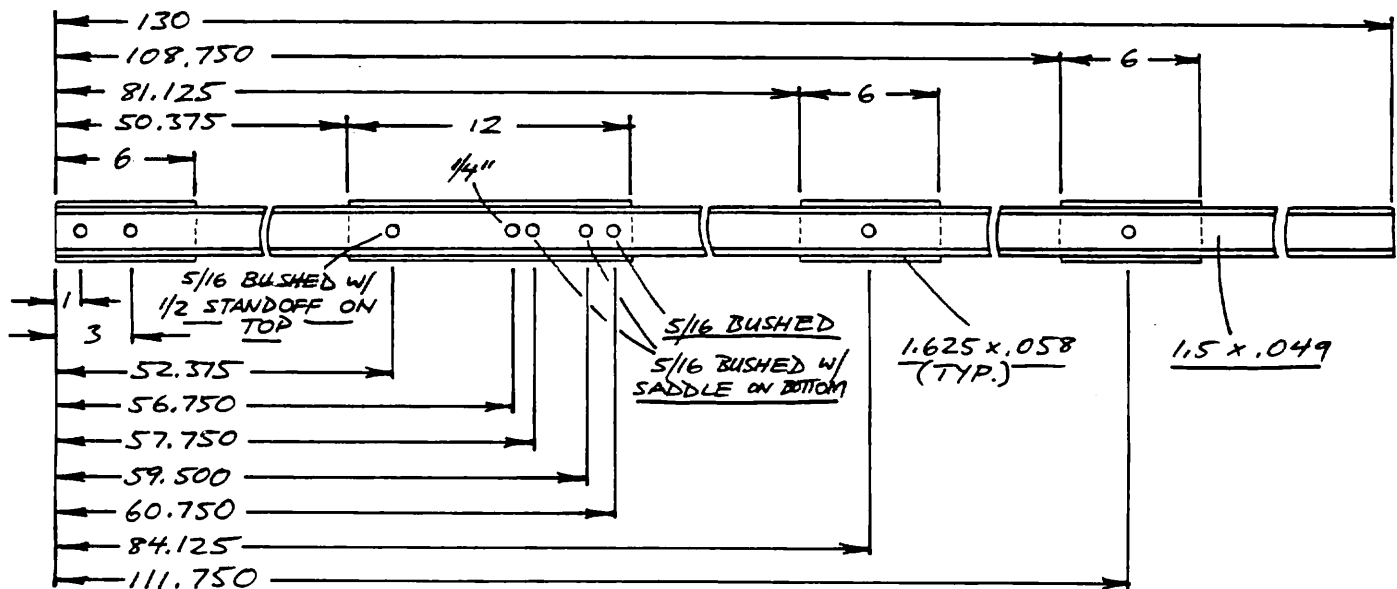
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LEADING EDGE



