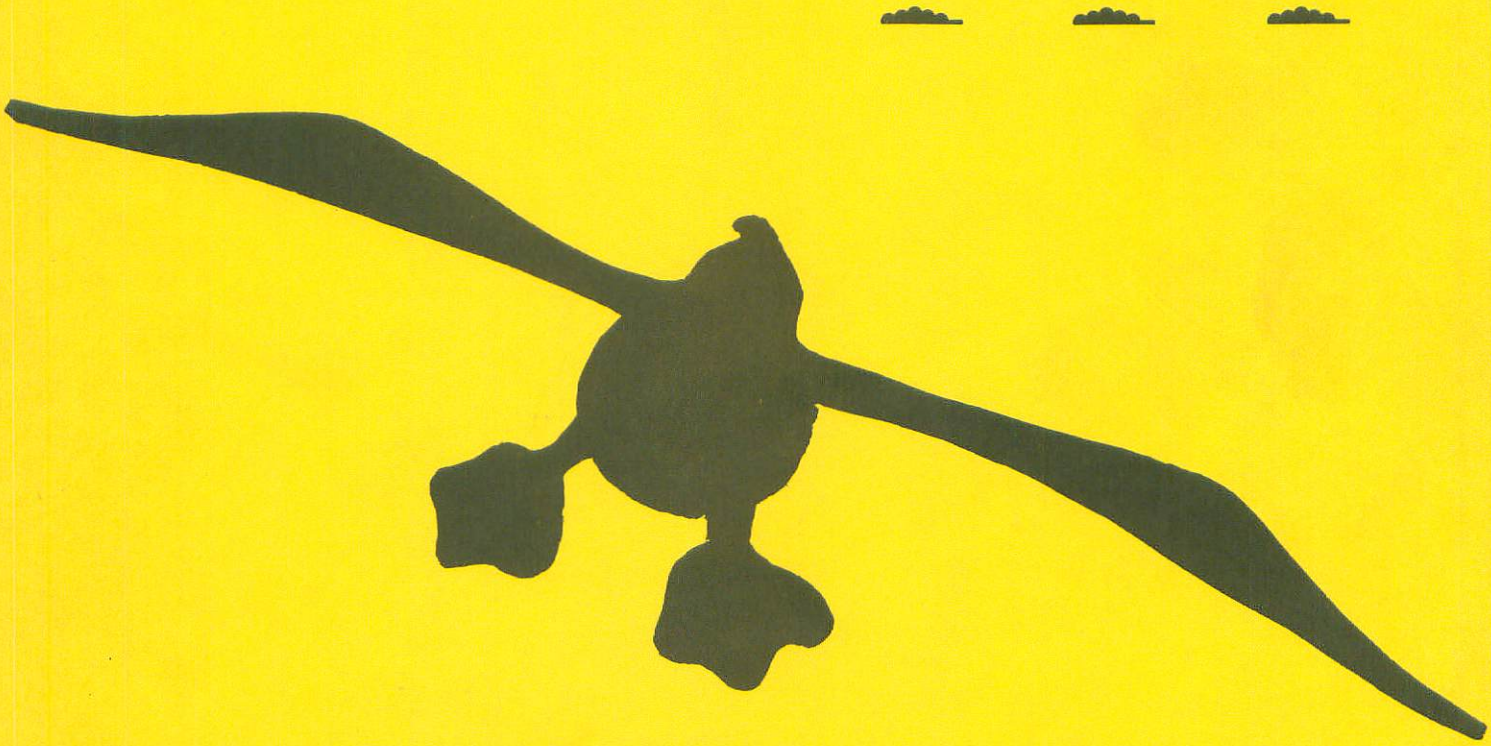
WILLS WING DUCK



OWNER'S MANUAL
& SERVICE MANUAL

WILLS WING , INC.
BATTEN TEMPLATE

TYPE D2

PLEASE SPECIFY D2 WHEN
ORDERING REPLACEMENT BATTENS
OR TEMPLATES.

Wills Wing, Inc.
1208 H. East Walnut
Santa Ana, California 92701
714 547-1344

• REVISED 5/25/83

CONTENTS

OWNER SECTION

SERVICE SECTION

DECEMBER 10, 1981

WILLS WING DUCK RELEASED

Wills Wing is happy to announce the release of their newest model, the DUCK. The DUCK is a highly refined high performance flexwing featuring a 63% double surface enclosing the crossbar. The primary size now offerred for release has a sail area of 180 $ft.^2$ distributed over a 35' span. The nose angle is 130°, and the planform is similar to that of the Harrier, although with a slightly higher aspect ratio (approximately 6.8). The DUCK has been under development since November of 1980. During this time, special attention has been paid to details of hardware design, minimizing the weight of the glider, and maximizing the simplicity of design and construction. The result is a glider of exceptional performance and flight characteristics, that is light weight, assembles quickly and easily, and can be offerred at the very reasonable introductory price of $1895.

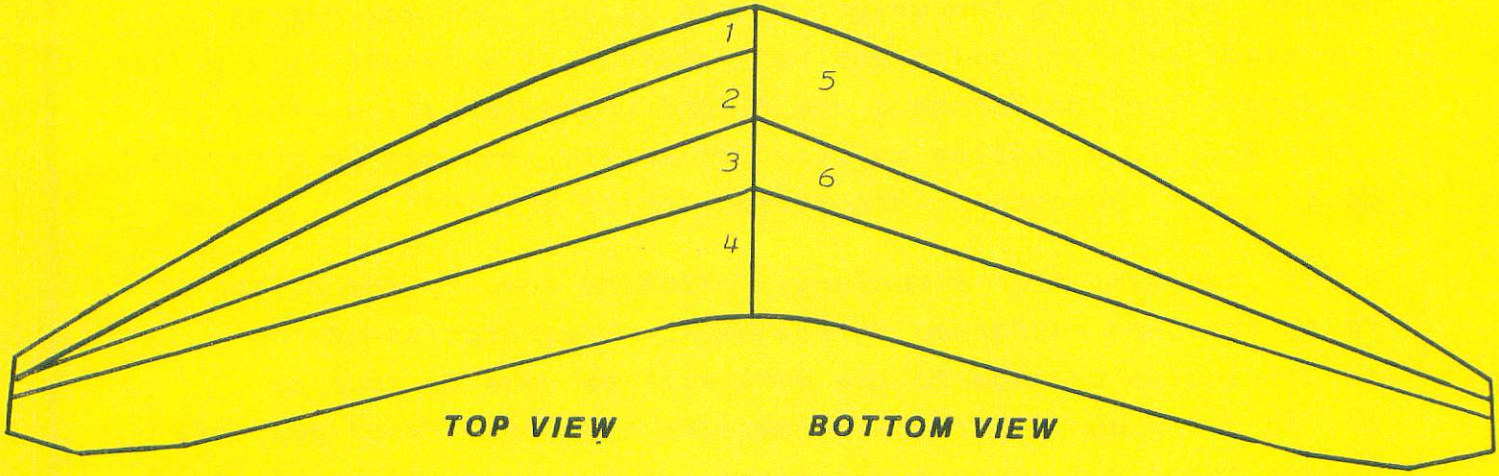
A full complement of structural, pitching moment, and flight tests has been performed on the DUCK. Presentation of the documentation package to the HGMA will be made as soon as all hardware and construction details have been finalized, and before the first unit is delivered. We are currently evaluating various tuning configurations while awaiting the production of new tooling for the DUCK's special hardware. Due to the long and unpredictable lag time on such tooling, and our desire to deliver only a finished product, we anticipate that shipment of the first DUCKs is about 12 weeks away. However, because of the exceptionally high level of interest shown in the glider, we have decided to accept deposits from those people who wish to reserve one of the first production gliders. The required deposit will be $600, and gliders will be shipped in the order that the deposits are received. No specification of sail colors need accompany the deposit at the present time.

WILLS WING, INC. 1208 H E. Walnut Santa Ana Ca. 92701

WILLS WING DUCK

Specifications

AREA	180 ft^2
SPAN	35 ft
NOSE ANGLE	130^o
ASPECT RATIO	6.8
GLIDER WEIGHT (Without bag)	68 lbs.
PILOT WEIGHT	160 to 240 lbs.
PILOT SKILL	III



Sail Components

1) MYLAR POCKET
2) FRONT BODY TOP
3) WEDGE TOP
4) REAR BODY
5) FRONT BODY BOTTOM
6) WEDGE BOTTOM
7) KEEL POCKET

INTRODUCTION

Congratulations! You are now the proud owner of one of the finest footlaunched soaring flex-wings manufactured today. Your WILLS WING DUCK 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 Duck. 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.

DUCK

PERFORMANCE

Winner of the 1982 Nationals and 1982 Southern California Cross Country Championship, the DUCK offers proven performance in a weight-shift-controlled flexwing.

HANDLING

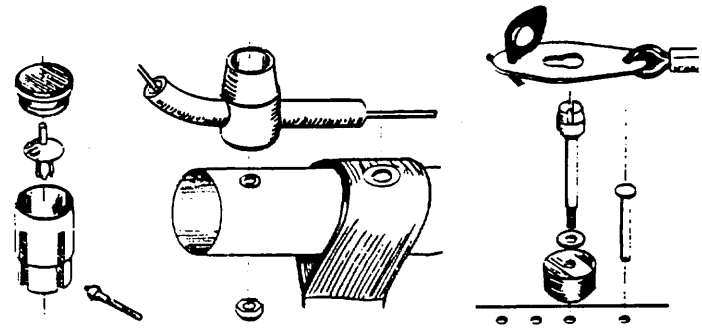
In combination with unmatched pure performance, the DUCK features traditional Wills Wing handling characteristics; quick response with light pressures, and exceptional coordination. The result is a fun-to-fly aircraft with powerful soaring capability.

QUALITY

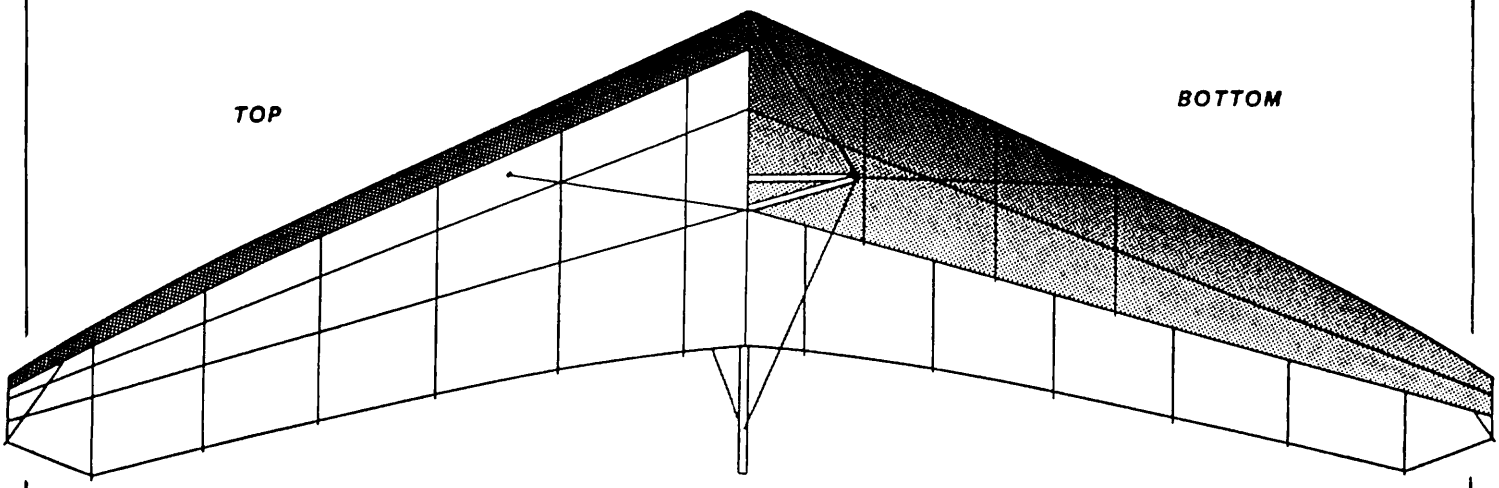
Engineered from the ground up, the DUCK features a completely new hardware system which includes:

- *QUICK-CONNECT KEYHOLE TANGS
- *SPECIAL DISCRETE CABLE KINGPOST CAP
- *NYLATRON CROSSBAR CABLE GUIDE FOR FATIGUE PREVENTION
- *NEW QUICK-DISCONNECT CONTROL BAR/KEEL INTERFACE FOR HIGH WIND "LAY-FLAT" SET-UP
- *INTEGRAL CROSSBAR SAFETY RESTRAINT CABLE

Using this advanced hardware system, the DUCK goes from cartop to cloudbase in a matter of minutes.



The DUCK comes standard with a rugged, padded storage and transport cover, spare parts kit, owner/service manual and a Wills Wing Team Cap. Retail price is $1995. for the 140, 160 & 180 in stock colors, & $2095 for the 200 in stock colors (Add $100. for custom colors).



SPECIFICATIONS

MODEL	130	160	180	200
AREA	130 ft.²	155 ft.²	180 ft.²	200 ft.²
SPAN	29'	32'4"	35'	36'8"
NOSE ANGLE	130°	130°	130°	130°
ASPECT RATIO	6.5	6.7	6.8	6.9
PILOT WEIGHT	110-200 lbs.	140-240 lbs.	160-260 lbs.	170-280 lbs.
PILOT SKILL	III	III	III	III
GLIDER WT.	52 lbs.	61 lbs.	68 lbs.	74 lbs.

Specifications are subject to change without notice.
Ask your authorized Wills Wing Service Center for a demonstration flight today!

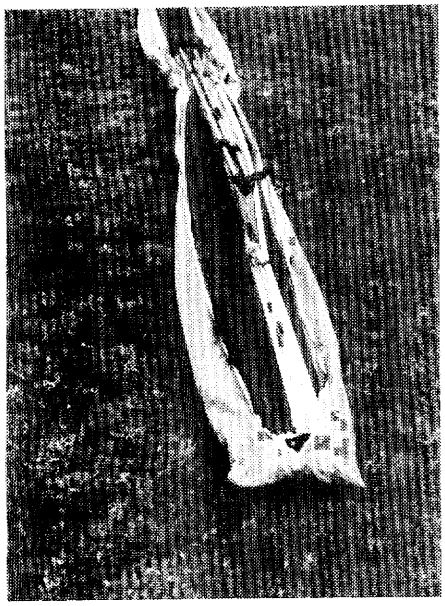
TECHNICAL INFORMATION

The Duck has been tested and found to comply with the 1982 / 83 HGMA Airworthiness Requirements. These standards require:
An ulmate positve load test at the maximum lift angle of attack at a speed of 65 mph.
An ultimate negative 30 degree angle of attack test at a speed of 46 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 Duck 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 severly 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 aplicability to any specific purpose of any Wills Wing glider, except as described in the HGMA Airworthiness Standards.

Stall speed of the Duck at maximum recommended wing loading is 25 mph.
Top speed of the Duck at minimum recommended wing loading is 40 mph.
Recommended pilot weight: DUCK 130 - 110-200 lbs.
DUCK 160 - 140-240 lbs.
(including all equipment) DUCK 180 - 160-260 lbs.
DUCK 200 - 170-280 lbs.
Flight operation of the Duck 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 Duck 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 Duck should not be flown at speeds in excess of 46 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 III or higher is required to fly the Duck safely. Flight operation by unqualified pilots may be dangerous and is prohibited.



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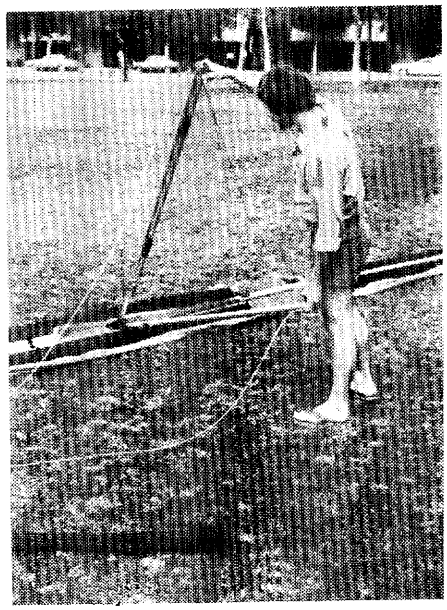

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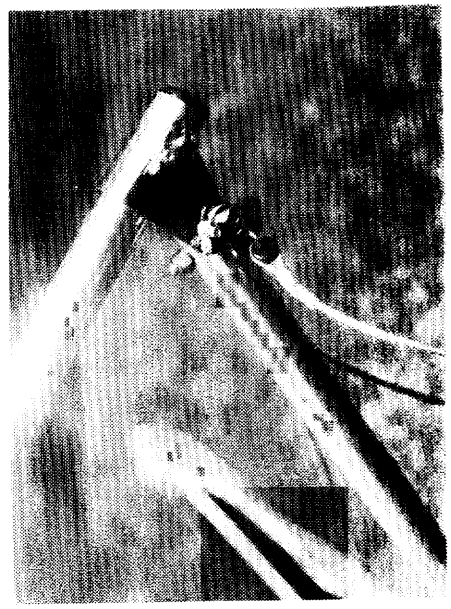

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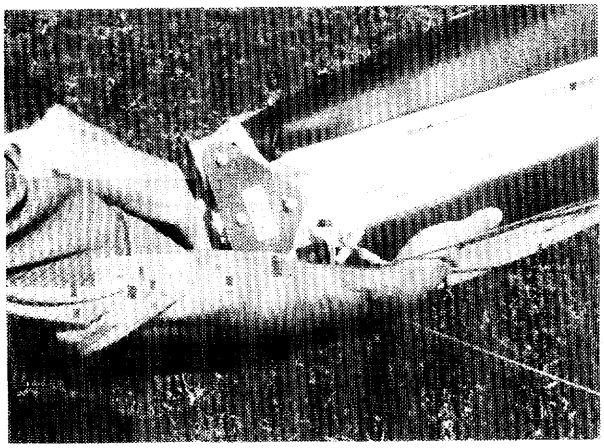

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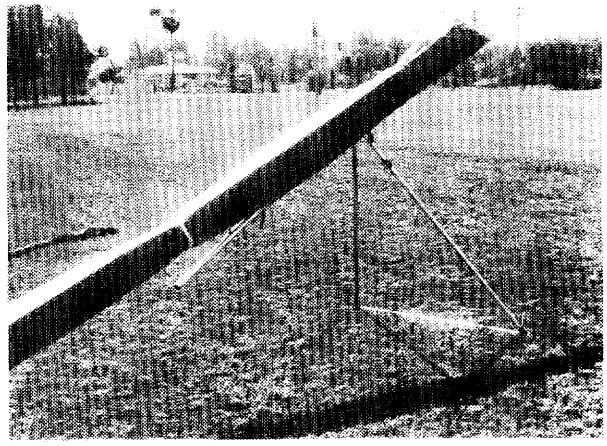

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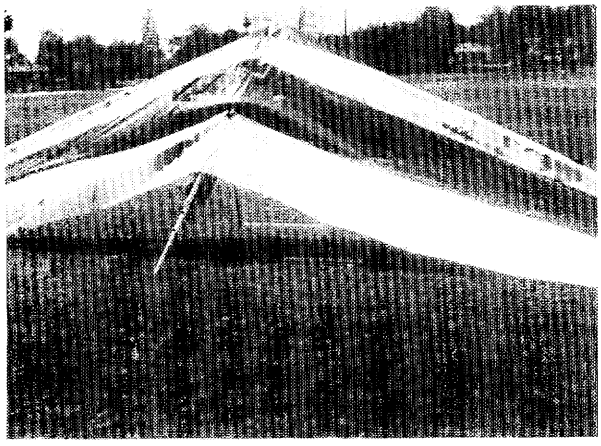

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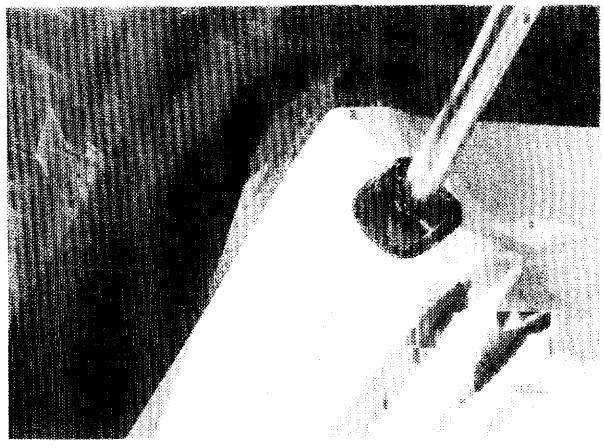

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DUCK SET UP PROCEDURE

NOTE: THE DUCK 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.

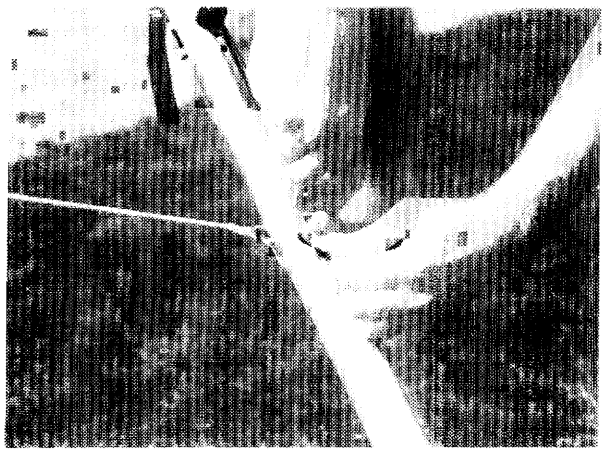
1) Lay the bag on the ground, nose into the wind, zipper up.