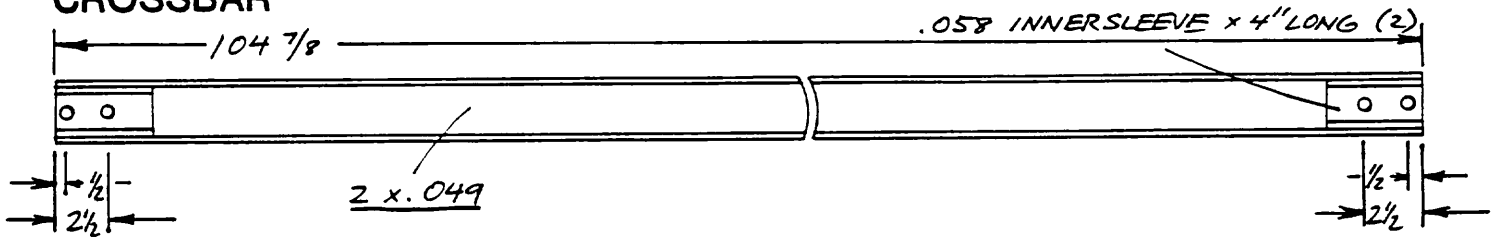
KEEL



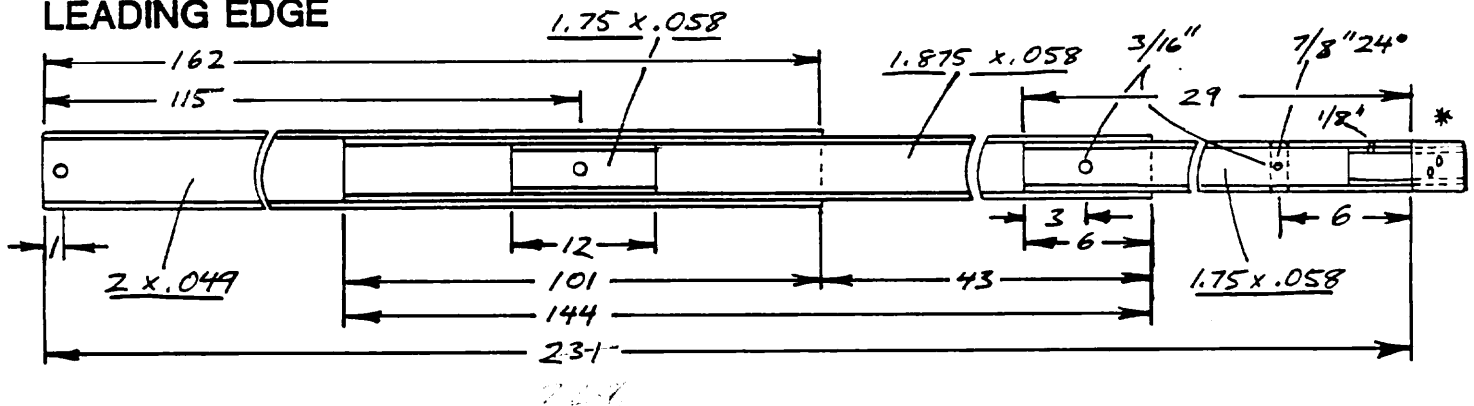
* SEE SAIL ADJUSTER DETAIL

187 HARRIER II

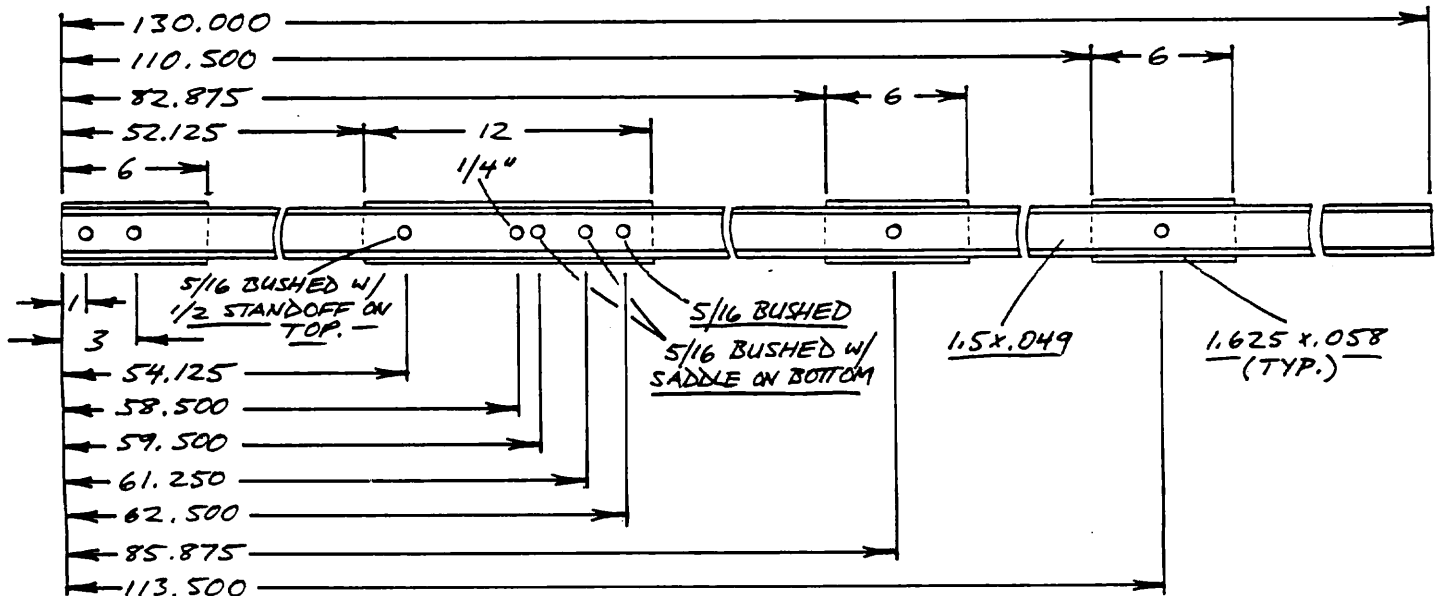
CROSSBAR



LEADING EDGE



KEEL



* SEE SAIL ADJUSTER DETAIL

ALL DIMENSIONS ARE IN INCHES

WILLS WING COMPLIANCE VERIFICATION SPECIFICATION SHEET

NOTE: THESE SPECIFICATIONS ARE FOR THE PURPOSE OF VERIFYING THAT THE GLIDER IS IN THE CONFIGURATION IN WHICH IT WAS HGMA CERTIFIED. THEY SHOULD NOT BE USED FOR PARTS FABRICATION.

Glider Model: Harrier II 147

- 1) Glider Weight 51 lbs. or 54 lbs. with optional mylar (lbs., with bag)
- 2) Leading Edge Tube
Length, Outside Diameter 200, 1.75
Holes at: 1, 102, 114, 191
Keel Tube
Length, Outside Diameter 130, 1.5
Holes at: 1, 3, 48.625, 54, 55.75, 57, 80.375, 108
Xbar Tube
Length, Outside Diameter 92.625, 1.75
Holes at: .5, 2.5 each end
Kingpost Tube
Length, Outside Diameter 41.625, 1.125
Holes at: .25, 1
Control Bar Leg
Length, Outside Diameter 63, 1.125
Holes at: .5, .875, .5 other end
Control Bar Base
Length, Outside Diameter 54.5, 1.125
Holes at: .5 each end
Washout Tips
Length, Outside Diameter 33, .75
Holes at: 1.375
- 3) Washout Tip Angle 24 degrees
Control Bar Angle 1 degree
- 4) Distance Sail to Crossbar 5" +/- 1"
- 5) Distance Sail to Keel 7" +/- 1"
- 6) Bridle Measurement 51.5 inside / 79.5 outside; top front wire at cap to trailing edge at batten
- 7) Chord at Root + 3' 78"
Chord at Tip - 3' 43"
- 8) Span of Sail 30'
- 9) Bow In Leading Edge approx 4"
Bow In Keel 0
Bow In Crossbar 0
- 10) Placard Location xbar
Test Fly Sticker Location xbar
- 11) Pilot Weight Range 110 to 210 lbs.
Pilot Proficiency Required II

WILLS WING COMPLIANCE VERIFICATION SPECIFICATION SHEET

NOTE: THESE SPECIFICATIONS ARE FOR THE PURPOSE OF VERIFYING THAT THE GLIDER IS IN THE CONFIGURATION IN WHICH IT WAS HGMA CERTIFIED. THEY SHOULD NOT BE USED FOR PARTS FABRICATION.