2) Undo the zipper, the velcro securing the control bar, and lift the bar up and forward, ALLOWING THE LEGS TO SPREAD APART AS YOU LIFT THEM. Attach the free end of the base tube to the leg using the wingnut 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. Check that the nylatron crossbar cable guide is seated as far rearward in the kingpost base as it will go, and that is is properly aligned with the keel, pointing forward and upward. Lift the kingpost, and fit it over the plug on top of the keel, taking care not to pinch the sail or the crossbar safety cable in the process. The crossbar safety cable may be on either side of the kingpost; it will be slack in flight. Check that the bridle cables are not twisted or tangled.(fig 7)



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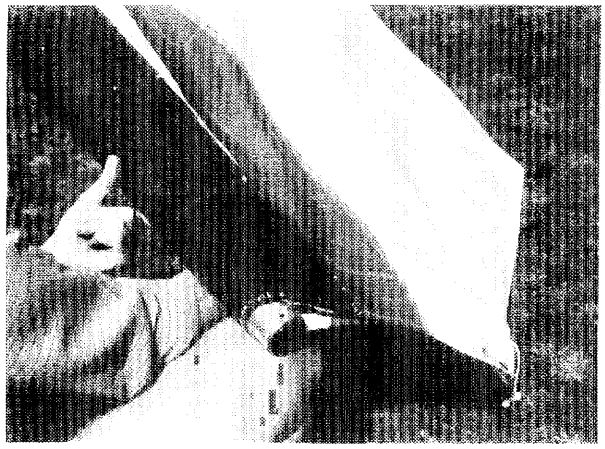

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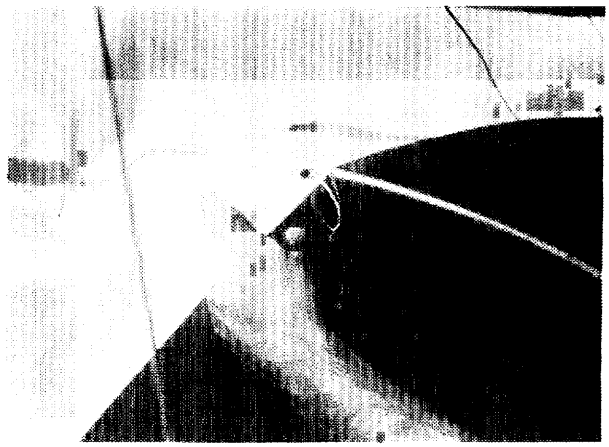

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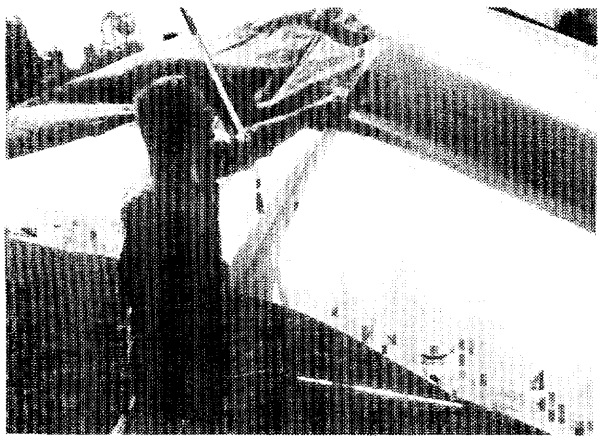

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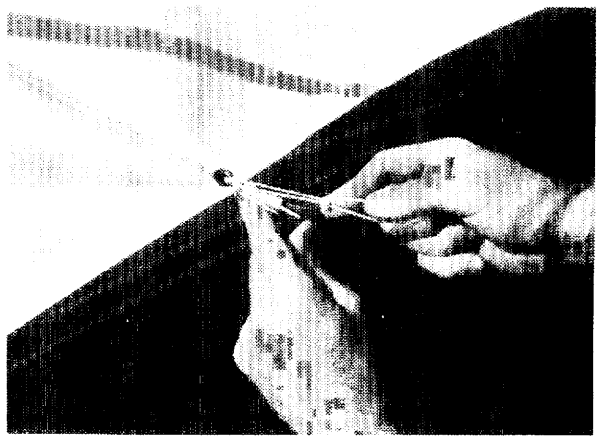

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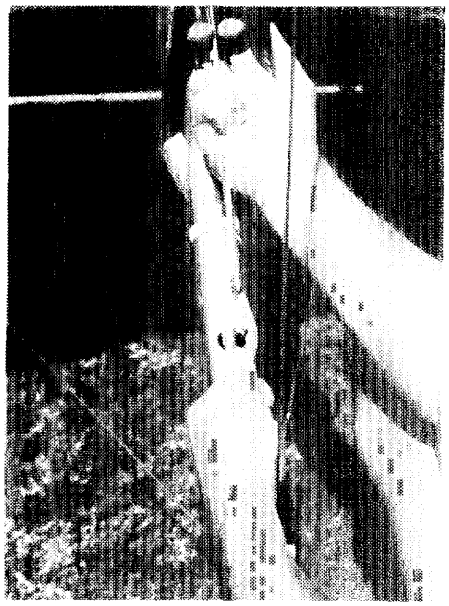
6) Attach the rear kingpost tang to the rearward most bolt on the keel. BE SURE TO ATTACH THE SAFETY!! (fig 8-9)

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 (you can feel the ball through the sail) 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 top surface 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 TOP SURFACE BATTENS MUST BE INSTALLED BEFORE THE CROSSBAR IS TENSIONED. OTHERWISE YOU WILL DECAMBER THE BATTENS AND MAY RUIN THE SAIL.



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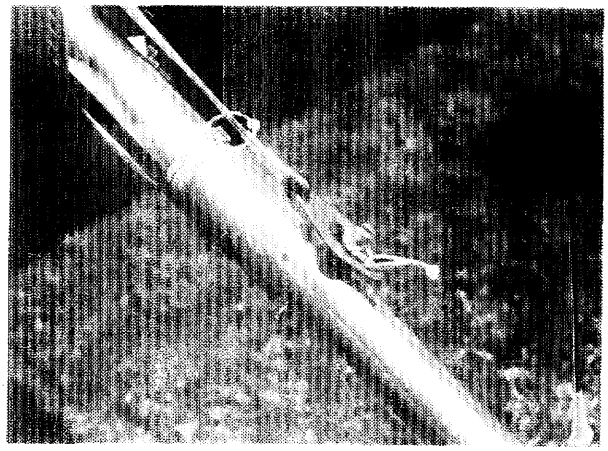

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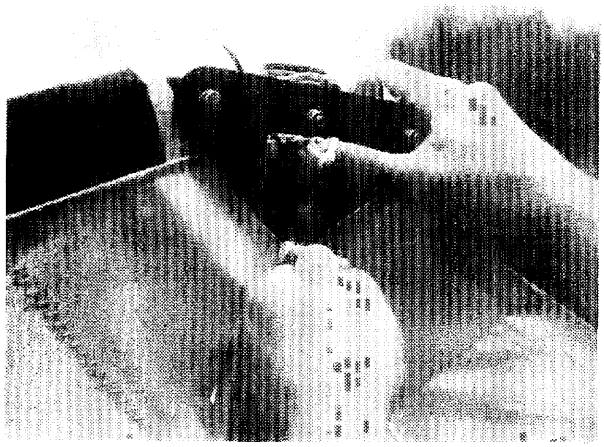

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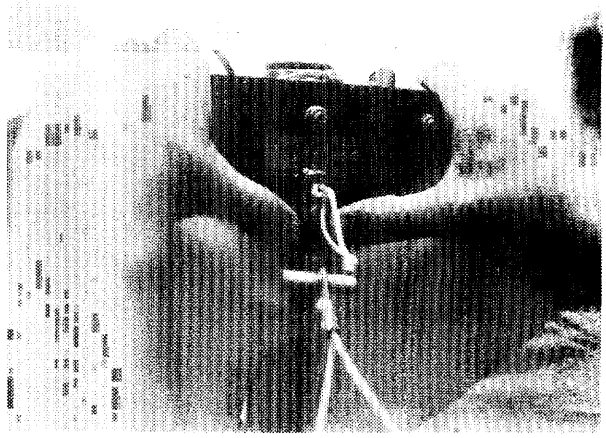

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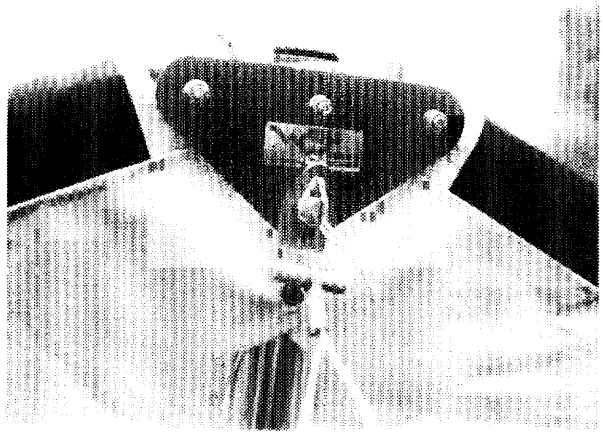

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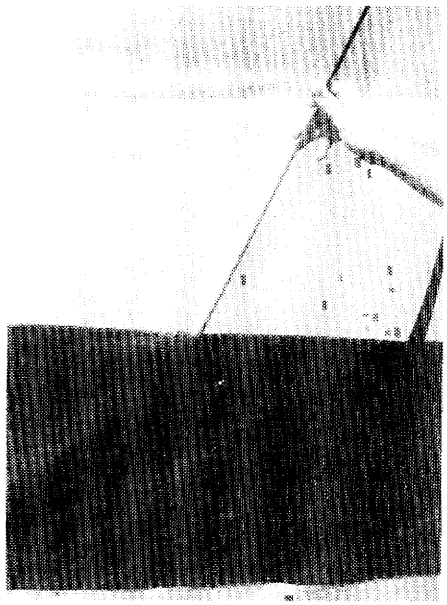
9) Spread the wings all the way and check all wires for twisted thimbles or tangs. NOTE:IF YOU ACCIDENTALLY SET THE GLIDER UP WITH A COCKED THIMBLE AND KINK THE CABLE, YOU MUST REPLACE THAT CABLE IMMEDIATELY OR IT MAY FAIL IN FLIGHT.Pull the crossbar back from the rear of the keel, and fit the keyhole tang over the bolt on the keel. Attach the safety. (fig 14-15)

10) Attach the bottom nose wire to the nose using the technique shown. BE SURE TO ATTACH THE SAFETY! (fig 16-18)



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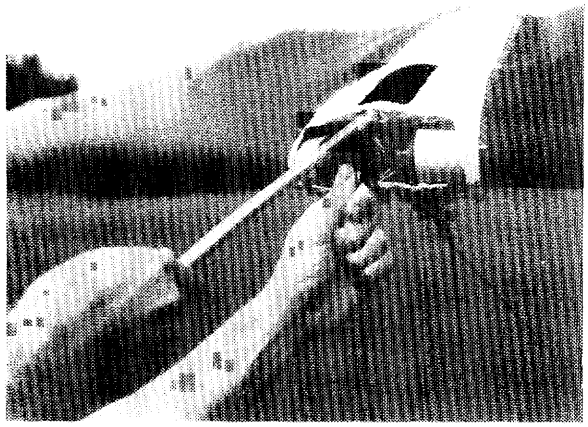

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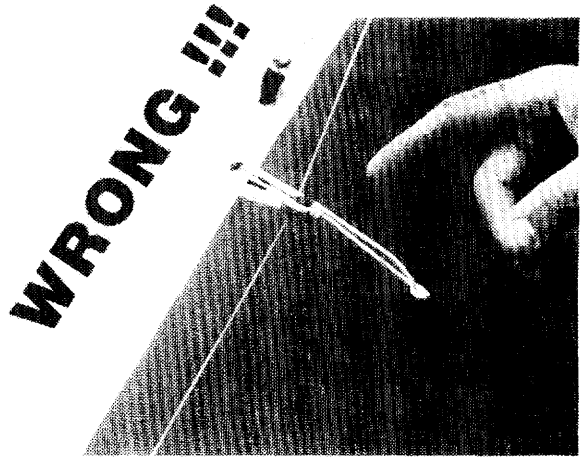

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11) Install the bottom surface battens. If the wind is less than 10 mph, this is done most easily by putting the nose down (into the wind.) The order of the bottom surface battens is longest to shortest, from the root out. Installation of these battens involves inserting the tip of the batten between the rear edge of the bottom surface and the top surface, through the gap in the seam, with the batten angled toward the pocket. The batten enters the pocket from the side, and will, when seated properly in the pocket, align itself parallel to the keel as it is inserted farther into the pocket. When the front of the batten reaches the leading edge seam, you may have to press upward on the batten in order to allow it to clear the seam. Push the batten all the way into the pocket and slide the rear end to the side so that it is tucked into the pocket and retained by the seam at the rear end of the pocket.(fig 19-20) The strings on the rear ends of the bottom surface battens are to facilitate removal of the battens from the sail during beakdown.

12) Carefully insert the nose batten, or if it has been left installed, check that the velcro is properly secured.(fig 21)

13) Do a complete walk around prefight of the glider. Check every assembly. Make sure there are no twisted wires or thimbles. Make sure all keyhole tangs (nose, tail, and crossbar restraint) are properly seated, and that the nose and tail keyhole tangs are safetied. Make sure the bridle lines are not tangled, nor looped under an inboard batten. (fig 22) 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.

NOTE: ON THE 130, IT IS POSSIBLE FOR THE XBAR TO BE PULLED BACK OVER CENTER IF THE RESTRAINT IS NOT IN PLACE. CHECK TO MAKE SURE THE XBAR IS FORWARD OF CENTER BEFORE FLYING THE GLIDER!!!

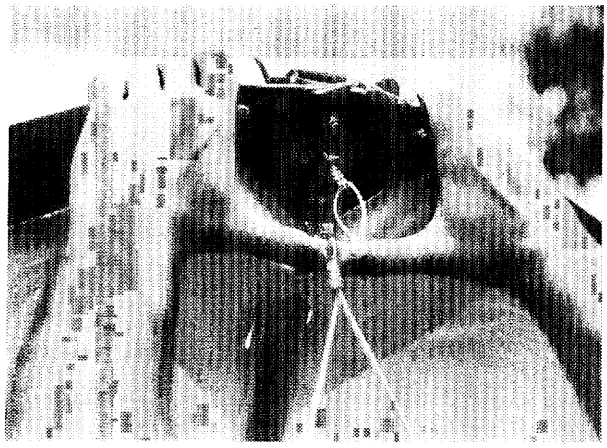
14) NOSE CONE INSTALLATION

If your glider is equipped with a nose cone, you should intall it now using the following procedure:

a) Fit the nose cone over the extended front keel, and pull the top surface of the nose cone back over the top surface of the sail.

b) Align the center seam on the nose cone with the center seam on the sail, and press the velcro down at the top rear of the nose cone.

c) When attaching the under side, work with one side at a time as follows: Grasp the pointed rear tip of the nose cone on the under side and pull it directly away from the leading edge towards the rear so that the nose cone is pulled tight on the underside of the nose and the velcro on the nose cone aligns with the velcro on the under side of the sail. Press the velcro together. When you are finished check to see that the nose cone fits snugly and smoothly against the sail without gaps or puckers.



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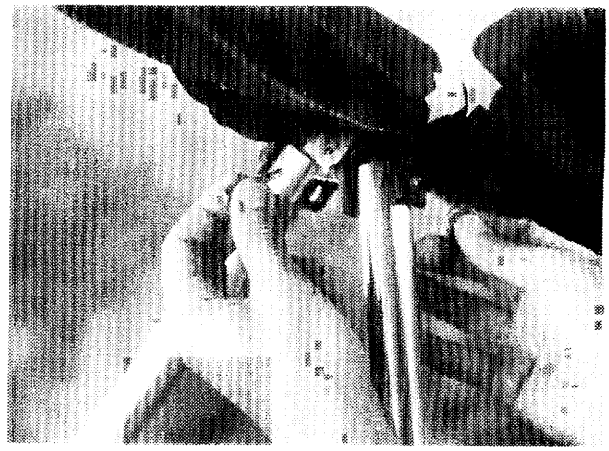

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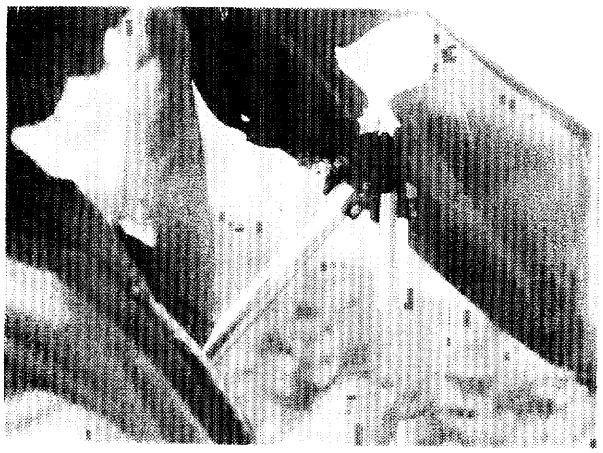

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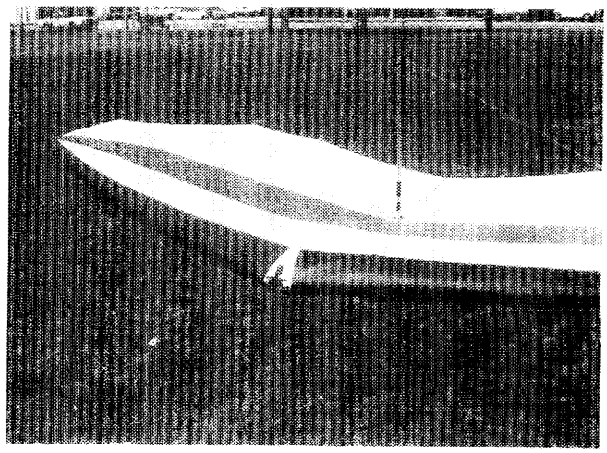

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LAYING THE GLIDER FLAT

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 23) 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 24)

3) Lifting the keel, pull the top of the control bar sideways out of the "U" channel, (fig 25), and lay the control bar down.

4) Lay the glider flat on the ground (fig 26). 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 24 & 25.

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 DUCK

The Duck 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 agressive run and ease the bar out for lift-off.

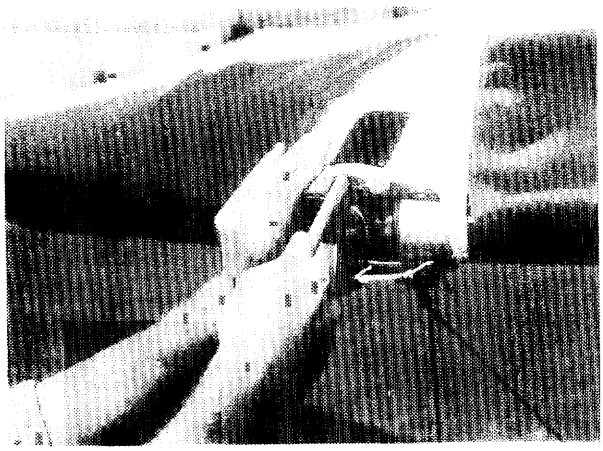
Have a good one!

FLYING THE DUCK

The Duck 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 DUCK

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 agressively 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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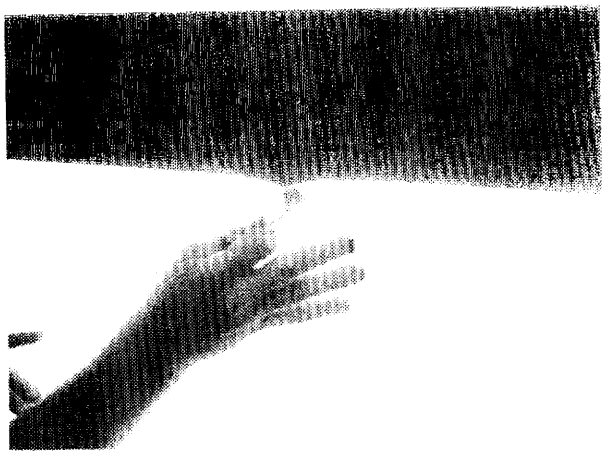

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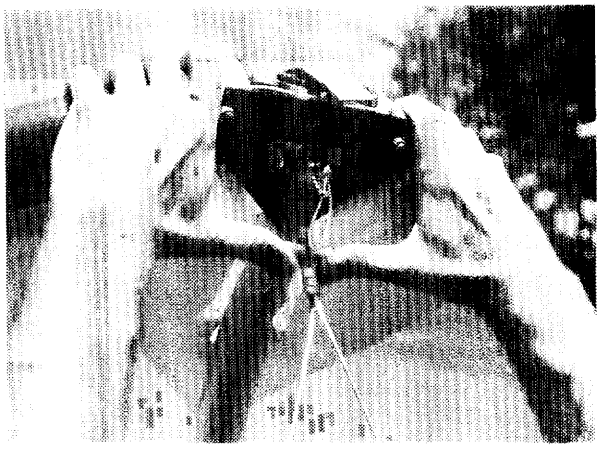

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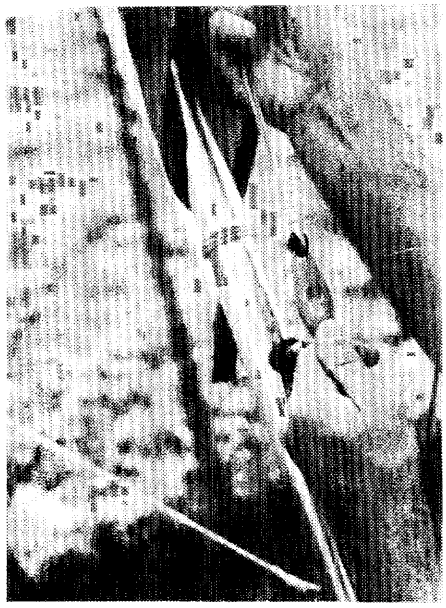

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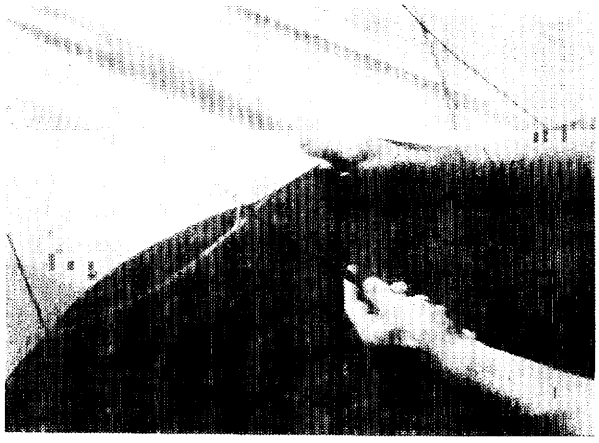

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DUCK BREAKDOWN

Breakdown of the Duck is simply the reverse of the set up procedure.

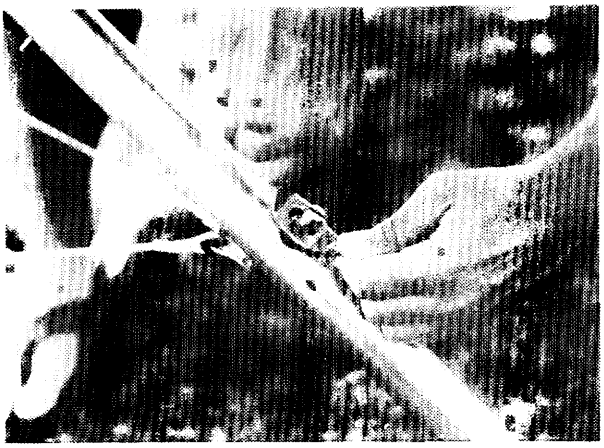
1) Remove the nose batten first, if you plan to remove it. (fig 27)

2) Remove the bottom surface battens. (fig 28) DO NOT REMOVE THE TOP SURFACE BATTENS AT THIS TIME!