Glider Model: Harrier II 177

- 1) Glider Weight 56 lbs., or 60 lbs with optional mylar (lbs., with bag)
- 2) Leading Edge Tube
Length, Outside Diameter 222", 2" front, 1.875" rear
Holes at: 1", 112" 213"
Keel Tube
Length, Outside Diameter 130", 1.5"
Holes at: 1, 3, 52.4, 56.75, 57.75, 59.5, 60.75, 84.125, 11.75
Xbar Tube
Length, Outside Diameter 101.25, 2
Holes at: .5, 2.5 each end
Kingpost Tube
Length, Outside Diameter 41.625 1.125
Holes at: .25, 1
Control Bar Leg
Length, Outside Diameter 66.25, 1.125
Holes at: .5, .875, .5 other end
Control Bar Base
Length, Outside Diameter 57.125, 1.125
Holes at: .5, 1.125, .5 other end
Washout Tips
Length, Outside Diameter 33, .75
Holes at: 1.375
- 3) Washout Tip Angle 24 degrees
Control Bar Angle .5 degrees
- 4) Distance Sail to Crossbar 5" +/- 1"
- 5) Distance Sail to Keel 7" +/- 1"
- 6) Bridle Measurement 67 inside/ 98.4 outside; top front wire at cap to trailing edge at batten
- 7) Chord at Root + 3' 83"
Chord at Tip - 3' 46"
- 8) Span of Sail 33' 4"
- 9) Bow In Leading Edge approx. 4"
Bow In Keel 0
Bow In Crossbar 0
- 10) Placard Location xbar
Test Fly Sticker Location xbar
- 11) Pilot Weight Range 150 to 250 lbs.
Pilot Proficiency Required II