3) Detach the bottom front wires at the noseplate. (fig 29)

4) De-tension the crossbar. (fig 30)

5) Pull the wings in slightly and remove all the battens. (fig 31)



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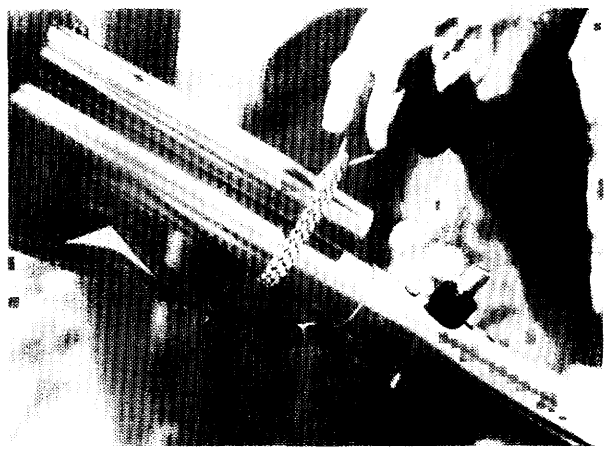

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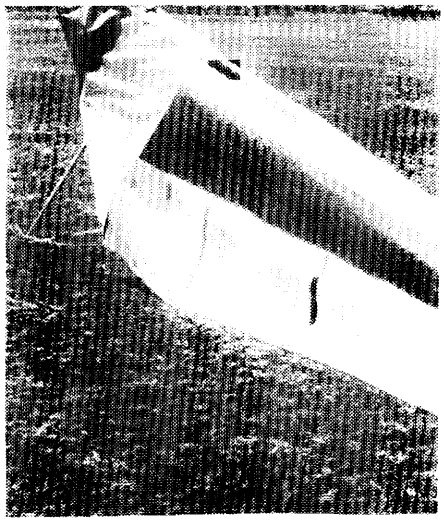

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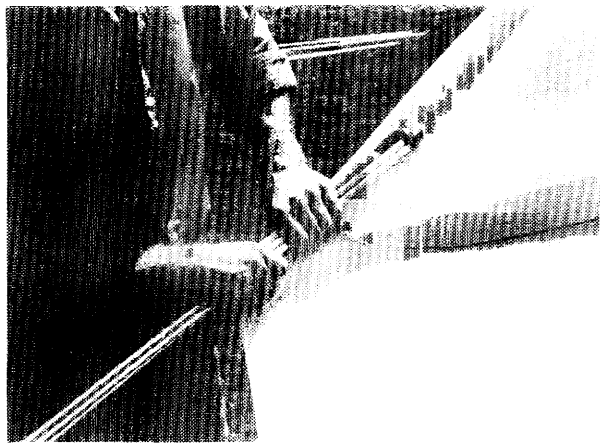

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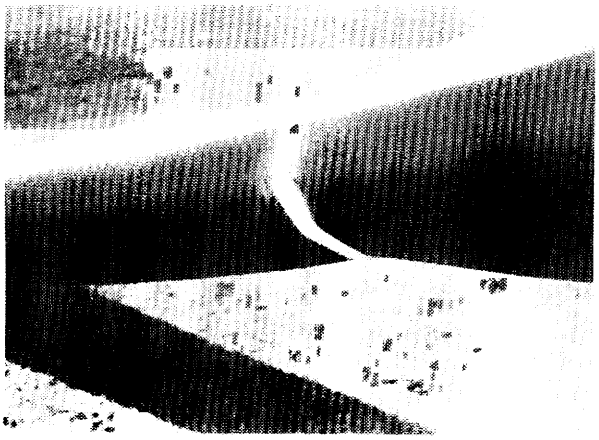

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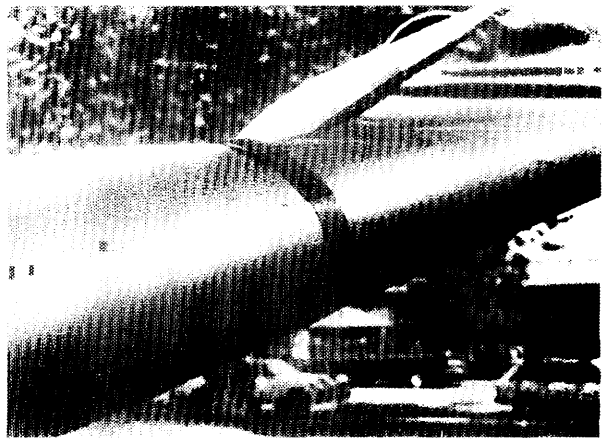

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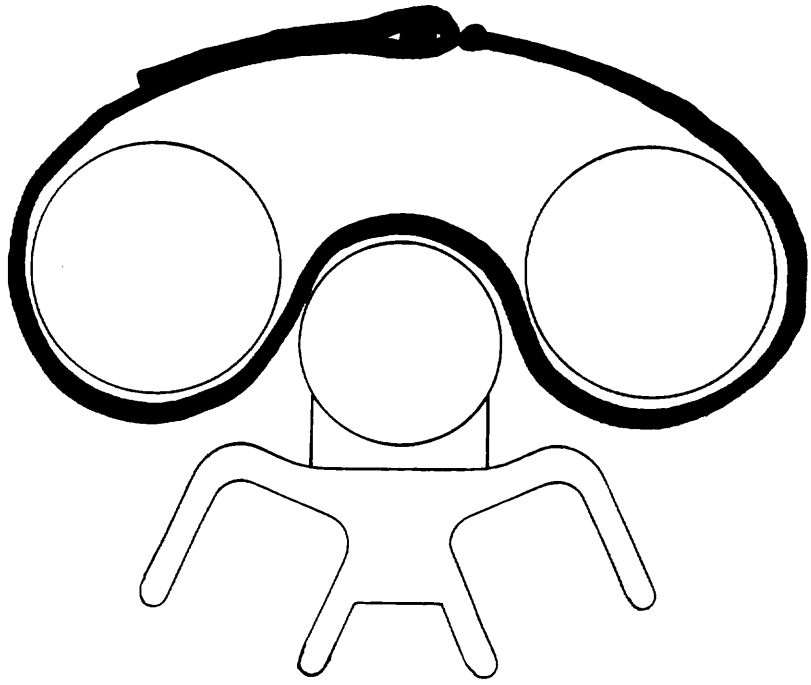
6) Detach the top rear wire keyhole tang from the rear of the keel. (fig 32)

7) Remove the kingpost from the base, and slide it back into the keel pocket securing it under the bungee retainer. (fig 33)

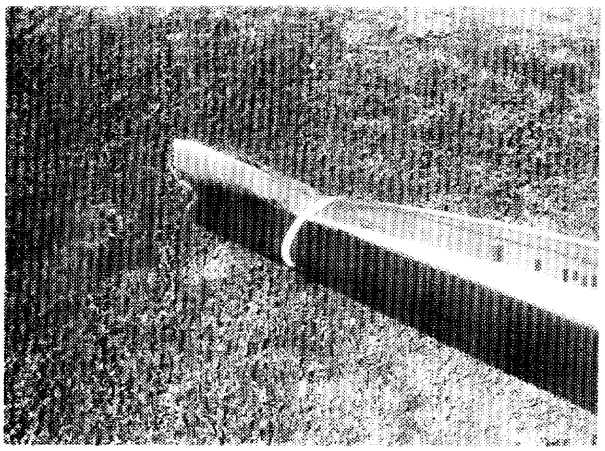
8) Remove the washout tips. Fold the wings in pulling the sail over the top of the leading edges. (fig 34) IF YOU MEET RESISTANCE WHILE FOLDING THE WINGS IN, STOP AND CHECK THAT THE CROSSBAR CENTER SECTION IS NOT CAUGHT BETWEEN THE KEEL AND FRONT LEADING EDGE.

9) Roll the washout tips and lower surface battens up in the sail. (fig 35)

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 36-37) 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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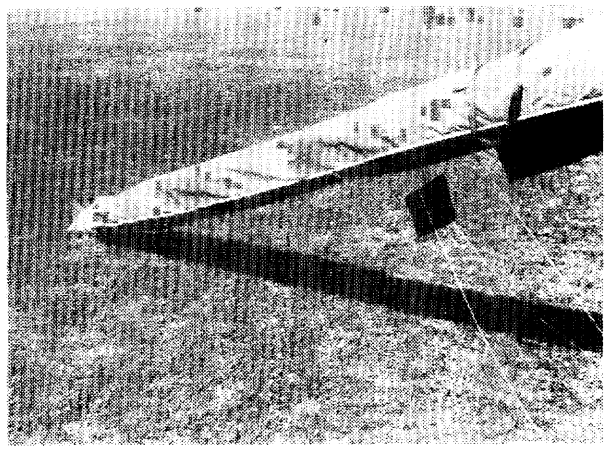

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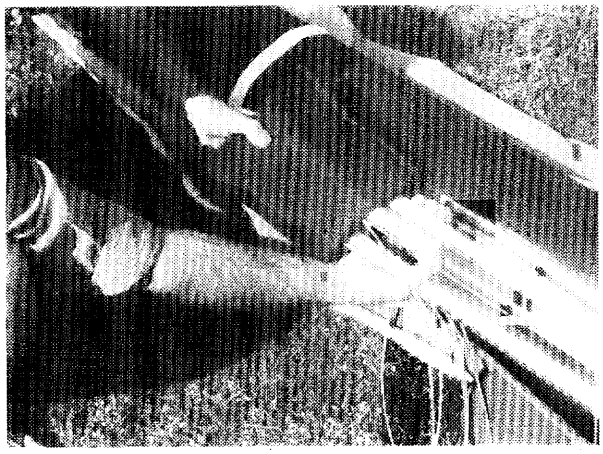

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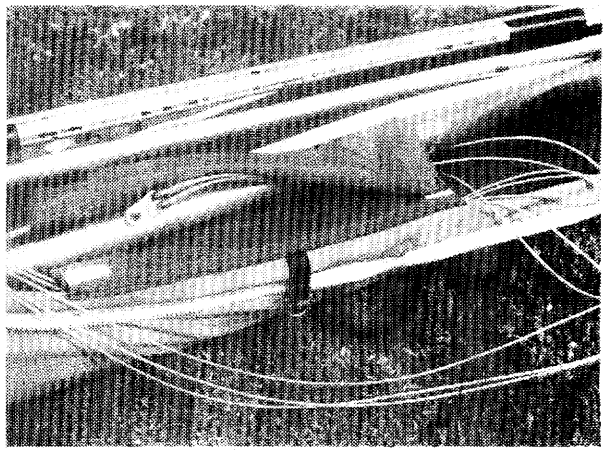

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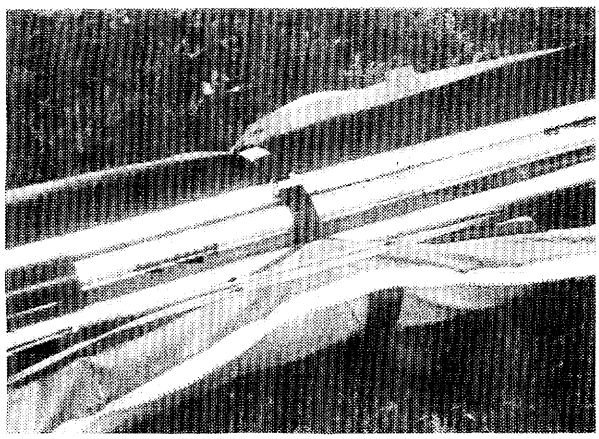

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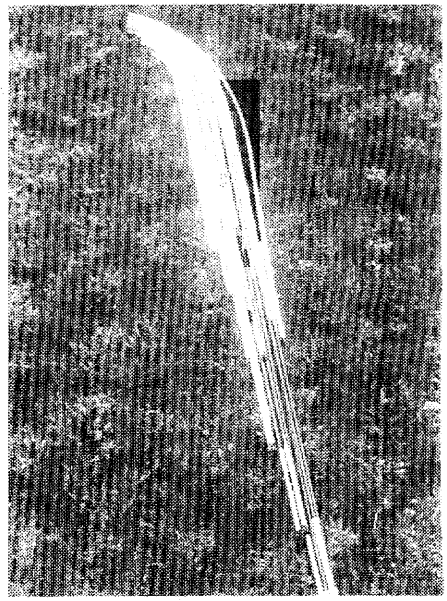

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11) Place the last velcro around the sail near the rear end of the leading edges. (fig 38). Place the bag on the glider with the flag at the tail end. (fig 39) Lay the glider on the ground, disassemble the control bar and fold it rearwards.

12) Install the protective rubber caps over the washout studs. Install the protective bag over the end of the control bar. (fig 40) Insert the pads underneath the keel, and between the keel and control bar and secure the velcro tabs. (fig 41)

13) Secure the velcro strap around the control bar (fig 42) and zip up the bag.

14) Place the battens together carefully (fig 43) and stow them in the batten bag.

DUCK 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.

DUCK 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 Duck should have a complete maintenance inpspection 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 including crossbar restraint cable.

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. Inpspect 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.

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. Never leave your sail rolled up wet, as the colors may bleed.

With proper care and maintenance, your glider will retain for some years a high level of airworthiness. The Duck was tested and found to comply with the 1982 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 severly injured in accidents that could easily have been prevented.

CAR TOP MOUNTING

Your Duck 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 Duck 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. Also notice that each rear leading edge has two 3/16" clevis pins holes in the forward end. This is so each leading edge can be used as either a left or right. It is important that you use the proper clevis pin hole to secure the leading edge in place. When the leading edge is properly installed, the plug in tip sleeve will point up and in, at an angle of about 20 degrees from the horizontal. If improperly installed, the sleeve will point either outwards, which would make it impossible to assemble the glider, or in and down at 20 degrees from the horizontal, which would put 20 degrees of negative twist in the tip and make the glider extremely unsafe to fly. 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)

2) Once the leading edges are properly installed and secured with the clevis pin and safety as shown in the diagram, 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 BOTTOM OF THE LEADING EDGE (WHICH WILL BE ON TOP IF THE GLIDER IS LYING UPSIDE DOWN) AND THAT IT SHOULD BE MOUNTED AT THE LOOSEST SETTING (FARTHEST FORWARD HOLE)UNLESS THIS HOLE IS TAPED OVER.The proper orientation of the sail mount plug will have the sail mount clevis pin aligned perpendicular 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 perpendicular orientation.

ANYTIME YOU ARE MOUNTING OR DISMOUNTING THE SAIL AT THE REAR LEADING EDGE, CHECK THE CONDITION OF THE WEBBING LOOP WHICH SECURES THE SAIL TO THE CLEVIS PIN. IF IT IS WORN, HAVE A SAILMAKER REPLACE IT, MAKING SURE THAT THE REPLACEMENT LOOP IS OF EXACTLY THE SAME LENGTH. 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 by cutting the leach line (505) which ties the sail around the nose plate. 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. When remounting the sail at the nose, refer to the diagram for the proper routing of the leach line. Note that the line passes behing the saddle on the keel. With the glider set up, the line across the nose will be much looser that with the glider broken down and the leading edges folded in. Therefore, when tying the line with the wings spread, you should make it slightly slack. When tying the string with the leading edges folded in, you should make it tight.

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 snipping.

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. Overtightening of the inboard battens may make the glider stiff in handling.

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, 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 in 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 exibited 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 keel.

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.

Bottom surface battens should be straight.

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.

CROSSBAR ADJUSTMENT

The crossbar can be pulled further rearward by moving the restraining cable mounting bolt aft in the keel. The normal setting is the forward hole. Moving the crossbar back tightens the sail, producing a small increase in performance at the expense of handling. For most pilots, in most conditions, the normal adjustment will provide the highest effective performance. NOTE: PRIOR TO CHANGING THE CROSSBAR ADJUSTMENT, BE SURE TO READ AND UNDERSTAND THE SECTION BELOW ON SIDE WIRE LOOP ADJUSTMENT!

BASETUBE-SIDE WIRE LOOP LENGTH ADJUSTMENT

The basetube can be lengthened by moving the base tube bracket out to the outboard hole. This puts more slack in the side wire loop. The purpose of this adjustment is to allow for slack in the side wire loop when the crossbar is pulled back. The normal basetube position will allow moderate slack in the side wires when the crossbar anchor bolt is in the forward hole, and slight slack in the side wires when the crossbar anchor bolt is in the middle hole. THE SIDE WIRES SHOULD HAVE AT LEAST SLIGHT SLACK IN THEM FOR PROPER HANDLING. The rear-most crossbar position will require the use of the extended base tube to maintain side wire slack. The extended base tube can also be used to add dihedral to the frame and extra slack to the side wires when used in conjunction with the forward or middle crossbar positions.

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 three holes in it (early models have two holes) for the adjustment of leading edge sail tension. The normal adjustment is obtained with the sail mounted in the forward most hole or the middle hole, depending on the individual glider. 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 perpendicular 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 at right angles 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.

CG ADJUSTMENT

The positions of the control bar and hang loop can be interchanged to adjust the glider trim speed. If additional adjustment is required, an additional hole (1/4") can be drilled in the keel at the desired hang loop location. Moving the hang loop forward will increase the hands off trim speed, reduce the pressures required to fly at speeds faster than trim, and increase the pressures required to fly at speeds below trim. The glider's aerodynamic performance will not be effected by changes in hang loop location, however the resulting changes in bar pressure may alter your effective performance.

NOTES ON EARLY VERSUS LATE MODELS

This manual is written primarily for the late model DUCK. A number of 180 Ducks were built in an earlier configuration. All of these had serial numbers less than 10200. These early Ducks have one or more of the hardware differences listed below:

1) CROSSBAR ADJUSTMENT

The crossbar restraint cable was adjustable by virtue of two rectangular tangs connecting the cable to the keyhole tang.The two adjustments available are the equivalent of the forward two holes in the keel on late model Ducks. There was only one hole in the rear keel on these early Ducks.

2) BASETUBE ADJUSTMENT / SIDE WIRE LENGTH

Early Ducks which had the tang-adjustable crossbar cable also had only one available control bar basetube length. The basetube was the same length as late model Ducks, but the inner hole on one end was not drilled. As a result, the bottom side wires on these gliders were shorter; as they are designed to duplicate the side wire loop dimensions of the late Duck narrow basetube when used on the full width basetube.

WHEN ORDERING A BOTTOM SIDE WIRE OR A BASETUBE FOR AN EARLY MODEL DUCK, YOU SHOULD REPLACE BOTH BOTTOM SIDE WIRES AND/OR CONVERT TO THE NEW STYLE BASE TUBE (DRILL THE EXTRA HOLE) AT THE SAME TIME TO MAKE SURE THAT THE PROPER DIMENSIONS FOR THE SIDE WIRE LOOP ARE PRESERVED.

3) SAIL MOUNT PLUG

Early Ducks may have had a sail mount plug with only two holes. Some of these had the forward hole 3/8" further back than the end of the leading edge, some had it 5/8" further back. Most of these did not have extra set screw holes for alignment adjustment, and will have to be drilled if adjustment is necessary.

Some early Ducks had a smaller washer on the bottom of the plug on the sail mount clevis pin. These may not adequately protect the sail mount webbing and should be replaced with the larger washer (see diagram for approximate size of the proper washer.)

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. Inpsect 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 severly 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 loop at the rear of the leading edge; have this replace by a sail maker if it shows any signs of wear. THE LENGTH OF THIS LOOP IS CRITICAL; IF YOU HAVE IT REPLACED, MAKE SURE THE NEW ONE IS THE SAME LENGTH AS THE OLD ONE! 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. Inpsect 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, including the crossbar restraint cable. 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) Slide the nylatron out of the front of the kingpost base, and unbolt the kingpost base from the keel.
3) Remove the clevis pin from the control bar "U" channel and detach the control bar from the keel.
4) Detatch the bottom side and lower front to rear wires from the control bar.
5) 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.

6) Cut the string mounting the sail at the nose, and dismount the sail at the rear leading edges.
7) Remove the screw securing the sail to the bottom of the keel at the nose.
8) Carefully slide the frame out through the nose of the sail. (It is best to have a helper at this point.)

SERVICE RECORD

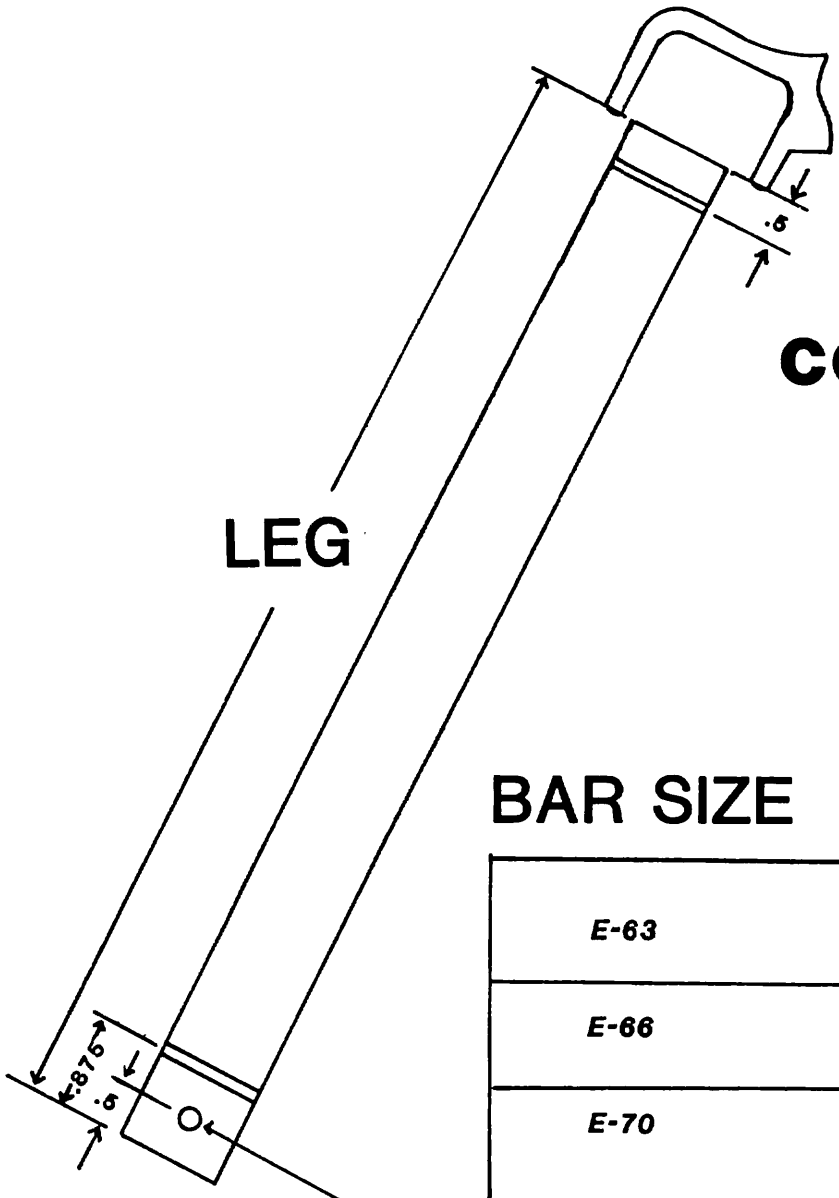
EVERY SIX MONTHS

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

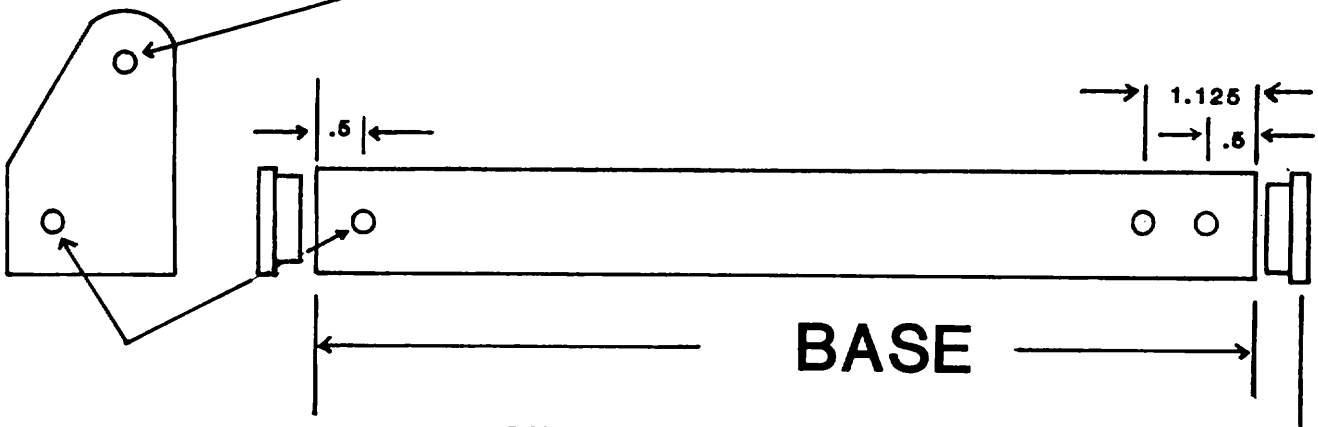
Additional Service Work

DESCRIPTION OF WORK DONE AND PARTS REPLACED	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



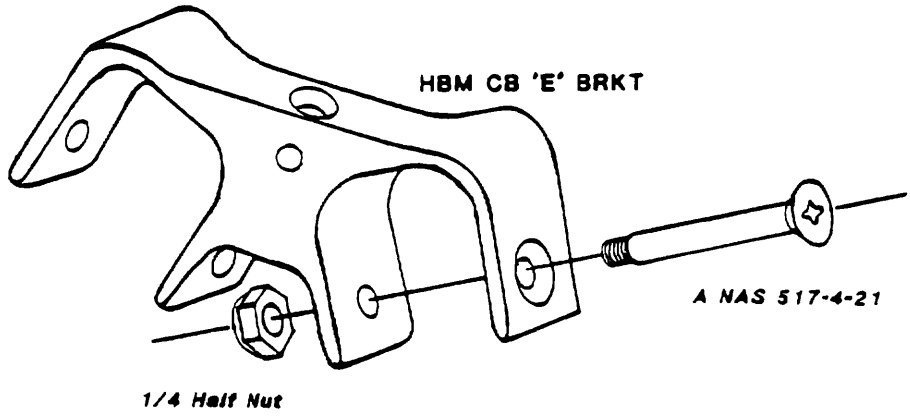
NOTE: ***All holes 1/4"***

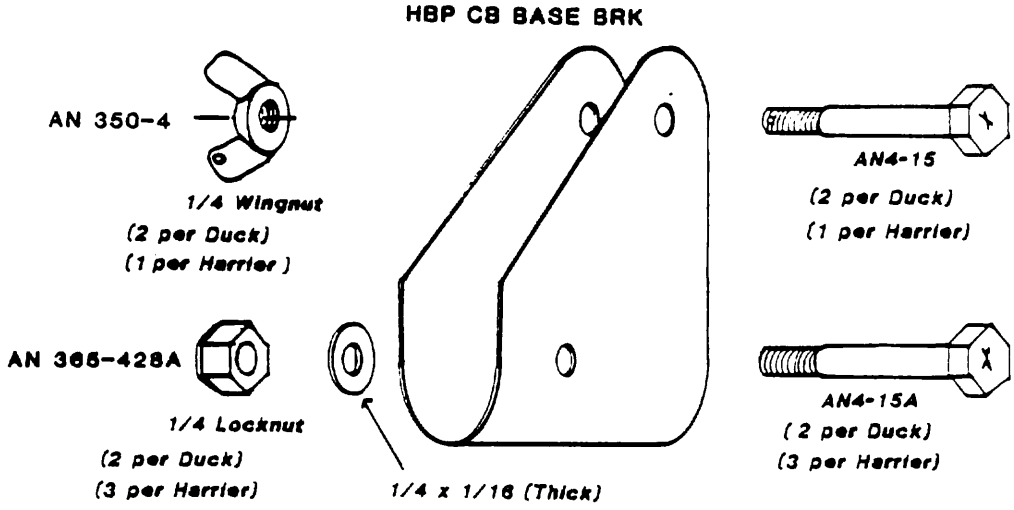
Not to scale

Supine Harriers used an E-63 bar with .095 legs

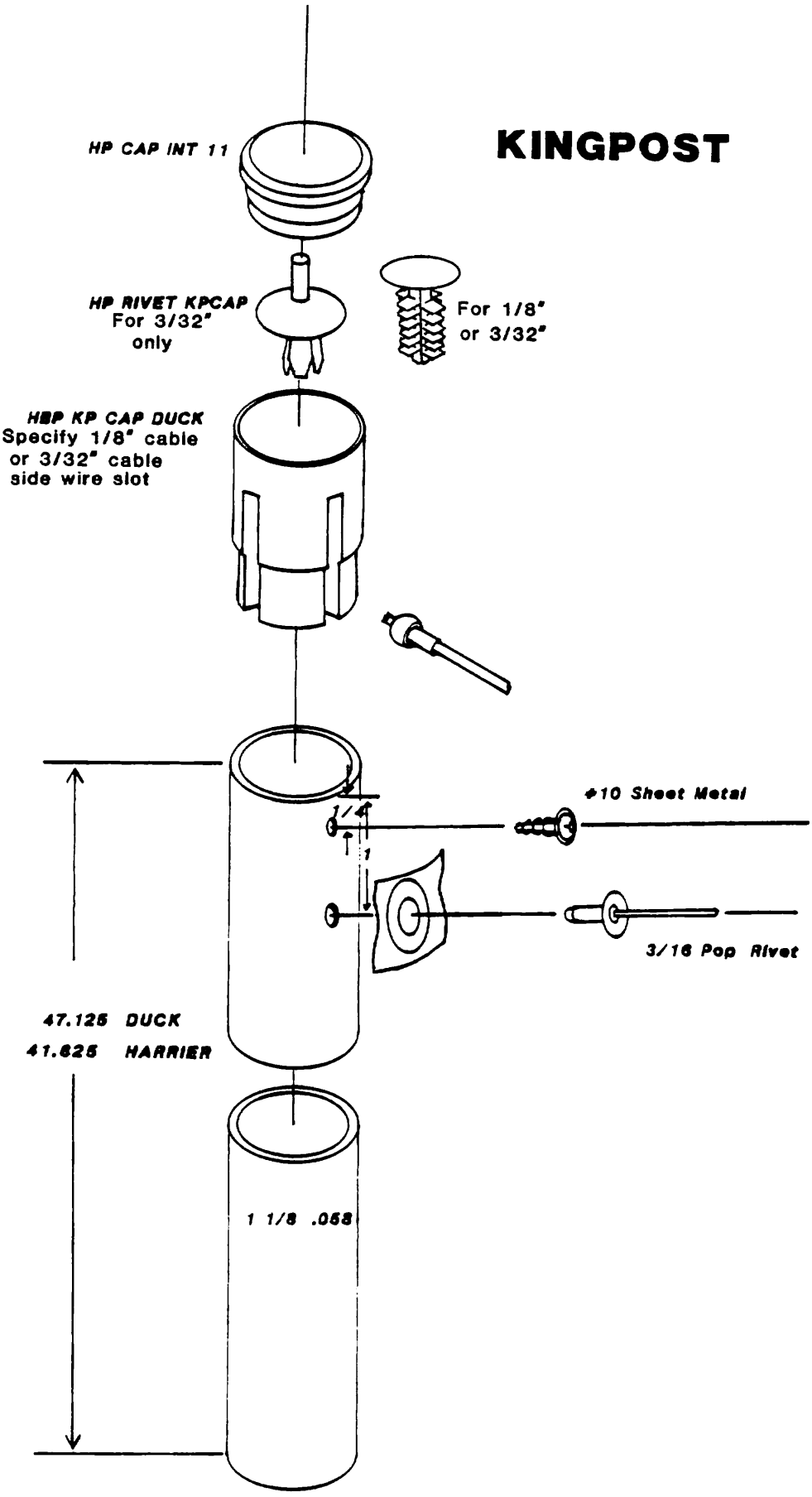
APPLICATION		
E-63	*H-I,II 147*	*Duck 130*
E-66	*H-II 177*	*Duck-160*
E-70	*H-I 177, H-I,II 187*	*Duck-180*

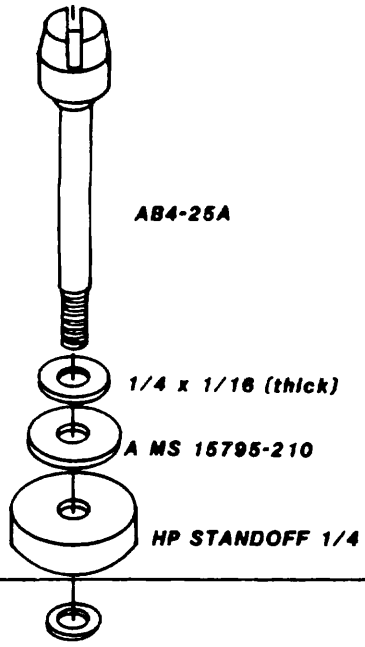
CONTROL BAR

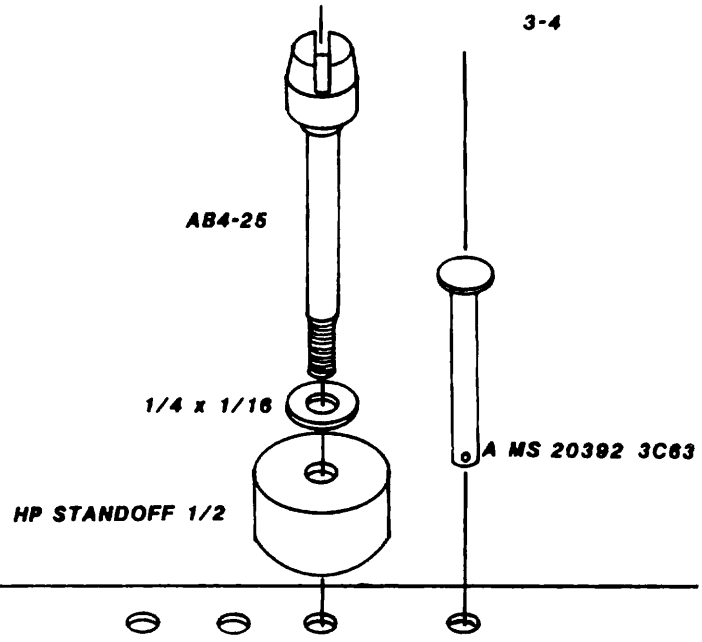

HBM CB 'E' BRKT
A NAS 517-4-21
1/4 Half Nut


HBP CB BASE BRK
AN 350-4
1/4 Wingnut
(2 per Duck)
(1 per Harrier)
AN 365-428A
1/4 Locknut
(2 per Duck)
(3 per Harrier)
1/4 x 1/16 (Thick)
AN4-15
(2 per Duck)
(1 per Harrier)
AN4-15A
(2 per Duck)
(3 per Harrier)

KINGPOST

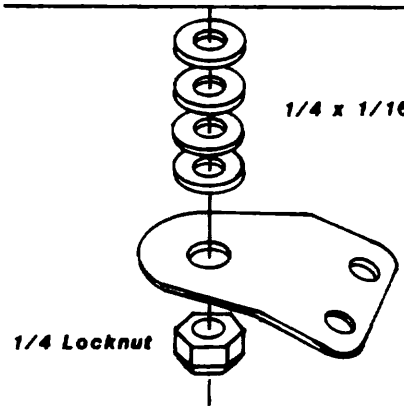

HP CAP INT 11
HP RIVET KPCAP
For 3/32"
only
For 1/8"
or 3/32"
HBP KP CAP DUCK
Specify 1/8" cable
or 3/32" cable
side wire slot
#10 Sheet Metal
1/4
1
3/16 Pop Rivet
47.125 DUCK
41.625 HARRIER
1 1/8 .058

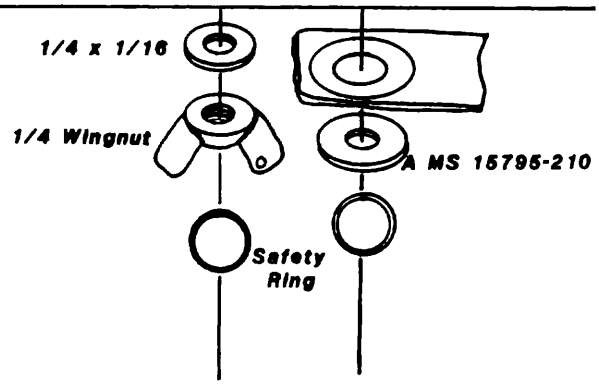




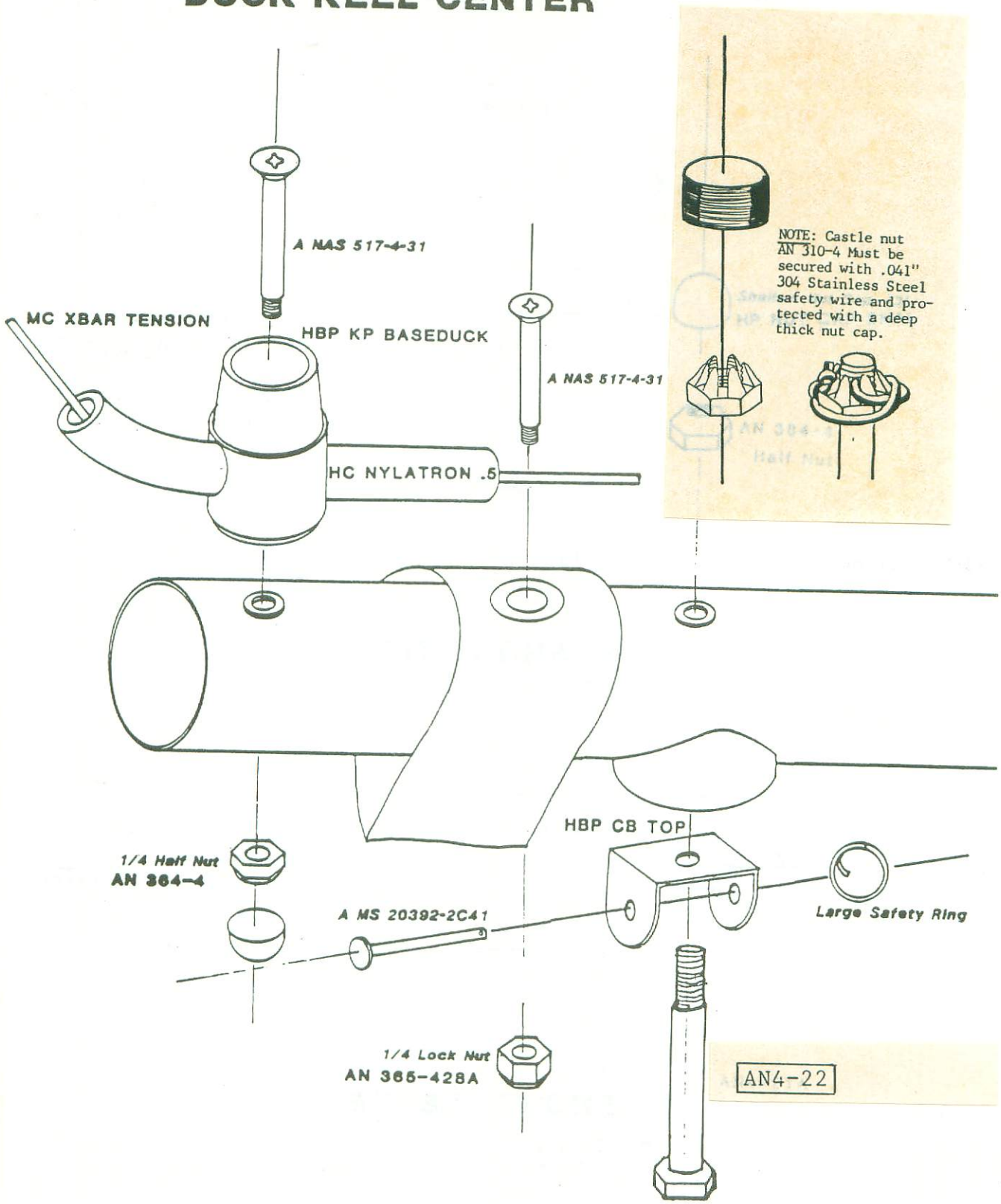
DUCK
REAR KEEL

NOTE: Early DUCKS had only one hole in this area





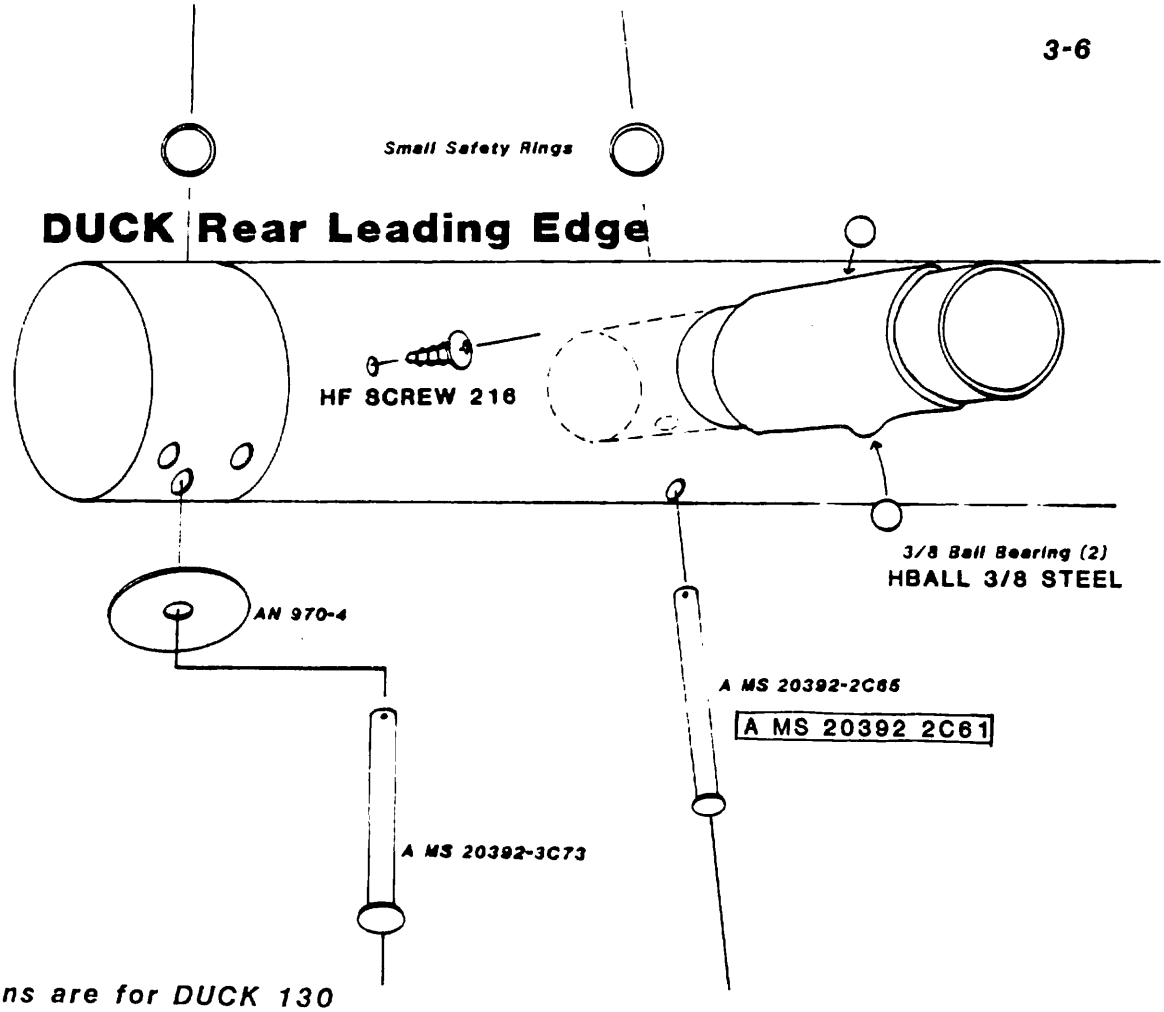
DUCK KEEL CENTER



Duck 180 and 130 are shown. Hang loop mounts behind control bar on Duck 160.