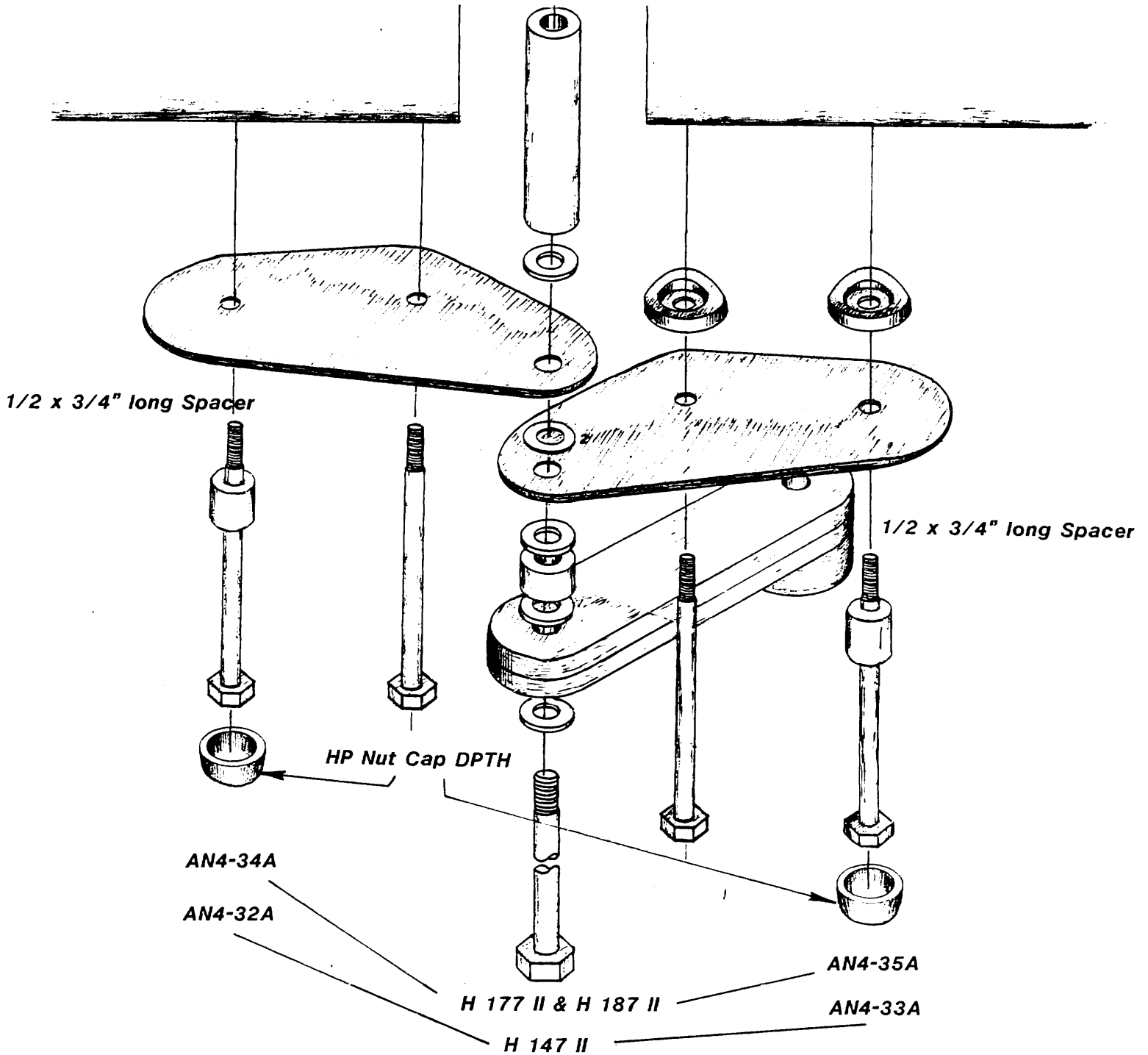
WILLS WING COMPLIANCE VERIFICATION SPECIFICATION SHEET

NOTE: THESE SPECIFICATIONS ARE FOR THE PURPOSE OF VERIFYING THAT THE GLIDER IS IN THE CONFIGURATION IN WHICH IT WAS HGMA CERTIFIED. THEY SHOULD NOT BE USED FOR PARTS FABRICATION.

Glider Model: Harrier II 187

- 1) Glider Weight 65 lbs. or 69 lbs. with optional mylar (lbs., with bag)
- 2) Leading Edge Tube
Length, Outside Diameter 231", 2" / 1.875" / 1.75"
Holes at: 1, 115, 222
Keel Tube
Length, Outside Diameter 130, 1.5
Holes at: 1, 3, 54.125, 58.5, 59.5, 61.25, 62.5, 85.875, 113.5
Xbar Tube
Length, Outside Diameter 104.875, 2
Holes at: .5, 2.5 each end
Kingpost Tube
Length, Outside Diameter 41.625, 1.125
Holes at: .25, 1
Control Bar Leg
Length, Outside Diameter 69.5, 1.125
Holes at: .5, .875, .5 other end
Control Bar Base
Length, Outside Diameter 59.75, 1.125
Holes at: .5, 1.125, .5 other end
Washout Tips
Length, Outside Diameter 33, .75
Holes at: 1.375
- 3) Washout Tip Angle 24 degrees
Control Bar Angle 2 degrees
- 4) Distance Sail to Crossbar 5" +/- 1"
- 5) Distance Sail to Keel 7" +/- 1"
- 6) Bridle Measurement 75.25 inside/ 105.75 outside; top front wire at cap to trailing edge at batten
- 7) Chord at Root + 3' 85"
Chord at Tip - 3' 46"
- 8) Span of Sail 34' 8"
- 9) Bow In Leading Edge approx 4"
Bow In Keel 0
Bow In Crossbar 0
- 10) Placard Location xbar
Test Fly Sticker Location xbar
- 11) Pilot Weight Range 165 to 265 lbs.
Pilot Proficiency Required II

HARRIER II CENTER SECTION ADDENDUM



Harriers manufactured after June, 1982 will have longer crossbar plate bolts with spacers, as shown, instead of the safety lanyard, to discourage improper set-up. It is strongly recommended that earlier Harriers be retrofitted with this safety system. NOTE: All sizes of the Harrier **1** will require the bolts shown for the Harrier **2** 147.