Hang loop mounts ahead of kingpost on 200

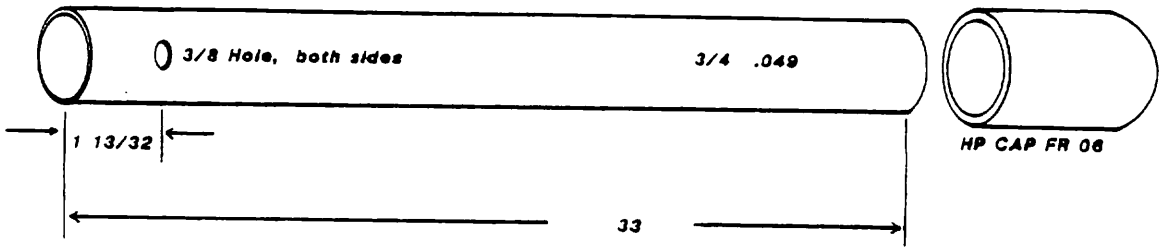
DUCK Rear Leading Edge



BOXED Designations are for DUCK 130

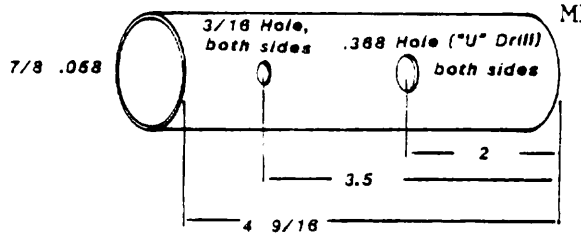
WASHOUT TIP

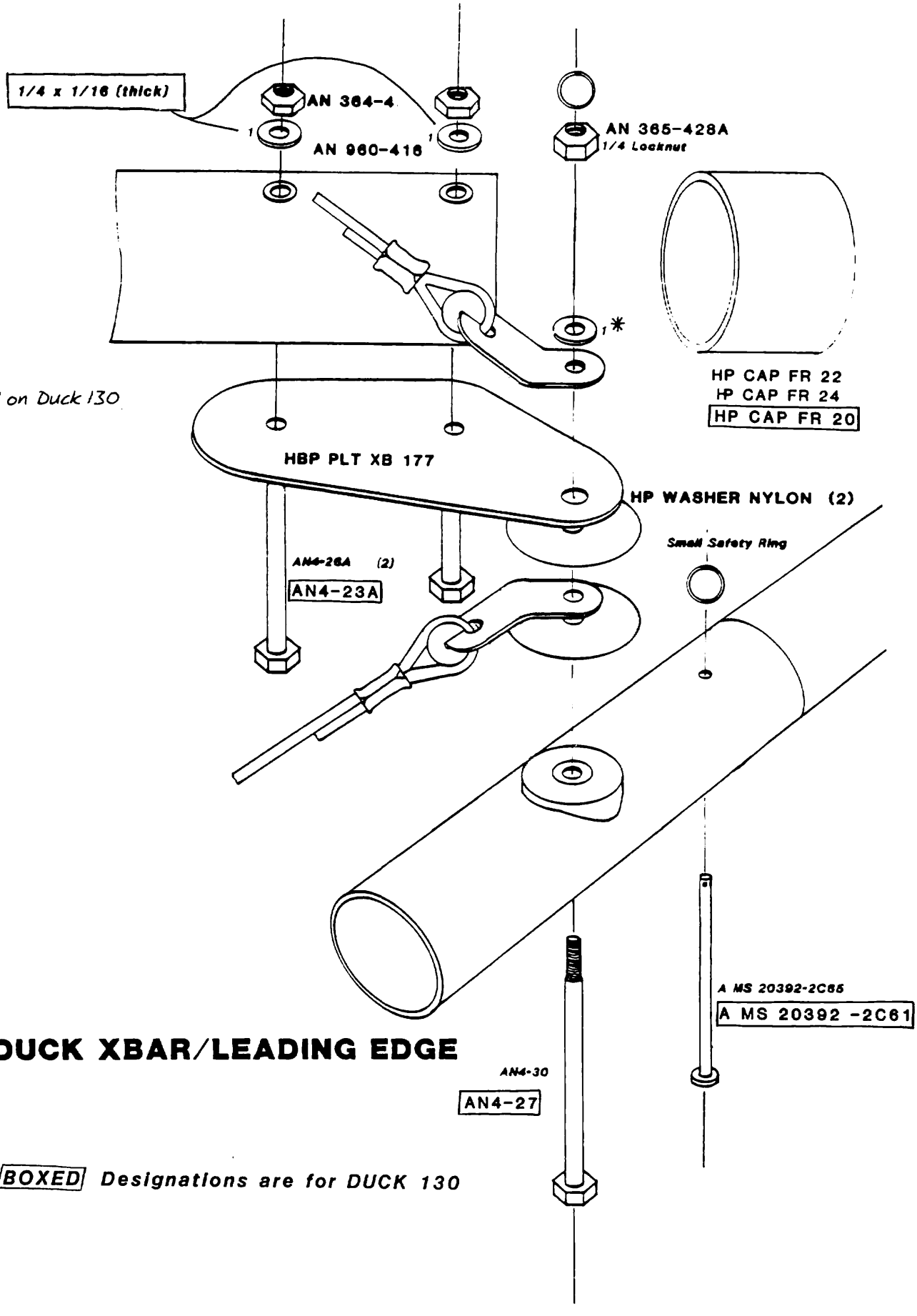
MF WSHT TP DHII



WASHOUT SLEEVE

MF WSHT SLV D

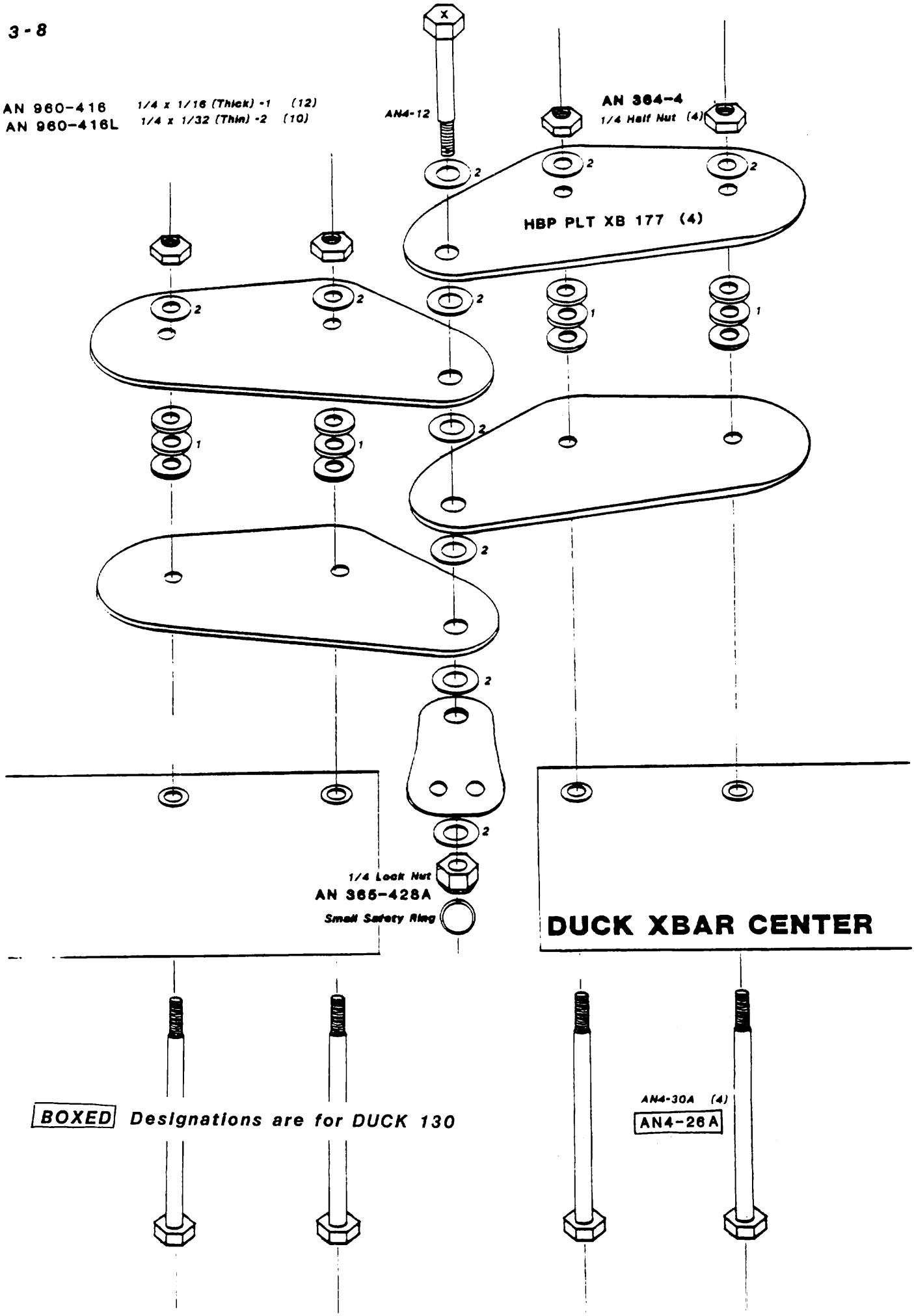




* Not found on Duck 130

DUCK XBAR/LEADING EDGE

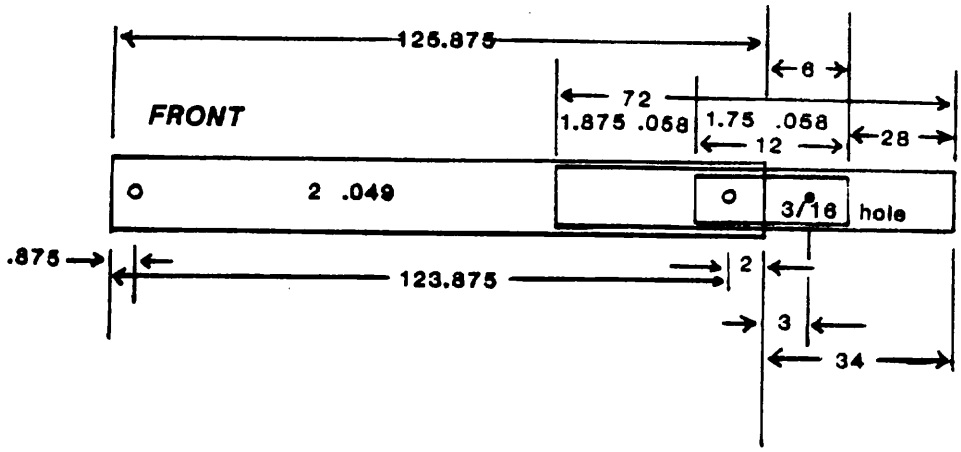
BOXED Designations are for DUCK 130

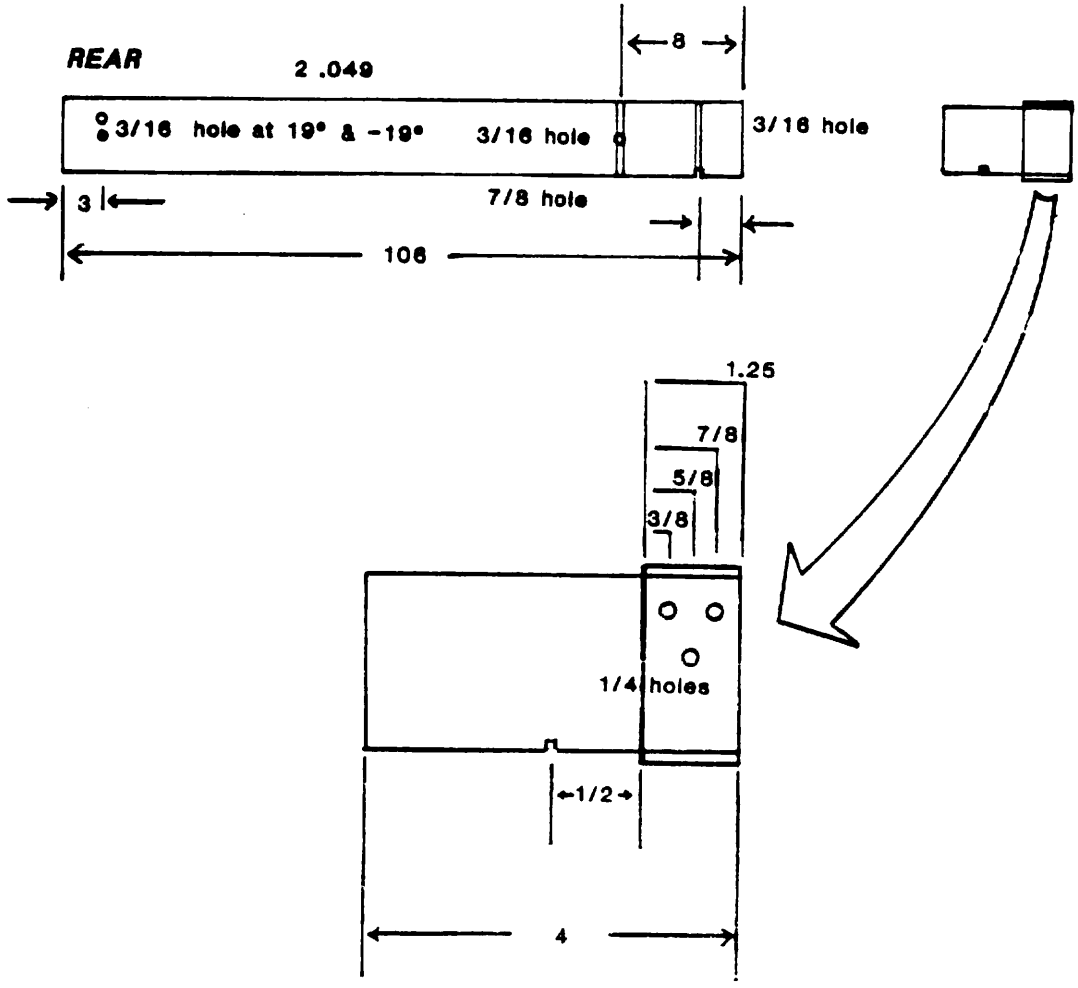

AN 960-416 1/4 x 1/16 (Thick) -1 (12)
AN 960-416L 1/4 x 1/32 (Thin) -2 (10)
AN4-12
AN 364-4
1/4 Half Nut (4)
HBP PLT XB 177 (4)
1/4 Lock Nut
AN 365-428A
Small Safety Ring
DUCK XBAR CENTER
AN4-30A (4)
AN4-26A
BOXED Designations are for DUCK 130

DUCK 180

LEADING EDGE

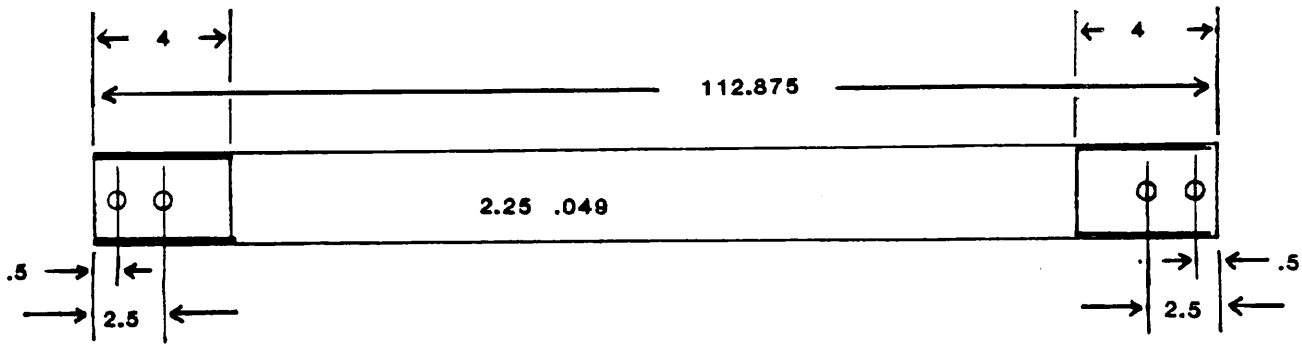
NOTE: All holes drilled 3/8 & bushed unless otherwise noted





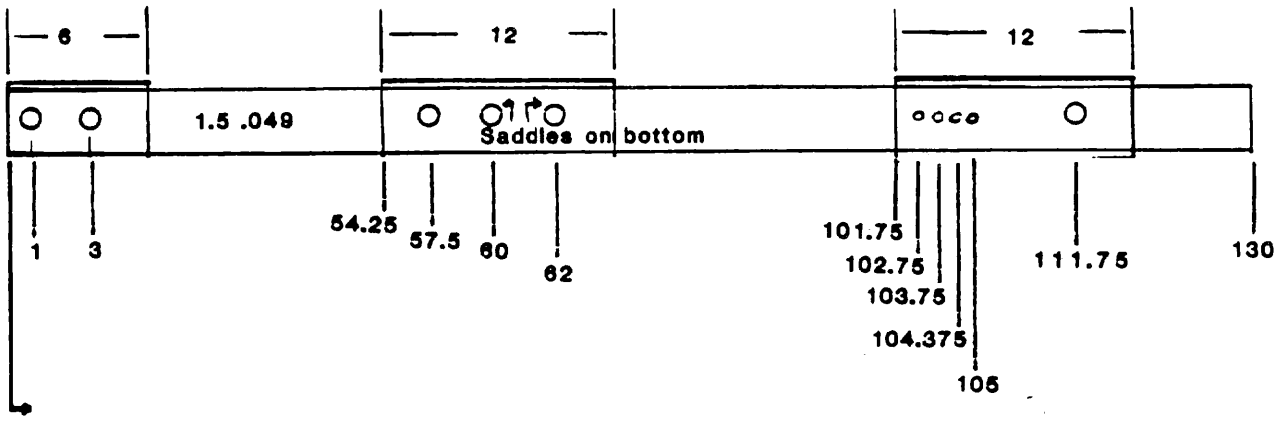
DUCK 180

CROSSBAR

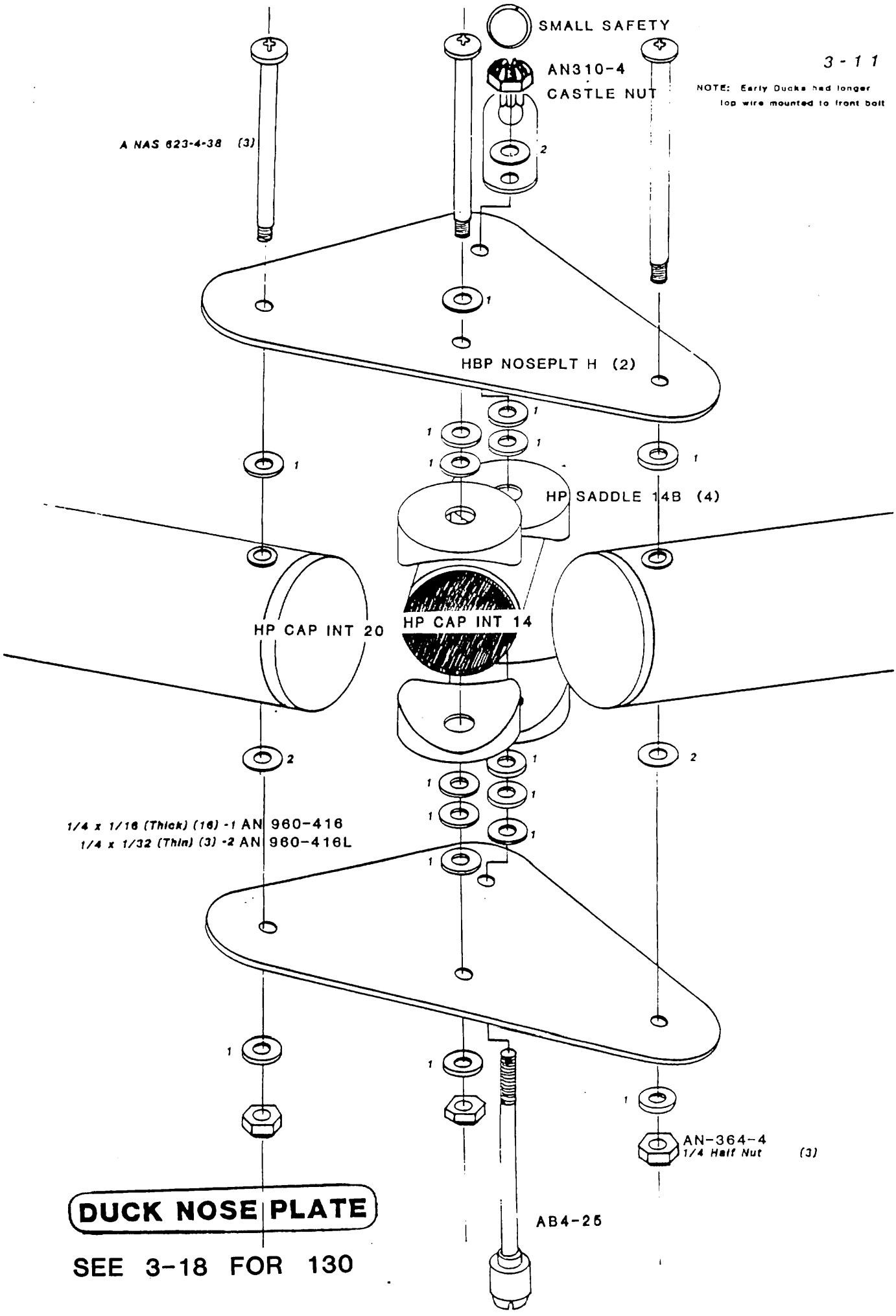


KEEL

All sleeves 1.625 .058



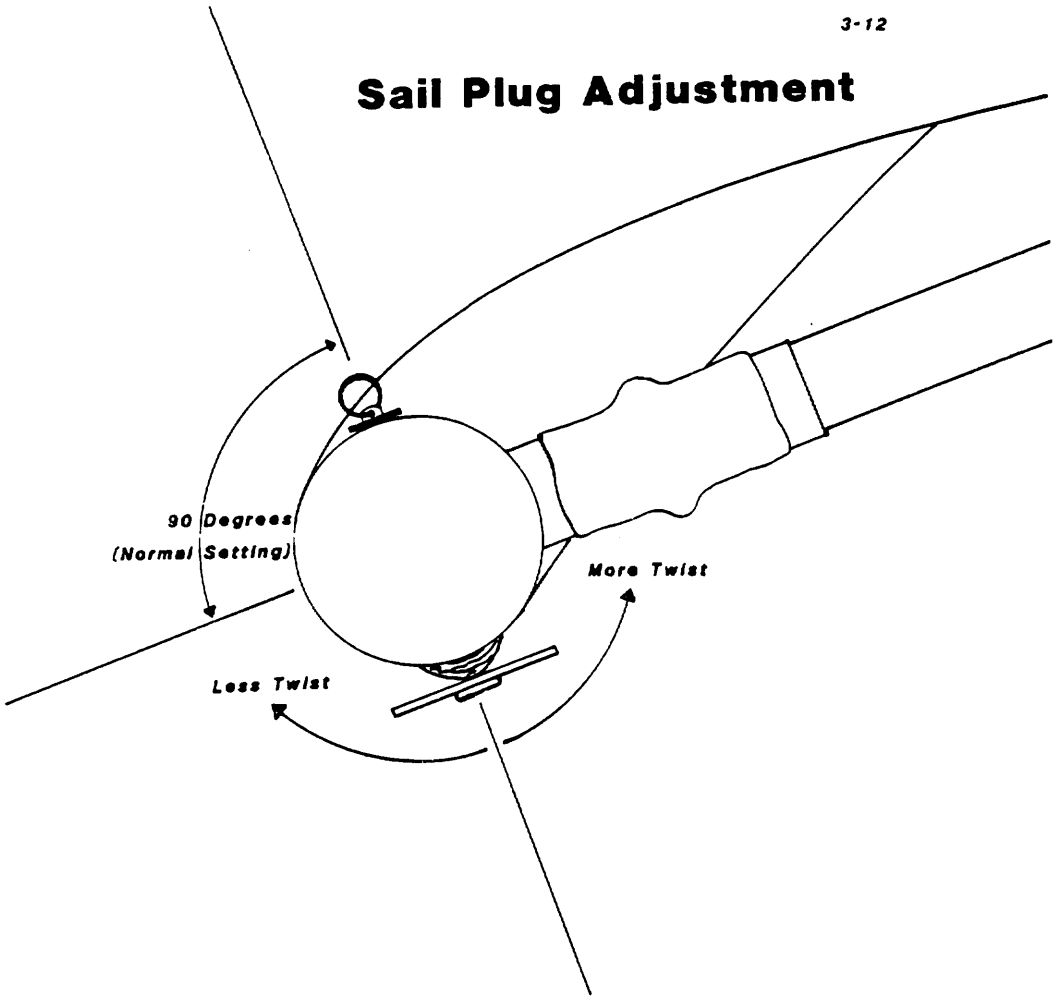
NOTE: All holes drilled 3/8 & bushed unless otherwise noted

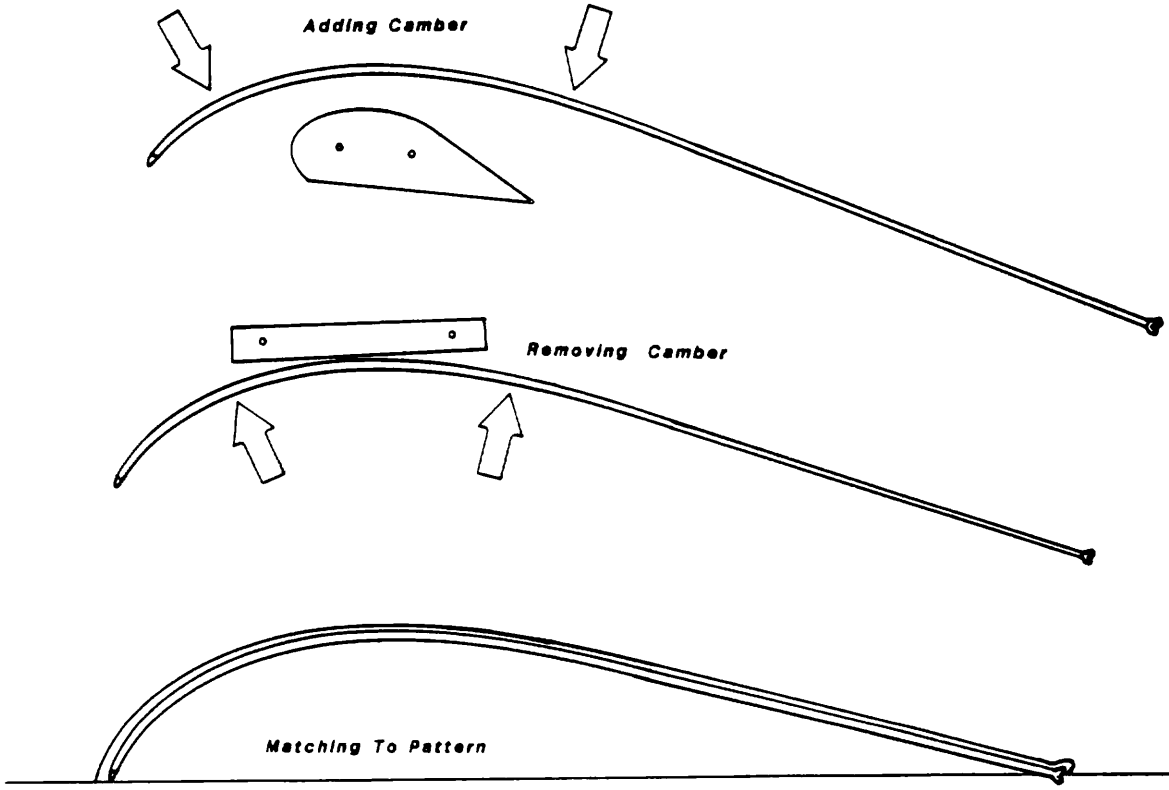


DUCK NOSE PLATE

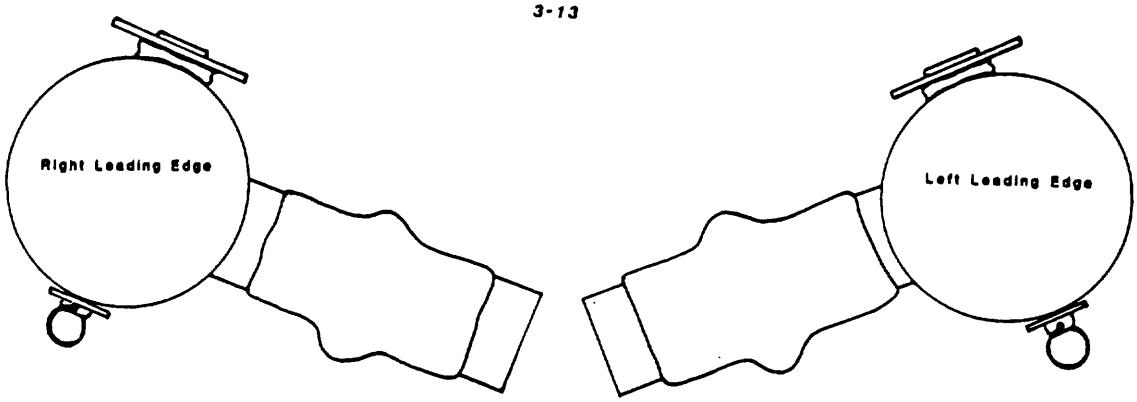
SEE 3-18 FOR 130

Sail Plug Adjustment



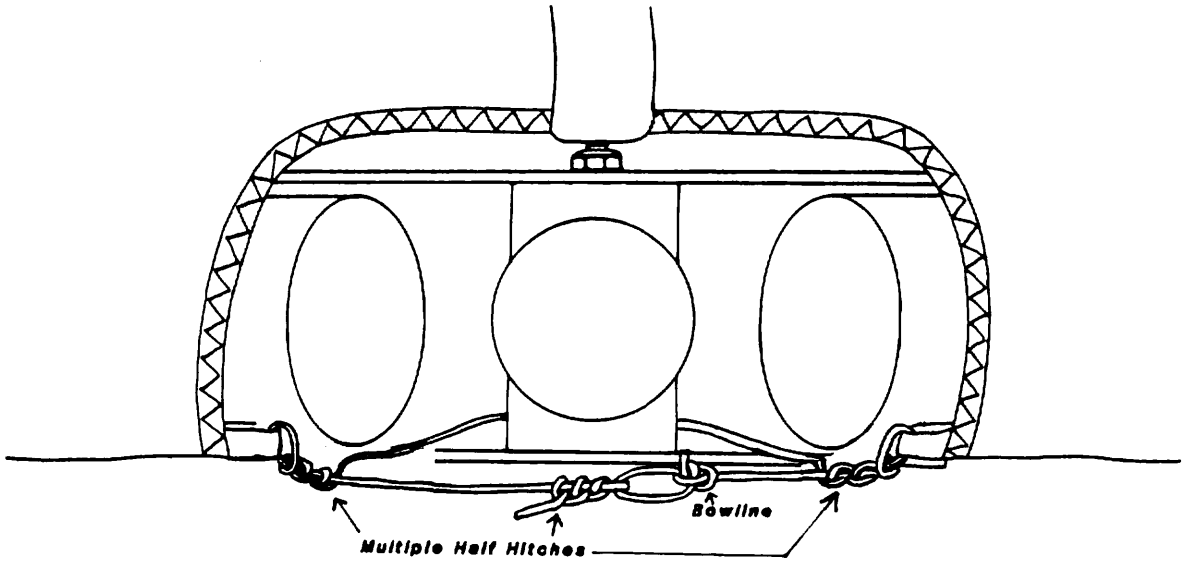


Batten Maintenance

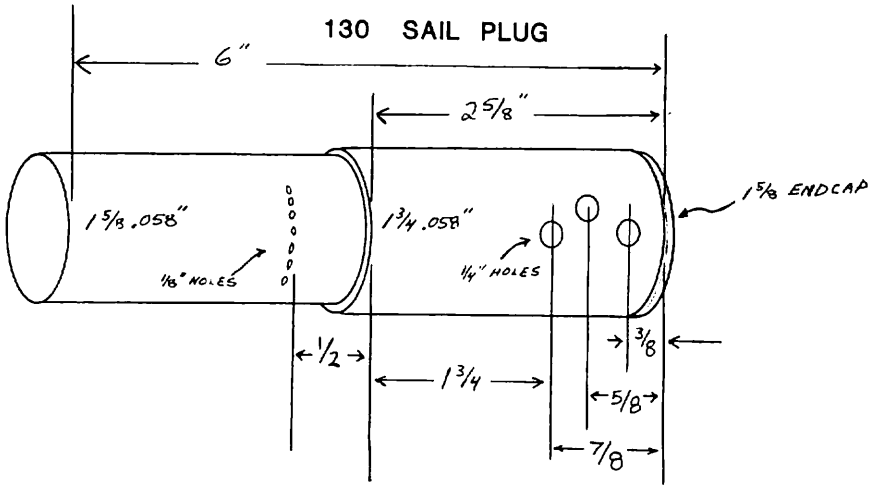


Installation of Rear Leading Edges

REAR VIEW GLIDER UPSIDE DOWN

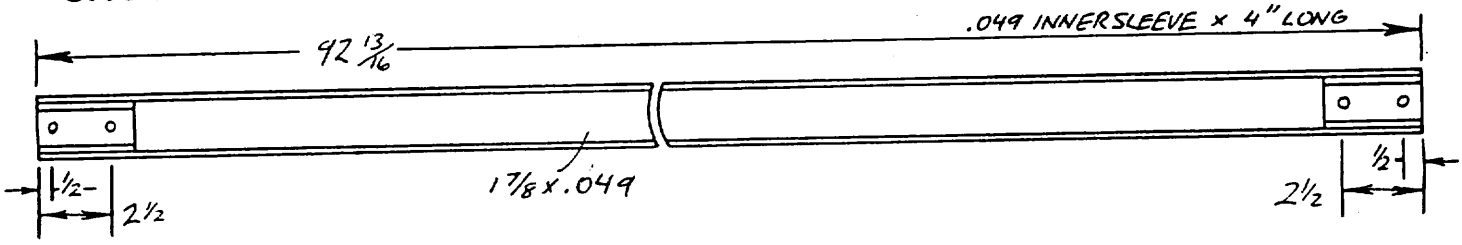


Nose Sail Mounting

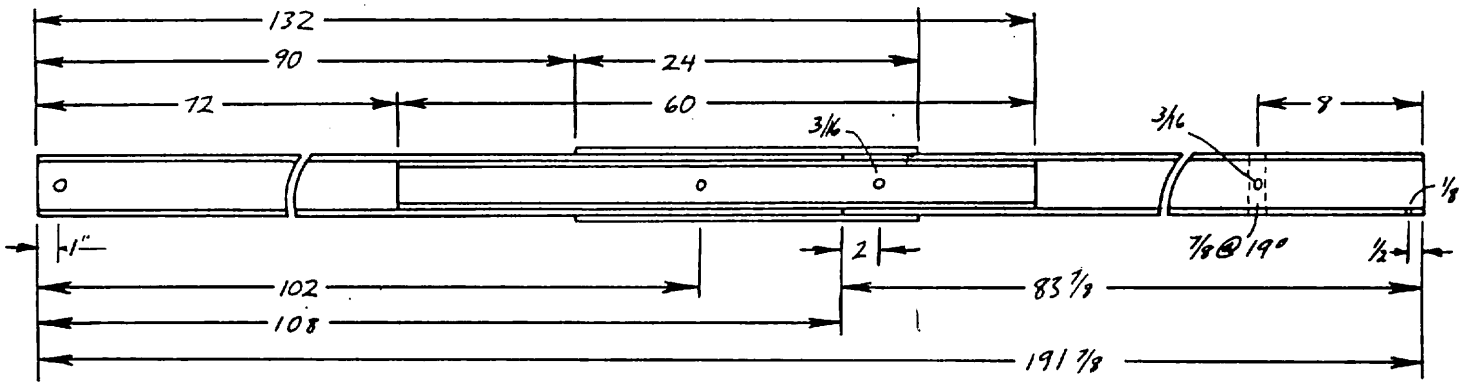


DUCK 130

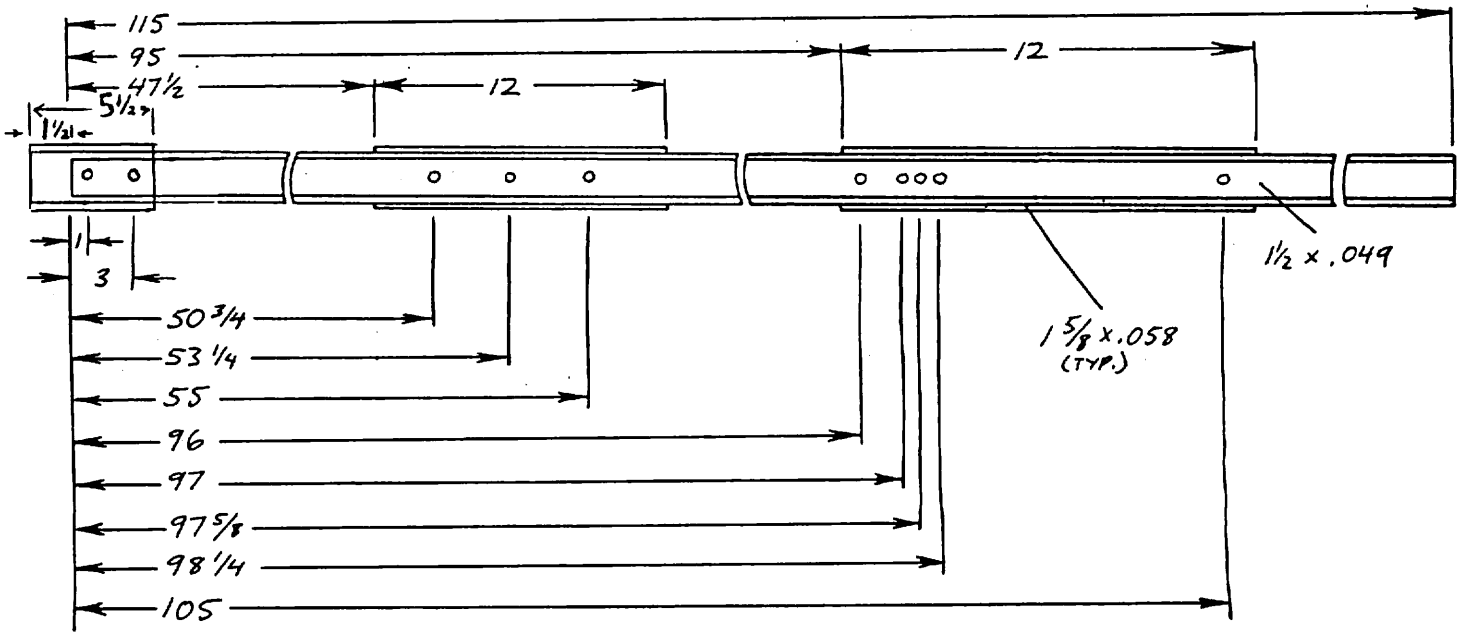
CROSSBAR



L.E.

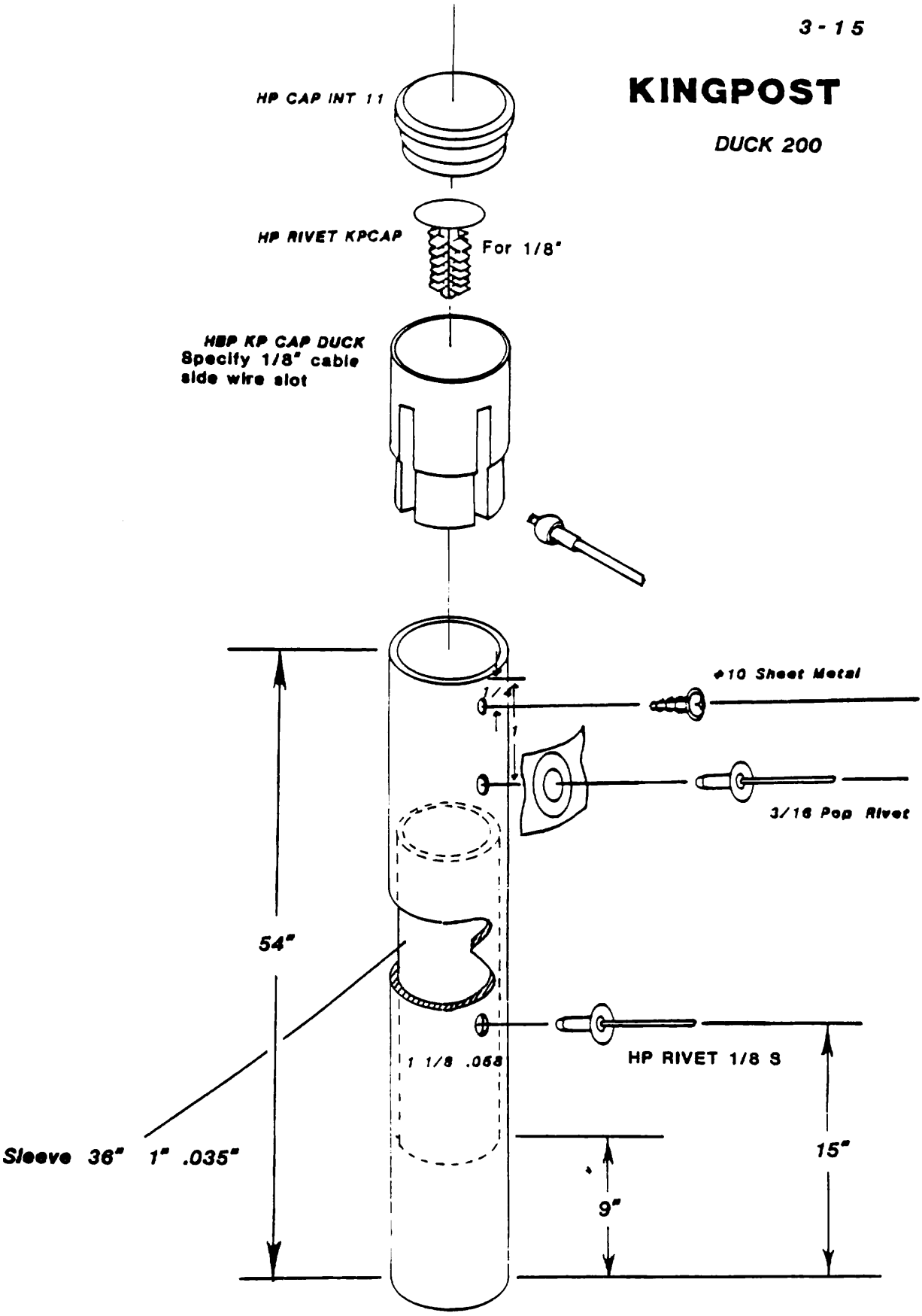


KEEL



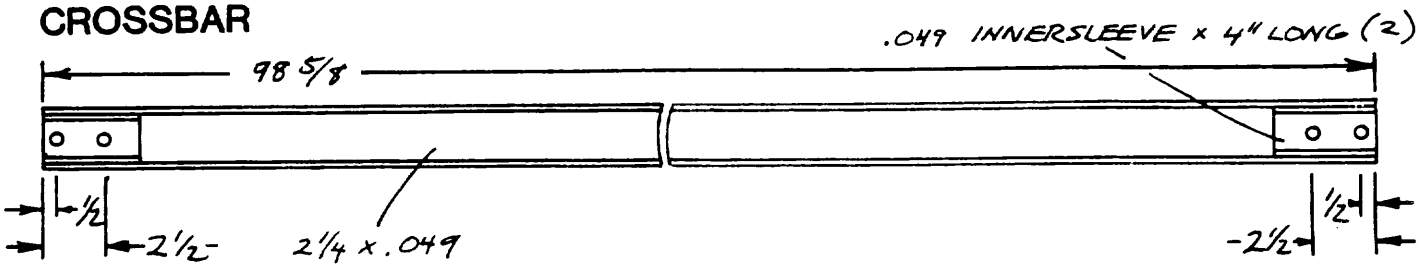
KINGPOST

DUCK 200

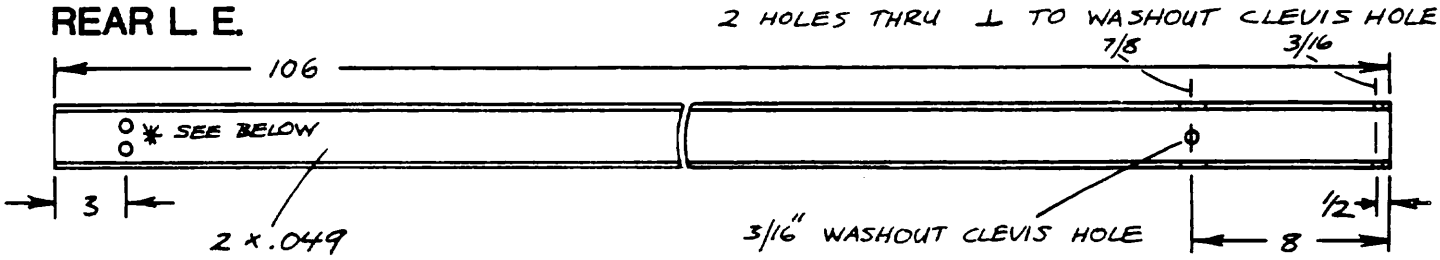


DUCK 160

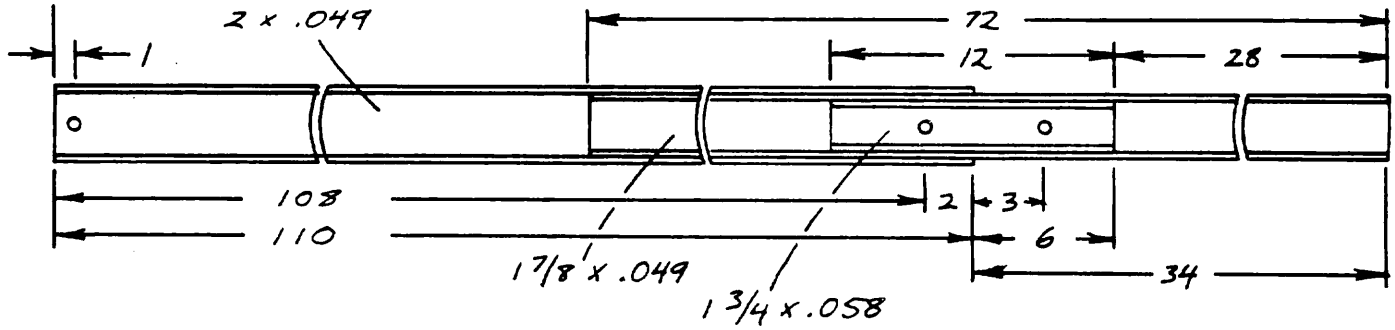
CROSSBAR



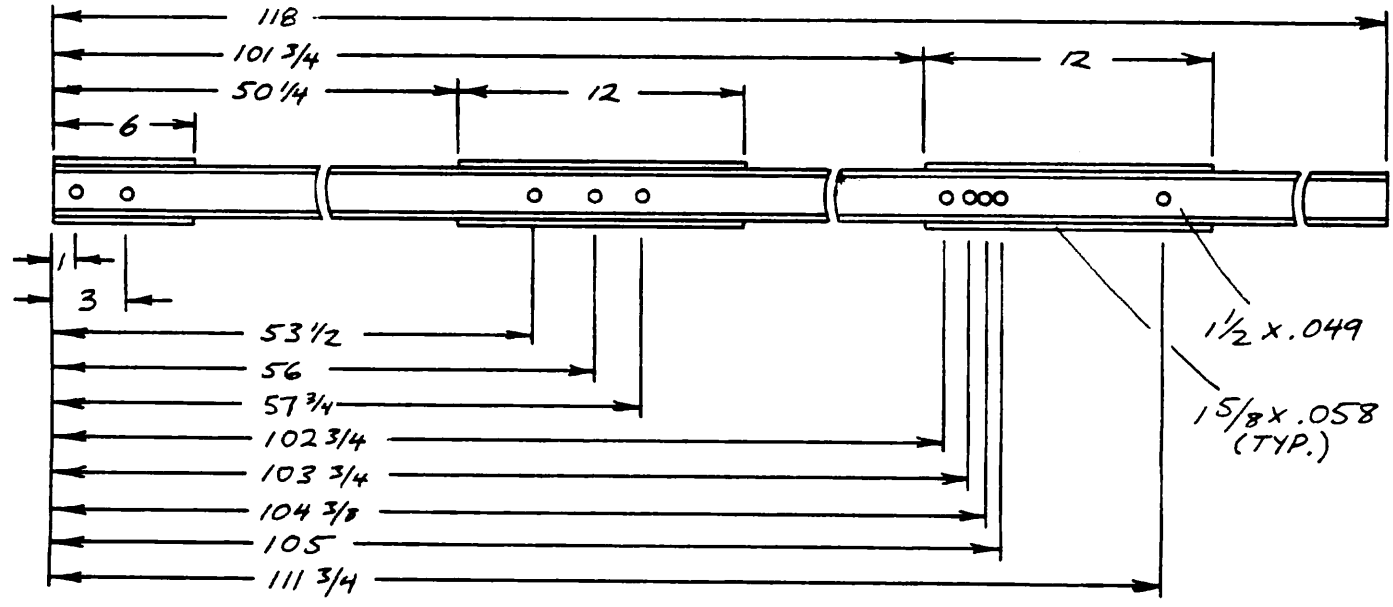
REAR L. E.



FORWARD L. E.



KEEL

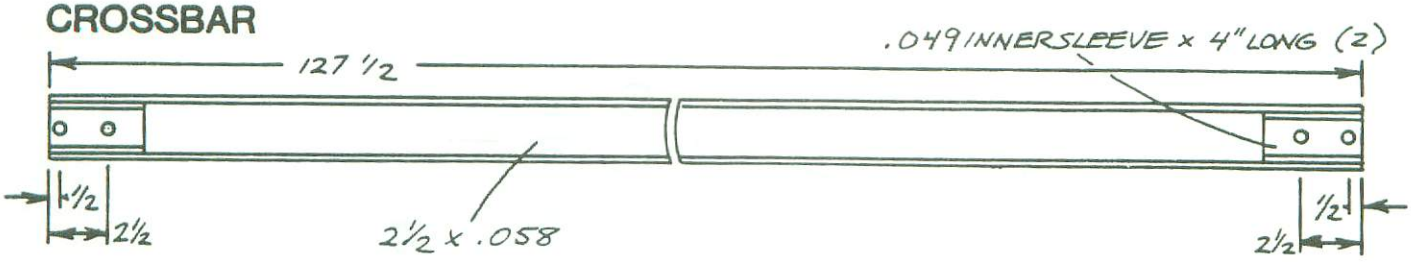


NOTE: ALL DIMENSIONS ARE IN INCHES

* (2) 3/16 HOLES 19° OFF-AXIS EITHER SIDE OF WASHOUT CLEVIS HOLE

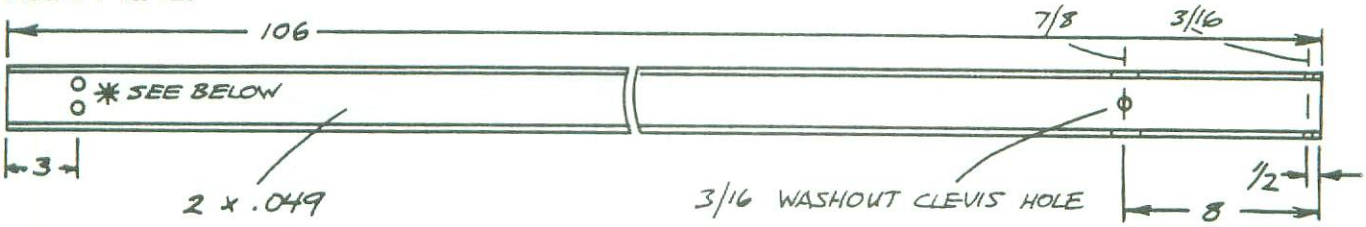
DUCK 200

CROSSBAR

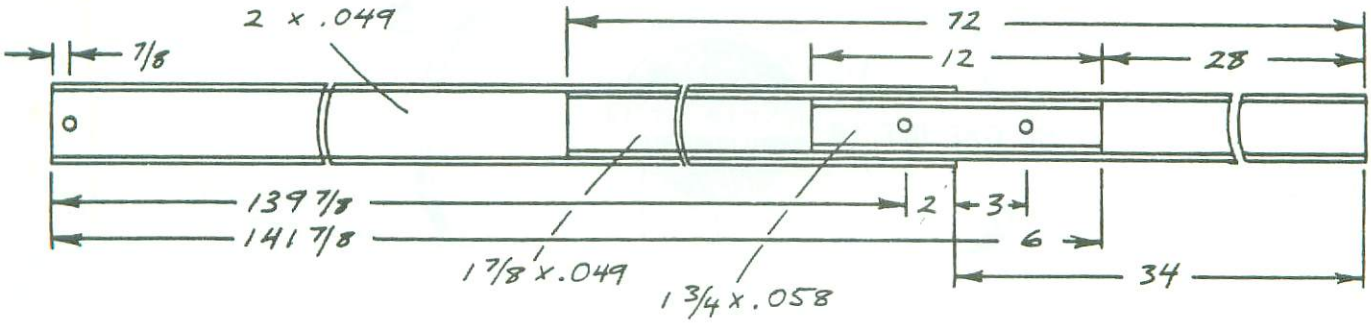


REAR L. E.

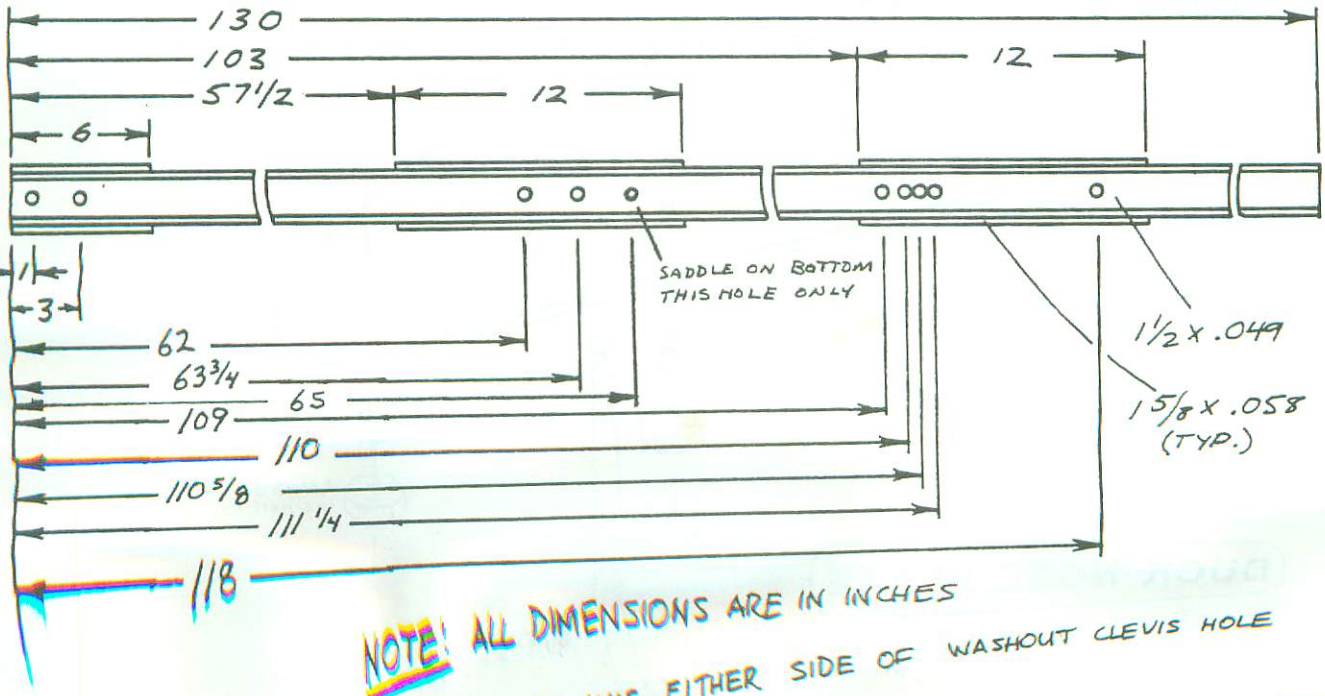
2 HOLES THRU ⊥ TO WASHOUT CLEVIS HOLE:



FORWARD L. E.

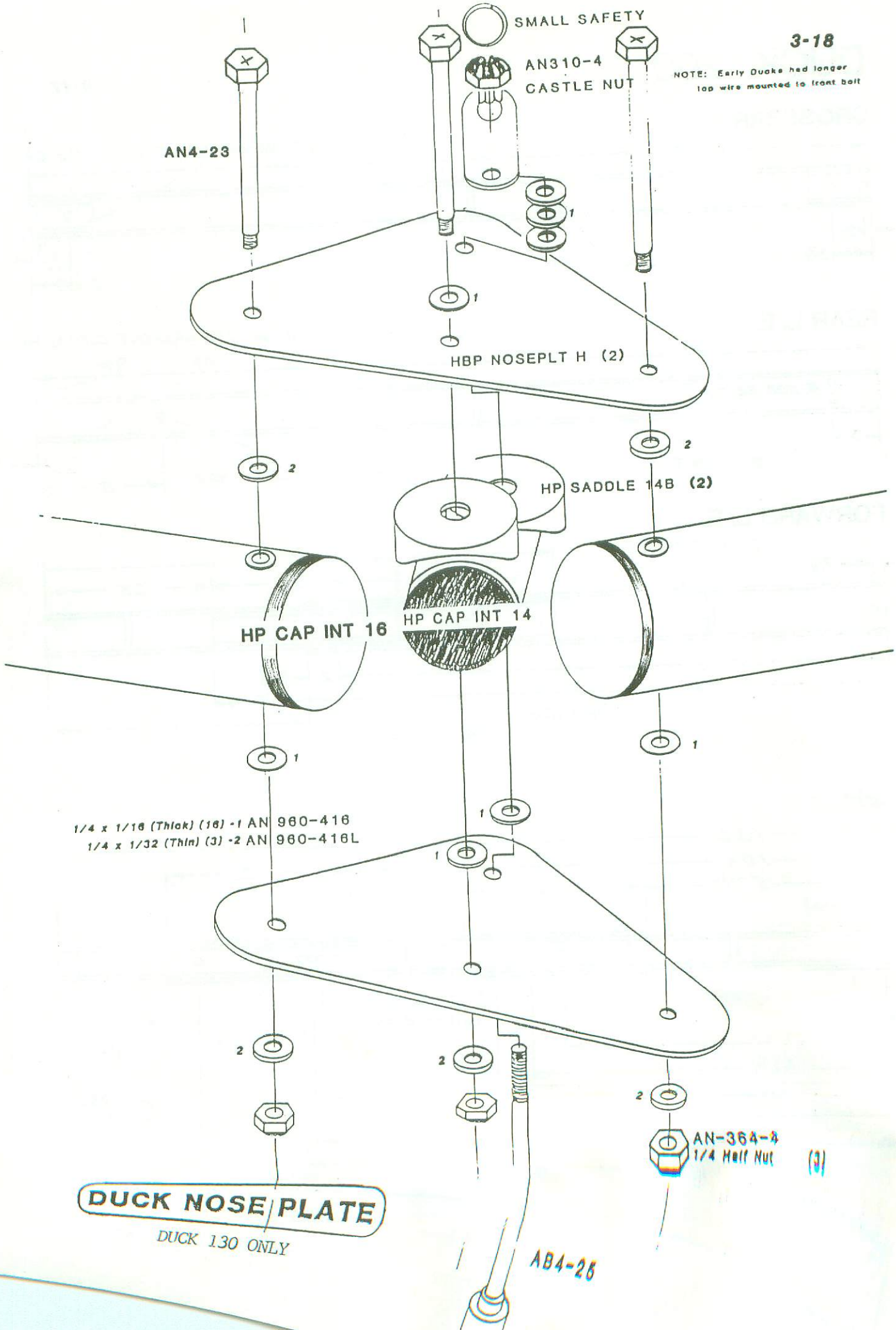


KEEL



NOTE! ALL DIMENSIONS ARE IN INCHES

HOLES 19° OFF-AXIS EITHER SIDE OF WASHOUT CLEVIS HOLE



DUCK NOSE PLATE

DUCK 130 ONLY

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: Duck 130

1) Glider Weight 56
   (lbs., with bag)
2) Leading Edge Tube
   Length, Outside Diameter 194.5, 1.75
   Holes at: 1,102,183.875,193.625,193.875,194.125
   Keel Tube
   Length, Outside Diameter 115, 1.5
   Holes at: 1, 3, 50.75,53.25,55,96,97,97.625,98.25,105
   Xbar Tube
   Length, Outside Diameter 92.8125,1.875
   Holes at: .5, 2.5 each end
   Kingpost Tube
   Length, Outside Diameter 47.125, 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, 1.125, .5 other end
   Washout Tips
   Length, Outside Diameter 33, .75
   Holes at: 1.40625

3) Washout Tip Angle 19 degrees
   Control Bar Angle 2.7 degrees

4) Distance Sail to Crossbar N/A
5) Distance Sail to Keel N/A

6) Bridle Measurement 73 inches front wire at cap to trailing edge at batten.

7) Chord at Root + 3' 67 inches
   Chord at Tip - 3' 43 inches

8) Span of Sail 29 feet

9) Bow In Leading Edge 7 inches
   Bow In Keel 0
   Bow In Crossbar 0

10) Placard Location Keel
    Test Fly Sticker Location Keel

11) Pilot Weight Range 110 to 210 pounds
    Pilot Proficiency Required III

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: Duck 160

1) Glider Weight 68
(lbs., with bag 74 lbs with optional steel control bar and kingpost
2) Leading Edge Tube
Length, Outside Diameter 217.125 , 2
Holes at: .875, 108, 113, 208
Keel Tube
Length, Outside Diameter 130, 1.5
Holes at: 1, 3, 53.5, 56, 58, 102.75, 103.75, 104.375, 105, 111.75
Xbar Tube
Length, Outside Diameter 98.625, 2.25
Holes at: .5, 2.5 each end
Kingpost Tube
Length, Outside Diameter 47.125, 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: 1.40625

3) Washout Tip Angle 19 degrees
Control Bar Angle 3 degrees

4) Distance Sail to Crossbar N/A
5) Distance Sail to Keel N/A

6) Bridle Measurement 82.125 front wire at cap to trailing edge at batten.

7) Chord at Root - 3' 79.25"
Chord at Tip - 3' 42"

8) Span of Sail 32' 4"

9) Bow In Leading Edge 5"
Bow In Keel 0
Bow In Crossbar 0

10) Placard Location Keel
Test Fly Sticker Location Keel

11) Pilot Weight Range 130 to 230 pounds
Pilot Proficiency Required III

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: DUCK 180

1) Glider Weight 72
   (lbs., with bag) 78 lbs with optional steel control bar and kingpost
2) Leading Edge Tube
   Length, Outside Diameter 233.5, 2
   Holes at: 1, 124, 129, 224
   Keel Tube
   Length, Outside Diameter 132, 1.5
   Holes at: 1, 3, 57.5, 60, 62, 103.75, 111.75
   Xbar Tube
   Length, Outside Diameter 112.875, 2.25
   Holes at: .5, 2.5 each end
   Kingpost Tube
   Length, Outside Diameter 47.125, 1.125
   Holes at: .25, 1
   Control Bar Leg
   Length, Outside Diameter 67.5, 1.125
   Holes at: .5, .875, .5 other end
   Control Bar Base
   Length, Outside Diameter 59.75, 1.125
   Holes at: .5 each end
   Washout Tips
   Length, Outside Diameter 33, .75
   Holes at: 1.375

3) Washout Tip Angle 19 degrees
   Control Bar Angle 2 degrees

4) Distance Sail to Crossbar n/a
5) Distance Sail to Keel n/a

6) Bridle Measurement 73.25 inside,105.625 outside (front wire at cap to trailing edge at batten)

7) Chord at Root + 3' 78"
   Chord at Tip - 3' 42"

8) Span of Sail 34' 10"

9) Bow In Leading Edge 4"
   Bow In Keel 0
   Bow In Crossbar 0

10) Placard Location keel
    Test Fly Sticker Location keel

11) Pilot Weight Range 160 - 260
    Pilot Proficiency Required III

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: Duck 200

1) Glider Weight 78
(lbs., with bag 84 lbs with optional steel control bar and kingpost
2) Leading Edge Tube
Length, Outside Diameter 249.125, 2
Holes at: .875, 139.875, 144.875, 239.875
Keel Tube
Length, Outside Diameter 130, 1.5
Holes at: 1, 3, 62, 63.75, 105, 106, 106.625, 107.25, 114
Xbar Tube
Length, Outside Diameter 127.5, 2.5
Holes at: .5, 2.5 each end
Kingpost Tube
Length, Outside Diameter 54
Holes at: .25, 1
Control Bar Leg
Length, Outside Diameter 67.5, 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: 1.40625

3) Washout Tip Angle 19 degrees
Control Bar Angle 2 degrees

4) Distance Sail to Crossbar N/A
5) Distance Sail to Keel N/A

6) Bridle Measurement 81.25 inside, 118.625 outside (front wire at kingpost cap to batten at trailing edge)

7) Chord at Root + 3' 87"
Chord at Tip - 3' 42"

8) Span of Sail 36.7'

9) Bow In Leading Edge 6"
Bow In Keel 0
Bow In Crossbar 0

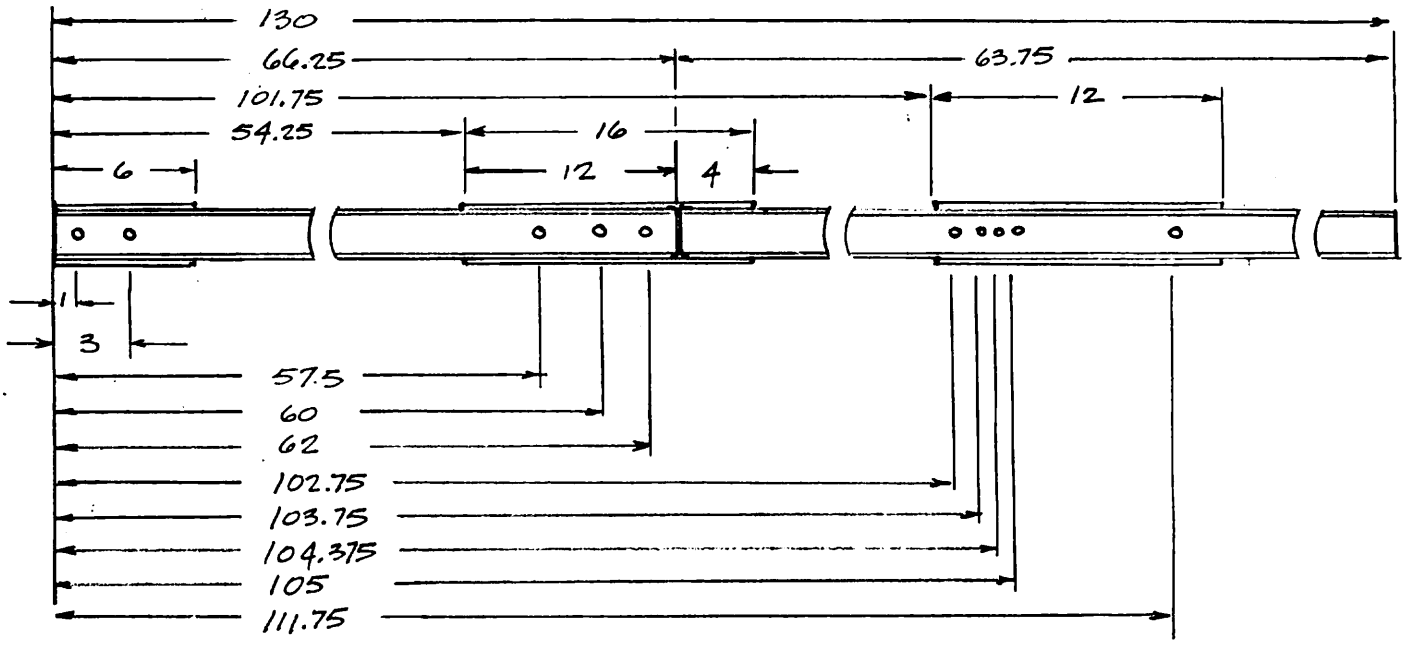
10) Placard Location Keel
Test Fly Sticker Location Keel

11) Pilot Weight Range 170 to 280 lbs.
Pilot Proficiency Required III

180 DUCK ALTERNATE KEEL CONFIGURATION

1/6/84 SK

SPLICE IN CENTER SLEEVE



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INDUSTRIAL SHEETING
SAILMAKERS HARDWARE

WET BLEEDING OF SAILCLOTHS

When either dyed Nylon or dyed Dacron sail fabrics are stored wet, the color will bleed or transfer from the colored to the white or even from a darker shade to a lighter shade. The wetter and more compressed the fabric, the greater the bleeding - such as stuffed in a sailbag.

You can prove this to yourself by twisting together tightly a narrow strip of white fabric and a narrow strip of a colored and placing them overnight in either fresh or salt water.

To prevent color transfer on your sails dry them as thoroughly as possible after using. Try not to store wet in sailbag for any longer periods of time than necessary.

To anticipate trouble, we suggest that your customers are made well aware of this fact.

HOWE & BAINBRIDGE, INC.

INDUSTRIEWEG 27, MIJDRECHT, HOLLAND TELEX A/C 844 18678
815 PRODUCTION PLACE, NEWPORT BEACH, CALIF. 92663 TELEX 678 438
350 5TH AVENUE, SUITE 3304 NEW YORK, N. Y. 10001
135 LAKE STREET SOUTH, SUITE 230, KIRKLAND, WASH. 98033

WILLS WING NEWS

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Santa Ana, CA 92701

INTRODUCING: WILLS WING NEWS

Welcome to the first issue of WILLS WING NEWS! In this and future issues you will find a wide assortment of information about the sport of hang gliding, the care and maintenance of your equipment, flying tips, and so forth. You are receiving WILLS WING NEWS because you purchased a Wills Wing glider, filled out your customer response form and sent it in. If you are a Wills Wing customer and are reading a borrowed copy of WILLS WING NEWS because your name didn't get onto the list, please send us your name, address, and glider model and serial number and we will add you to our list of subscribers.

This newsletter is for you. If you have any questions, comments, or if there are topics of special interest to you that you would like to see covered in WILLS WING NEWS, please write in and let us know!

SERVICE NEWS

This column will be devoted to important service information on *Wills Wing gliders*, harnesses, and other hang gliding products. If we need to issue airworthiness directives or product recalls, they will appear here as well as in Hang Gliding Magazine. Included in this issue will be a summary of recent glider modifications and advisories. First, however, a word about your relationship with your dealer and with Wills Wing.

If you have a problem or dissatisfaction with your glider, or with any other Wills Wing product that you cannot solve yourself (remember your owner's manual!), your next contact should be with your dealer. If he can't solve the problem, he will contact us, and we will help him solve it. If your glider has a turn, or flutter in the sail, or your harness isn't comfortable, don't assume that there's nothing you can do about it. Talk to your dealer, and if he can't figure it out, have him talk to us. We want to make sure that the products you buy from us are a source of satisfaction rather than frustration.

SERVICE ADVISORIES

1) GLIDER TUNING

A couple of quick tips on glider tuning:

a) Read Your Manual !!

b) If your glider has a few hours on it and the handling feels a little "loose", try pulling the sail back 1/4" on the leading edges. (Don't forget to re-align the sail plugs; Read Your Manual!). This will give you a little better performance, clean up the sail a little, and make the handling feel a little "more connected." (If it

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CHOOSING A HIGH PERFORMANCE GLIDER

There is one thing that almost all hang glider pilots have in common: they all want more performance! Where, in the design of a glider, does perfomance come from? Armchair designers are fond of throwing around terms like "aspect ratio", "twist", "induced drag", "percentage of double surface", "L/D", etc., and coming up with all manner of explanations for how they all relate to one another. There is a lot of folk wisdom about what makes gliders perform, and which gliders perform better than which others under which circumstances. The following is a brief, highly simplified, but accurate explanation to help you sift out the facts from the superstitions.

The first thing to realize is that performance is extremely difficult to measure accurately. It is impossible to "feel" the level of performance of a glider with any degree of accuracy by flying it. It is very easy to get fooled on this whole subject. Gliders with light pitch bar pressure will often give the impression to the pilot of having a "really good high speed glide." Gliders that are trimmed slow will feel like they "get a really good sink rate, but don't penetrate too well."

Another problem with measuring performance is that the difference in performance from one glider to another of the same model and size is often as much or more as the difference in performance of two different designs! This means that even if you do a highly controlled and valid comparison to measure the relative performance of two gliders, your results may be valid only for those two specific gliders and not for the models in general.

A third problem is that there are variables other than the glider which can affect performance; a difference in drag due to different pilot body positions is probably the most significant example.

All of these problems in measuring performance are present even in ideal circumstances; that is when two scientifically minded pilots are conducting a still air side by side glide comparison with the mutual goal of gaining objective information. In most situations in which performance is compared the variables are much more numerous and complex; varying lift and sink in the air, different skill levels of two pilots who are competing against one another and trying to "win," etc.

The end result of all this complexity is that you have to take anyone's conclusions about relative glider performance with a whole

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HOW DO YOU LAND THESE THINGS?

Your two hour soaring flight in your new high performance glider is coming to an end. It is the end of a beautiful day, and as dusk settles over the landing area, you carefully set up your approach. The wind streamer indicates light and variable winds at the surface. You come smokin' in, level off, and you notice that you're cruising across the landing area at about Mach 1! As you let the bar out and your arms begin to run out of length, and your speed does not significantly diminish, and the panic starts to rise, and you draw your feet up in front of you to cushion the impact and FLARE for all you're worth, and your life passes before your eyeballs, and you end up in a crumpled heap balled up in your once proud glider, you wonder: "What am I doing wrong?"

Has this ever happened to you? You can avoid this type of landing if you just keep in mind five basic principles of landing theory and technique:

1) Your new high performance glider is smaller and aerodynamically cleaner than your old "billow cruiser." With less twist and less area you cannot slow down prior to your flare as much as you used to be able to, and YOU SHOULD NOT TRY TO! Many nose ins are caused by pilots slowing down so much before they flare that their arms are fully extended, their glider is mushing and when they try to flare they get no response at all. If you are landing in light or no wind, you will still have considerable ground speed when the proper moment to flare arrives. The most important key to good landings on a high performance glider other than the execution of the flare itself is judging the proper moment to flare. There is a specific angle of attack and airspeed where your glider transitions from flying to "mushing". The difference is that

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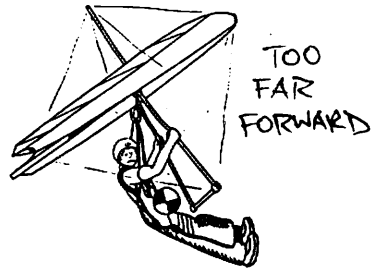
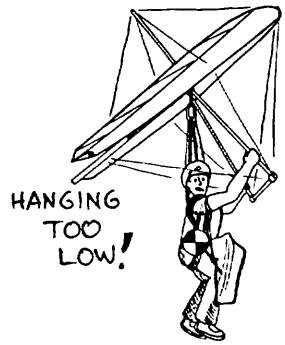
LANDINGS Continued from page 1

when you are flying, letting out the bar further will produce more lift, when you are mushing, pushing out on the bar further only produces more drag. You can demonstrate this for yourself by gradually pushing the bar out from trim while flying at altitude. Up until the onset of mushing, you will fly slower and slower as you push out, while your sink rate gets better and better. At the onset of the mush, although your glider probably will not undergo a "stall break", your sink rate will increase and your speed will no longer decrease. This is the realm you want to avoid during your landing, because it is quite possible to end up with your arms fully extended, with no reach left to flare, and with the same forward speed you had when the mush began! You must learn to judge this by the glider's angle of attack and those clues to angle of attack, such as airspeed and the glider's response to pitch input, and not by ground speed.

2) The speed at which you land is not primarily dependent on the speed that you are flying before you flare, but on HOW SHARPLY YOU EXECUTE THE FLARE! A sharply executed flare will rapidly raise the angle of attack of the whole wing right on through the range where any of the wing is capable of flying and into the realm where the entire wing is functioning as a drag brake. (See photo.) You can't flare sharply if your arms are already at full extension from trying to slow down.

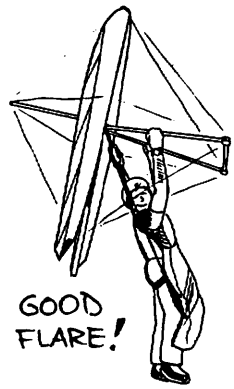


3) Any posture which brings your feet forward shortens your arms and interferes with a full, sharp flare. The reason is simple; prior to the flare the attainment of your minimum speed angle of attack will require a specific position for your body CG. If you draw your feet forward, you have to move everything else back to get the same CG position. Moving your shoulders back "shortens your arms" and makes it much harder to acheive a decent flare. Moral: don't bring your feet forward, let your body



incline forwards with your feet to the rear and your arms and shoulders forward. Bending your knees slightly to draw your feet up behind you, and flying down as close to the ground as possible prior to flaring seem to help in achieving the proper body position.

4) The effect that allows you to land on your feet with the glider resting under control on your shoulders, is the RAPID PRODUCTION OF DRAG CAUSED BY THE SHARP, NOSE HIGH FLARE. This causes the glider to stop suddenly, while your momentum swings you forward under the glider, bringing your feet underneath you and allowing the glider to settle BEHIND you, nose up, resting on your shoulders instead of continuing forward and nosing over.



5) PITCH AUTHORITY is what allows you to stand up your landing. This is why small gliders of the same model are usually easier to land than larger ones, even though you would think the smaller glider would land "hotter." Anything that gives you more pitch authority makes clean landings easier. Some of the things which help are: longer arms (see above for how to lengthen yours), smaller control bars (if you hang a little higher in your harness by shortening your leg straps and grab the same bar higher on the downtubes it becomes "smaller"!), and a more agressive PUSH at the proper time.

Finally, don't be afraid to flare a second time if you have any left. It may be just the extra you need to "stand it up."

-PERFORMANCE Continued from page 1

shaker full of salt. Many more people hunger for knowledge than are willing to do the work required to aquire it. Your best bet is to make many observations, few conclusions, and no assumptions.

If measuring performance is difficult, predicting it based on the configuration of the glider is impossible. It is completely sound, from a theoretical point of view, to say that increased aspect ratio tends to produce higher performance, that increased percentage of double surface tends to yield better performance at lower angles of attack (higher speeds), etc. The only problem with this theoretical information is that it is largely useless in predicting the performance of a given glider by looking at it. The current list of available models of hang gliders is full of examples which "violate" these rules, not because the rules are wrong, but because they address only a small part of a large and complex picture. One of the most important variables affecting this performance picture is the mysterious variable known as "twist". It is mysterious because you usually can't see it. With the glider on the ground you can't see it at all because the flexible membrane wing has a different shape than it does when loaded and flying. With the glider in the air you can only see it when you are positioned directly behind the glider you are viewing, and this situation usually only lasts for a brief moment. Even then, what you are seeing is not the twist but the "profile" which relates to the twist a little differently on each different model of glider.

"Your best bet is to make many observations, few conclusions, and no assumptions"

One factor you can relate to which has a large effect on twist is the tension in the sail. Twist in flex wing sails is controlled by sail tension, the more tension the less twist. This is why competition pilots sometimes favor exotic cloths using some form of mylar film (tempercoat, sandwich, etc). The mylar is highly resistant to stretch, and allows the pilot to increase the sail tension more and squeeze an extra half a percent of performance out of the wing. This reduced stretch of the cloth and the increased tension in the sail usually exacts a high price in handling response in exchange for the small gain in performance. This is why most competition and recreational pilots favor the normal woven sail cloth.

Sail tension by itself is not a good predictor of glider performance either, however, because different planform configurations require different amounts of tension to produce the same twist. In general, the higher the aspect ratio the more tension is required in the sail to limit the twist.

Continued on page 3, column 2

GLIDER BARGAINS!

Your dealer has a list of inventory, slightly used gliders now available from Wills Wing at tremendous savings! If you are looking for a new glider but can't quite afford a brand new Wills Wing, see your dealer about a bargain on a slightly used, factory re-conditioned and test flown Wills Wing!

SERVICE Continued from page 3

more thing to consider. Listen carefully. If you have your glider fully assembled, resting on the control bar, and you disconnect the nose wires and rock the glider forward to lay it flat on the ground without disconnecting the control bar apex from the keel, YOU WILL PROBABLY BREAK THE CROSSBAR! You will also bend the U channel and bolt as previously discussed, but you probably won't notice because you will be so astounded by your broken crossbar. The reason for the crossbar failure in this situation is that the wires connecting the control bar corners to the leading edge / crossbar junction go UP AND FORWARD from the basetube to the end of the crossbar. Swinging the basetube rearwards with the control bar apex still attached creates TREMENDOUS tension in the side wire loop; enough to cause a compressive failure of the crossbar. It's enough to ruin your day.

4) SIDE WIRE FAILURES

Want to have one? All you have to do is set up your glider with the side wire thimble cocked on the control bar eyebolt. When you tension the crossbar, the tension in the side wire will put a sharp bend in the cable just outside of the nico. Then, over a period of time, the normal tensioning of the cable will fatigue it, and it will eventually fail. If you EVER kink a wire under tension, replace it.

5) BENT LEADING EDGES

Do you have one? You'll never know unless you pull your sail! A bent leading edge may offer no visual evidence and may not put a turn in the glider or otherwise change the flight characteristics of the glider. If you have reason to suspect frame damage, get your sail off the frame and take a look!

6) CONSTRUCTION DETAIL CHANGES - ALL DUCKS AND HARRIERS

The following have become standard procedure at the factory and are recommended as retrofits. Your dealer can assist you with these no cost modifications.

1) Replace the low profile nylock nut on top of the noseplatte with an AN 310-4 castle nut and small safety ring. This will require drilling a 1/16 inch hole in the AB4-25 special shouldered bolt, so that it will acept the safety ring.

2) Insert the AN4-21A bolt which secures the control bar U channel to the keel from the bottom of the keel instead of from the top. (This makes it possible to pre flight this nut / bolt assembly without removing the "E" bracket from the U channel, and reduces the chance that improper set up of the glider will bend this bolt or strip the nut.)

STOLEN !!!

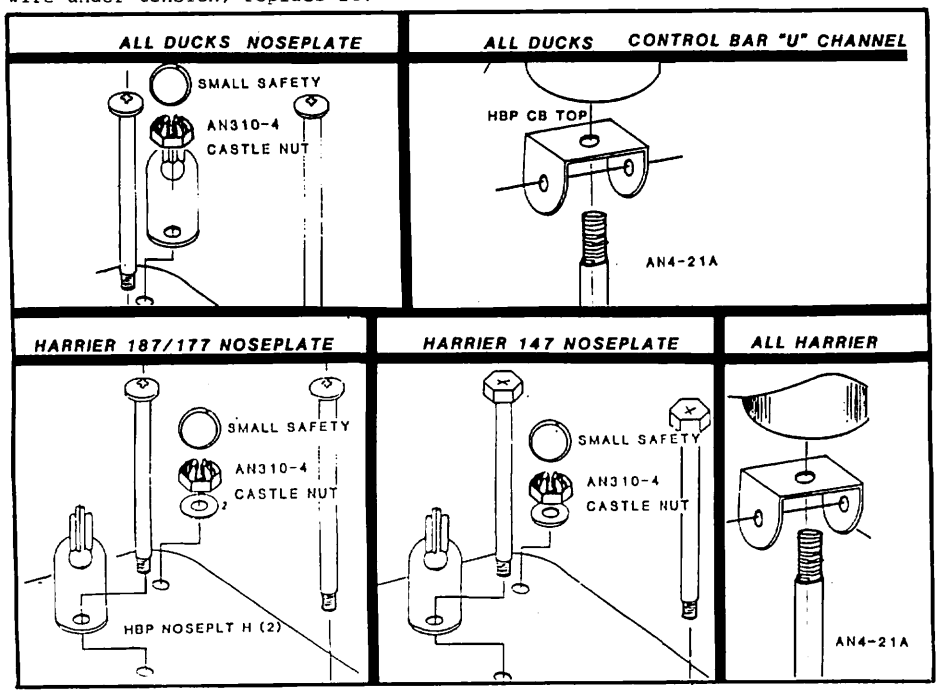
1982 WILLS WING DUCK 180 #10486

Sometime in Jan. / Feb. 1983 from BUFFALO SKYRIDERS' Shop

Colors:Black Front Body, top & bottom, spectrum wedge, white trailing edge.

********POSSIBLE REWARD ******

Contact: Buffalo Skyriders
PO Box 4512
Albuq. N.M. 87196
(505) 821 - 6842



WILLS WING SUMMER TOUR '83

The soaring season is upon us, and Jim Shaw is on the road for his second year as Wills Wing's Factory Representative, bringing the best from Wills Wing to every corner of the country. With a full schedule of Demo Days, Fly-ins, and parties, Jim promises to offer the most compresensive view of Wills Wing products ever. Contact the Wills Wing Dealer in your area for more information about Jim's exact itinerary so you won't miss the fun!

Fri, April 8 thru Mon, April 11	Kitty Hawk Kites Showcase Nag's Head, North Carolina
Wed, April 13 thru Fri, April 15	Sport Flight Demo Days Gaithersburg, Maryland
Fri, April 22 thru sun, April 24	Aerial Techniques Demo Days Ellenville, New York
Fri, April 29 thru Mon, May 2	Morningside Demo Days Claremont, New Hampshire
Fri, May 6 thru Mon, May 9	Eastern Ultralights Fly-in Hammondsport, New York
Tues, May 10 thru Thurs, May 12	*Hawk Air Sports Demo Days* Knoxville, Tennessee
Wed, May 26 thru Sun, May 29	Hensen's Gap Fly-in (Crystal) Chattanooga, Tennessee
Fri, June 3 thru Sun, June 5	Airtime Hang Gliders Demo Days Fort Smith, Arkansas
Tues, June 7 thru Thurs, June 9	Wings and Things Demo Days Saint Louis, Missouri
Fri, June 10 thru Mon, June 13	Aerosport Ultralights Demos Kansas City, Missouri
Fri, June 17 thru Mon, June 20	Northern Sun Demo Days Saint Paul, Minnesota
Thurs, June 21 thru Sun, June 26	Golden Sky Sails Demos Golden, Colorado
Fri, July 8 thru Mon, July 11	Wasatch Wings Demo Days Salt Lake City, Utah
Fri, July 15 thru Sun, July 17	Idaho Demo Days Boise, Idaho
Fri, July 22 thru Sun, July 24	Sport Flight Unlimited Demos Missoula, Montana
Tues, July 26 thru Fri, July 29	Sky Riders Demos Days Moscow, Idaho

WILLS WING

1208H E. Walnut, Santa Ana, CA 92701
(714) 547-1344/6366

WILLS WING FOR '83!

For 1983 Wills Wing offers a superb line up of gliders at exceptional prices.

THE DUCK

Winner of the 1982 US Nationals and 1982 Southern California Cross Country Competition, the Duck is a better value than ever in 1983. All 1983 Ducks come standard with an access zipper in the lower surface, allowing for easy access to the interior of the double surface. You can inspect the hardware inside, store your glider bag in there, or, as was done recently by a designer we know, park your head up in there when it rains! Some fun!

Seriously though, the new Ducks are looking and flying better than ever. We have held the price on inventory sail patterns at 1982 levels ($1995 for 180's and 160's, $2095 for the 200). All 1983 gliders that we know of with comparable performance (and some we know of without comparable performance) are selling now for $200 to $500 more than this. Your dealer has a list of a wide variety of inventory patterns in stock, or, if you'd rather spend an extra $100 and have a custom choice of sail colors or materials, your dealer can show you samples of sail cloth and help you make your selection. Delivery times are still quite reasonable even on custom sail choices (even quicker on inventory gliders), so see your dealer soon if you're considering a new glider this spring.

THE HARRIER

Still the best performance per unit dollar bargain in the industry, the Harrier continues to be especially popular for economy minded recreational pilots looking for a maximum of soaring enjoyment for a minimum of hassle and expense. The Harrier is light in weight, light in handling, light on your wallet, and yet offers a level of performance unmatched by any intermediate glider you can buy at any price. Whether you like cruising around the top of the pack at your local soaring site, or setting off downwind for a cross country adventure, the Harrier provides an unmatched level of "total performance" for a truly reasonable $1675 when purchased from inventory, without mylar. For $1895, you can have leading edge mylar and your choice of sail colors.

QUALITY ALL AROUND

All 1983 Wills Wings come with the industry's most comprehensive owner / service manual, and are backed by the industry's largest network of professional, factory supported service dealers. In addition, all 1983 Wills Wings that use white cloth in the rear body will be made with Howe and Bainbridges new, high performance 4.5 ounce sail cloth. This is the tightest woven fabric, regardless of cost, that Howe and Bainbridge can make. It should provide increased resistance to wear and stretching, and prolong sail life.

Continued from page 2

By now you must be wondering how to choose a glider if performance cannot be felt or predicted, and is so difficult to measure. Actually, it is not that hard. You will probably find yourself in one of two situations:

1) Someone is paying you to fly.
2) You are paying for your own flying.

In case #1, it's easy, you fly what they tell you to fly! No problem, right? In case #2, since you are not being paid to fly, you must be flying for enjoyment, right? Your choice of glider should be based on what will be the most enjoyable glider to own. Of primary importance is doing business with a dealer and a manufacturer that you can trust, and who can provide you with quality service when you need it. Also important is to choose a glider you will enjoy flying; one with pleasant, responsive handling characteristics. It's performance should be of a demonstrated level that at least will not hold you back from accomplishing what you want to in your flying. A demo flight can be a real help here, as can talking with other pilots about their gliders.

"One thing you should not do is choose a glider on the basis of its 'on paper' specs, or by how 'high performance' it looks."

One thing you should not do is choose a glider on the basis of its "on paper" specs, or by how "high performance" it looks. Unless of course you plan to spend most of your time just looking at it!

SERVICE Continued from page 1

makes the turn response unacceptably stiff, the sail tension was correct before you tightened it and you should return it to that setting.)

c) Check the tension on your inboard battens (the ones with fiberglass rear shafts). These should be noticeably looser than the outboard battens; if they are too tight they will stiffen the handling unnecessarily. There is no known penalty from having them a little loose. If you notice wrinkles in the root section of your sail, you have them too loose.

2) WET GLIDERS WILL BLEED!

If your glider gets wet, dry it completely at the soonest opportunity. Wet sail cloth, webbing, etc. will bleed under certain circumstances, and the longer a glider is left rolled up wet the more likely it is to bleed.

3) GET TO KNOW YOUR E BRACKET

The apex bracket on your control bar, what we refer to as the "E" Bracket, is a beautifully simple and functional piece of hardware when used as it was intended to be. HOWEVER, you will suffer uncomfortable consequences if you fail to recognize its limitations! The bracket was not designed to rotate about a lateral axis with respect to the keel. The only proper way to rotate the control bar legs with respect to the keel is to allow them to swing apart as they rotate away from the keel, and to swing together as they rotate back towards the keel. That is the only type of rotation the bracket will allow. If you try to rotate the assembled bar with the apex attached to the keel, you will bend the apex U channel and the bolt which attaches it to the keel. If you try to deploy the legs of the bar away from the keel without allowing them to spread, you get the same result. Now, there is one

Continued on page 4, column 1